Skills for the Future
SKILLS FOR THE FUTURE
NEW RESEARCH PERSPECTIVES
KRUS | WILDSCHUT | PETERSEN
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Abbreviations

AERAP African-European Radio Astronomy Platform
AgriSETA Agricultural Sector Education and Training Authority
CRT Crafts and related trades
DHET Department of Higher Education and Training
DST Department of Science and Technology
EU European Union
FET Further education and training
HCDP Human Capital Development Programme
HR Human resources
HSRC Human Sciences Research Council
ICT Information and communications technology
ILO International Labour Organization
IMF International Monetary Fund
ISO International Organization for Standardisation
LMIP Labour Market Intelligence Partnership
merSETA Manufacturing, Engineering and Related Services Sector Education and Training Authority
NASSP National Astrophysics and Space Science Programme
NQF National Qualifications Framework
NRF National Research Foundation
OECD Organisation for Economic Co-operation and Development
OEM Original equipment manufacturer
PLC Programmable logic controller
PMOA Plant and machine operators and assembler
PSET Post-school education and training
QLFS (Quarterly) Labour Force Survey
R&D Research and development
Sasa South African Sugar Association
Sasri South African Sugar Research Institute
SETA Sector Education and Training Authority
SKA Square Kilometre Array
SMRI Sugar Milling Research Institute
SSI Sectoral system of innovation
Stats SA Statistics South Africa
STC Shukela Training Centre
TVET Technical and Vocational Education and Training
UK United Kingdom
USA United States of America
CHAPTER 1

The need for new kinds of research

Glenda Kruss and Angelique Wildschut

For many years in South Africa, providers of education and skills training decided what programmes and qualifications to offer, and young people decided what courses to study, based on their own preferences, capabilities and financial resources. We now find higher education graduates who struggle to access available jobs, severe shortages of artisans and professionals with high-level skills, outdated intermediate-level curricula that do not equip people with the new technological skills required in rapidly changing workplaces, a post-school education and training (PSET) system that does not facilitate progression and mobility, and a large group of unskilled youth who are not working in the formal economy, and whom many regard as unemployable. Such critical problems constrain inclusive growth and socioeconomic development, and restrict opportunities for young people, particularly those who are women, African and located in rural areas and informal settlements.

Contemporary economic and political conditions in South Africa continue to yield a bleak outlook, despite initial post-apartheid optimism and belief in the possibilities that development holds for transformation. Unemployment and inequality are high and rising, and growth is very low, stalled not least by a destructive politics of patronage and corruption. What limited growth there is emanates from capital-intensive industries and a rapidly growing services sector, while primary and secondary sectors are shrinking and undynamic (Bhorat et al. 2014a). A striking indicator is that around 50 per cent of the labour market is employed in the government and community services sectors (Reddy et al. 2016).

National dynamics play out in the context of major economic shifts globally, characterised by the growing concentration of wealth to the benefit of a few (Boushey et al. 2017; Piketty 2014), the financialisation of economies (and growing volatility arising from the impact of financial speculation on national economies), the globalisation of production and the increasing significance of formal knowledge, technology and innovation. These dynamics drive major transformations in the nature of work, giving rise to new occupations and professions, and changing labour markets significantly, potentially accelerating and deepening unequal outcomes. Indeed, there is an emerging global concern to anticipate the implications of a ‘fourth industrial revolution’ (Schwab 2016) – technological automation, digitisation and artificial intelligence – for the future of work and, in turn, the post-school education, training and skills required to respond to changing labour force and labour market demand.

In these conditions, we need to be careful not to adopt contextually inappropriate models of skills planning and skills development from advanced economies with different development trajectories. During the period of transition from 1990, there was extensive borrowing from the UK and Australia to shape new national skills policies (Christie 1996; Jansen 2004; McGrath & Badroodien 2006). The consensus has been that a lack of critical skills, or a skills mismatch, is a ‘binding constraint’ on development, and
numerous national strategies have proposed skill targets (Badroodien 2004b; Kraak 2004a, 2004b; Kraak 2008a, 2008b; Kraak & Press 2008). Targets are typically determined on a very weak evidence base and with little regard for the capacity of the post-school system to reach them. The human capital theory underpinning these policies purports to determine what skills are likely to be required by key sectors, so that the education and training system can respond by producing the requisite scale of human resources to match skills needs. The assumption, typically, is that there will be a ‘trickle-down’ effect to the poor, the unemployed and those who are uneducated or without marketable skills.

However, even conservative global financial agencies have been forced to recognise that current growth models exacerbate inequality and widen the gap between the privileged and the excluded (OECD 2012). Innovation and technology have complex impacts on skilling, in some instances deskill-ing and excluding segments of the formally employed population and, in others, upskilling and empowering segments of the unemployed population. Matching skills supply and demand is therefore not a simple econometric exercise.

We need different approaches to understand the relation between skills and the economy, driven by different assumptions. These assumptions should confront the high levels of structural unemployment; aim to increase opportunities for mobility out of poverty for larger segments of the South African populace and to transform social relations resulting from decades of inequality; and respond to the volatility and changing nature of work and jobs, arising from global economic relations structured to the benefit of advanced economies.

The need for new kinds of research

The research base to inform our thinking in response to contemporary and future development challenges remains very thin. Oliver et al. (2016) show that human capital theory has tended to dominate as the most influential approach for understanding skills, education and training and their relation to employment and employability. The emphasis lies on determining the ‘returns to training’ for individuals, firms and training providers. Criticism from those working with institutionalist approaches from the 1990s led to a new focus on labour demand, the state and other key organisations like firms and trade unions (Ashton & Green 1996; Brown et al. 2001; Finegold & Soskice 1988). Key strands of theoretical work here are the Varieties of Capitalism school (Hall & Thelen 2009; Soskice & Hall 2001) and the skills ecosystem model (Pickett & Cadenasso 2002; Windsor & Alcorso 2008). More recently, those working within the ‘capabilities’ approach have questioned the value of economic growth if the benefits are not shared widely, in the face of growing inequality and poor quality of life for most people (Boni & Walker 2013; Walker & Unterhalter 2007). Here, the focus is on understanding skills shifts to consider individual capabilities and agency, broadening out to consider knowledge, skills and attributes in relation to work arrangements (Walker & Fongwa 2017). Over the past two decades since the democratic transition in South Africa in 1994, we find similar theoretical trends—a human capital model that prevails to inform skills planning, despite vigorous critique.

One such critical strand in the research literature on skills and development in South Africa was strongly influenced by the political economy of skills approach, specifically the Varieties of Capitalism school. The key concept of high-skill equilibria (Brown et al. 2001; Crouch et al. 1999) was used to analyse South African conditions (Ashton 2005; Edwards 2001; Kraak et al. 2006; McGrath et al. 2004). The developmental challenge was defined in terms of finding mechanisms to shift the ‘low-skills equilibrium’ in which the South African economy and education system were trapped towards a high-skills equilibrium that would promote global competitiveness and growth, following the model of successful Asian economies. The institutionalist approach promoted in this literature led to a focus on the non-market institutional arrangements required to support high-skills and high-performance workplaces.
and take into account the South African realities of low skills and unemployment, particularly joined-up policy-making and governance (Kraak 2004a, 2004b).

The empirical focus of much of this research was on dynamics at the macro-level of the state and the market. Research explored how education, labour market and economic policies could be integrated more effectively and how cross-sectoral policy driving socioeconomic reforms could be coordinated and planned in a ‘joined-up’ manner to ensure more effective implementation. One trend was to track how human resources (HR) development policies were integrated with government policy initiatives and programmes, as they evolved after 1994 under different leadership regimes (Kraak 2004a, 2004b, 2005; Kraak et al. 2006; McGrath & Akoojee 2007; McGrath & Badroodien 2006). A second trend was to gather data to measure the equilibria between education supply and the demand from the world of work, in sectors and occupations that are key to economic development (Cosser et al. 2003; Daniels 2007; Erasmus & Breier 2009; Kraak 2003, 2009; Kraak & Press 2008).

A second critical strand in the South African literature emerged more recently, focused on a critique of the dominant consensus around jobs, growth and employability, as shaped by global agencies (Vally & Spreen 2014). This literature critiques the way in which the relationship between education and work is typically conceptualised in policy and research (Allais 2012a). The policy discourse is seen to be dominated by a narrow economic reductionist focus on building human capital and promoting instrumental job-specific learning and competencies (Baatjes 2018). For example, the adoption of the concept of employability from the dominant skills models is seen to lead to a tendency to place responsibility on the individual who is not adequately educated or trained to get a job, rather than to recognise the impact of high levels of structural unemployment (Wedekind 2013a). Instead, these authors argue that skills development cannot drive economic change and job creation or resolve socioeconomic problems in the conditions of an emerging economy like South Africa’s (Allais 2012a, 2012c; Vally & Motala 2014). The call is to reconceptualise the relationship between education, skills and society to the benefit of those suffering most intensely the effects of poverty, unemployment and inequality. Some have turned to the capabilities approach to reconceptualise the ways in which vocational education can contribute to poverty alleviation (Powell 2012).

Here too, however, much of the empirical focus of research is at the macro-level of the state and the formal labour market, with analysis tracing policy intent and unintended consequences in skills development, and how the system should ideally be configured. A recent work by a group of scholars (Baatjes 2018) offers a welcome departure, questioning the ‘fit’ with formal education and training and trying to imagine alternative, more valuable educational futures. These authors start from the perspective of the lived experience, knowledge and culture of local communities as they make meaningful (informal) livelihoods.

Nevertheless, the predominant trends remain; the skills planning and development literature in South Africa either explores ways to build skills more effectively to promote inclusive growth or critiques the role that skills can play in inclusive development. Either way, the emphasis has been on formal structures, and at the macro-level: on the state, its policy instruments and its role in equitable development.

A research gap

There is a big gap in understanding skills needs at the meso- and micro-levels. We lack research evidence and insights from the actors involved in firms and production processes, higher and vocational education and skills training systems, and those responsible for implementing policy in specific sectors or regions. And, as Baatjes (2018) shows, there is a major gap in understanding the education and training needs of those outside of the formal economy or employment. South Africa has developed a strong
education, training and skills policy, setting admirable objectives and creating complex structures and funding mechanisms to achieve these (DHET 2013c; DoE 1995). However, we do not have a substantial understanding of what has changed on the ground in skills planning and development over the last 20 years, nor how key actors are positioned to respond to the changing skills demands of the future. How is work actually changing in different sectors in South Africa and how does this reflect shifting global patterns? What is its impact on the skills required by new forms of occupation and profession, and on education and training? What are the implications for skills and inclusive development in the future? Where and how is PSET aligned with or disconnected from labour market demand, and to whose benefit – private sector growth or national development and equity goals? How are development goals shared by skills networks? What are the capabilities of actors in skills systems, at different scalar levels, to address these development goals? What contextually appropriate skills planning models can we identify that have evolved in practice?

Theoretical experimentation

This book aims to contribute to the contemporary endeavour to address this gap, drawing on conceptually informed evidence from South Africa. The core is based on a set of experimental and innovative studies conducted by research teams from the Labour Market Intelligence Partnership (LMIP). The LMIP was funded by government to inform its attempts to build a centralised mechanism for skills planning. A review of the ‘state of the art’ of research in relation to key policy concerns was conducted in 2012, informing the focus and approaches used for multiple research projects organised under six themes.¹ The LMIP produced a significant body of labour market information and research to strengthen the South African evidence base for skills planning over the medium to long term. Researchers proposed an architecture and framework for decision-making, skills planning indicators and methodologies (Reddy et al. 2016; Reddy et al. 2018), and skills forecasting (Adelzaideh 2016). New labour market information datasets and systems were accessed, designed and piloted, to be further developed by the Department of Higher Education and Training (DHET) (Bhorat & Kimani 2017; Bhorat & Naidoo 2016; Bhorat & Pillay 2017; Bhorat et al. 2017; Cassim et al. 2016; Kerr 2013; Paterson et al. 2015; Reddy & Powell 2015; Woolfrey 2013). The LMIP was influenced by the prevailing skills planning approaches promoted by agencies such as the Organisation for Economic Co-operation and Development (OECD 2016) and the ILO (Aggarwal & Gasskov 2013), but with a core intention to be informed by the South African context in terms of the profile of its population, economic conditions, sectoral nuances and historical legacies.

The main analytical contribution of the LMIP was a contextually informed framework focused on the complexities of skills supply, demand and mismatches in South Africa, and not on assumed relationships drawn from international experience or knowledge:

In this approach, signals on current and intermediate demand for skilled, semi-skilled and low-skilled occupations are interpreted. An understanding of skills demand involves an exploration of three inter-related aspects: the characteristics of the employed and unemployed who make up the labour force; the state of the economy; and current and intermediate demand from the analysis of changes in the structure of employment. We juxtapose the signals of demand against the supply of skills coming out of the formal school education system, the post-secondary education and training systems and also the workplace. The interaction between supply and demand provides the basis for interpreting signals on the nature and extent of skills shortages and mismatches facing South Africa. Only through understanding the complexities of how demand and supply interact is it possible to guide future investments and interventions, as well as support a move towards a more inclusive skills development path. (LMIP 2016: 6)

¹ www.lmip.gov.za
Some research teams were critical of the limitations of human capital theory and sought to go beyond it, in order to illuminate dimensions of skills and development in a complex and historically unequal context. These projects aimed to contribute critical ‘labour market intelligence’ on under-researched, highly complex themes: the changing nature of work and occupations, attitudes to employment (Mncwango 2016), institutional responsiveness and interactive capabilities, and transitions to the labour market (Broekhuizen et al. 2017; Isdale et al. 2016; Papier et al. 2017; Rogan et al. 2015).

Research leaders adopted conceptual and analytical frameworks that had not yet been extensively used to think about issues of skills in South Africa, and experimented with their appropriation in this context, and the insights possible. They conducted fresh and ground-breaking research from a range of disciplinary locations: sociology of education, sociology of knowledge, sociology of work and occupations, or curriculum studies.

Some adopted the innovation systems approach, to explore how the actors and capabilities in skills development networks support growth in the interests of the private sector, or whether it is possible to support more inclusive socioeconomic development imperatives (Gastrow 2015; Kruss et al. 2015; McGrath 2015; Petersen 2015). Some worked with a skills ecosystem approach to throw new light on issues of responsiveness and employability (Wedekind & Mutereko 2016a, 2016b). Others sought to build a more robust understanding of the contextual factors impacting on the need for skills, historically, in terms of changing occupational jurisdiction, work identities, and knowledge and skills bases (Gamble 2016b; Mbatha et al. 2014; Wildschut et al. 2016a, 2016b, 2017).

The chapters in the book use these concepts to analyse skills development structures, processes and dynamics, whether located in universities, technical and vocational colleges, or workplaces, focusing empirical analysis on dynamics at the meso- and micro-levels. The objective is to inform skills planning and development in ways that more clearly reflect the complex realities of South African conditions, in a rapidly changing global context.

**Methodological exploration**

Skills planning typically takes the form of quantitative analyses of sectoral demand and education and training provision, to assess alignment, mismatches and gaps, of ‘skills in high demand’ or ‘critical skills lists’. In contrast, our research used multi-scalar, in-depth comparative qualitative case studies, employing a range of techniques and methods to create new datasets that allow new insights.

Methodologically, the authors share a common commitment to exploratory qualitative case studies that delimit their empirical focus with a sectoral, occupational and/or regional lens. The chapters each provide rich in-depth data that reflect the differences and complexity of skills and development in a sectoral and spatial context, to reflect real-life conditions (as far as possible) more effectively. This shared methodology aims to enable an integration of evidence of dynamics at the micro-, meso- and macro-levels, in a more holistic and systemic manner than has been evident to date. To this end, a degree of synergy was built into the selection of sectors and occupations. All projects included the automotive sector, some included the sugar sector, some included the field of mechatronics, and some were distinctive: astronomy, forestry, boatbuilding and film-making.

Policy-makers typically have a bias against such qualitative data, on the grounds that they are not representative or generalisable, and hence not easily adapted to inform interventions and strategies. The generalisability of case study research can be enhanced in a number of ways, such as thick description of each case as a basis for comparison; selecting case studies purposefully to reflect key dimensions of...
skills for the future

skills development; or conducting multiple case studies in different settings, using the same research approach and collecting the same data in a structured manner.

The chapters in this book will show the value of multiple comparative case studies for illuminating the complexity and non-linearity of skills processes. From the outset, the plan was to analyse across the case studies once they were completed, in order to investigate critical issues comparatively. For example, if we compare how well each sectoral system meets its skills needs, we may be able to identify organisational forms that work well, and that can be of wider relevance and application in other sectors and settings. If we synthesise across the cases to investigate what is common to the changing requirements for artisans across the trades, we can identify targeted incentive mechanisms and interventions that may be significant for wider use in apprenticeship training.

Abstracting from the analysis of empirical patterns, we may thus gain insight to inform policy to strengthen skills matches and enhance the role of education and training. Such insights are extremely valuable for use alongside quantitative datasets for interpretive purposes, but a strong case can be made for the value for skills planning of qualitative data in its own right. One of the contributions of the LMIP is that the partnership was created between a government department and a consortium of researchers. There were extensive efforts in terms of policy engagement and working at the research–policy nexus. The research process included engagement through policy roundtables, and the preparation of user-oriented outputs such as policy briefs, policy guides and research guides. The research guides are of especial methodological importance. For the case study research, the research design, methodology and instruments were curated into guides and templates with clear instructions, which can be used by other researchers. Such templates potentially facilitate the creation of large-scale qualitative datasets across diverse settings, to inform skills planning. Overall, reflecting on the type of policy insights made possible, the authors show the important contribution that a small number of qualitative sector studies can make to skills planning.

A shared reflective orientation

Although the authors of the chapters have different starting points, each has clear theoretical commitments, and attempts to extend and stretch these. Each chapter is structured in response to a set of reflective questions:

• What is the theoretical model adopted, and how was it extended, deepened or adapted for use in the South African context?
• What new empirical insights were possible using this approach?
• How does the approach inform an understanding of the relationship between skills development, skills planning and inclusive development in the current South African context?

Here, we describe how each chapter engages with the questions.

Part 1: Introduction

Chapter 1 identifies the research gaps at the meso- and micro-levels that shaped the research agenda and approaches.

Writing from years of experience in the Australian context, in Chapter 2 John Buchanan challenges South Africans to reflect on three simple threshold questions to position ourselves better in terms of skills planning and its intended impact: Planning for what? Planning about what? Planning with what? Essentially, he argues that for skills planning to contribute to desirable and sustainable trajectories of economic and social development, it is important to understand, first, the political-economic and social situation of interest, second, the objectives of priority interests and, third, the capacity of
institutional arrangements available to implement policies. With a view to shifting unequal relations and outcomes, he adds another critical question: Planning involving whom? Buchanan’s chapter raises critical questions that could catalyse planning and research to inform new approaches in South Africa.

Part 2: New analyses of work, occupations, institutions, employability and responsiveness

Through the presentation of empirical findings, the four chapters in Part 2 offer powerful critiques of narrow conceptualisations of skills, knowledge, occupation, employability and responsiveness, especially as these are typically used within current PSET planning. Essentially, the shared question remains: How do we understand the alignment between skills supply and demand as we intend to shift traditional assumptions of the skills and work relationships towards a more inclusive developmental approach for skills planning?

Chapter 3, by Angelique Wildschut and Tamlynne Meyer, argues that conventional human capital approaches are often ill-equipped to inform appropriate skills planning, as they do not take into account changes to the nature of work and occupations at the meso- and micro-levels in any meaningful or empirically informed way. Their contribution is to interrogate how work itself is changing, and the impact of such changes on the skills required to practise an occupation. The chapter shares evidence from a study of workplaces, which assessed how the changing nature of work affected the demand for different kinds of artisanal skills within firms across different industry sectors: mining, automotive and metals. The analysis illustrates that work change is complex, and that its relation to artisanal skills demand is not a linear process. The chapter highlights the value of focusing on organisational and occupational cultures in order to inform our understanding of the actual skills that firms require, and how these are shaped by complex workplace dynamics, as opposed to the formulation of generic competences.

Chapter 4, also by Wildschut and Meyer, builds on the insights from the previous chapter to highlight how employing an occupational lens can also be useful in elucidating the maintenance of social difference and inequality within workplaces. Together, Chapters 3 and 4 point to the concept of occupation as socially constructed, and caution against its simplistic application in supply-side planning.

Chapter 5, by Wildschut, draws from the key assumption that the rhythm and dynamics of a sector determines its organisation of work and labour processes, which feeds into the actual skills needs within different firms. It highlights how an understanding of labour process variations and their impact on diagnostics and problem-solving at the intermediate level provides a solid basis for supply-side planning, which does not take an ‘imaginary curriculum’ as starting point but refers to actual work processes and their differences in large and small enterprises.

Volker Wedekind, too, in Chapter 6, addresses the questions of alignment or disconnection between labour market demand and skills development at the meso- and micro-levels, but from the vantage point of PSET providers. Highlighting the constant pressure that PSET organisations are under from policy-makers, political actors and the public to make their programmes responsive to the needs of the economy and society, this chapter examines how educational organisations respond, and what makes their response effective or ineffective. Wedekind shows convincingly that making sense of the diverse ways in which responsiveness works, and the ways in which PSET organisations can enhance the employability of their students, requires an analysis of the ways in which educational processes are institutionalised. Informed by an institutionalist approach, the chapter uses a series of case studies

2 In many countries the term ‘artisan’ is used to describe a craft worker associated with traditional art or handwork. In South Africa, the notion of an artisan is strongly related to a particular type of industrial work and the skills are strongly associated with manual work.
in three industry sectors to demonstrate the ways in which policies, organisations and practice become institutions that have regulatory, normative and cultural-cognitive elements. Focusing on the mechanisms that strengthen or weaken the ways in which practices become institutionalised highlights the diverse ways in which employers, policy-makers and education providers interact within a field and what the consequences are for the employability of students, in a way that is more grounded in reality and, hence, what is possible to change.

Part 3: New ways to think about designing and resourcing effective institutional arrangements for skills planning and development

In Part 3, we present a set of chapters that draw on a shared conceptual framework and methodology using an innovation systems approach, which has not yet been used systematically or widely in South Africa to inform skills planning. Here, the focus shifts slightly, to provide evidence that can inform new ways to think about designing and resourcing effective institutional arrangements for skills planning and development.

Chapter 7, by Glenda Kruss and Il-haam Petersen, lays the foundation for the chapters in Part 3 by explaining the conceptual framework designed for a set of case studies grounded in innovation theory. This approach has not been widely used to analyse skills development, but it yields significant insights for skills planning.

In Chapter 8, Michael Gastrow, Kruss and Petersen attempt to understand how education and training are aligned with labour market demand from the perspective of both firms and PSET organisations, by analysing interaction within a sectoral system of innovation. The chapter offers a micro- and meso-level analysis of a national skills planning and development programme in the astronomy sector, reflecting on a 10-year period of structured investment in the skills required to design, build and operate the Square Kilometer Array (SKA) telescope. It examines how the main actors in the innovation network responded to changing demands in the science and engineering skills domains, with the main focus of analysis being the interactive capabilities of, and the intensity of interactions between, these actors. The main contribution is the explanation of the nature of these dynamic interactive capabilities built within the SKA network, to facilitate the achievement of shared skills planning and economic development goals. Through this case, the authors also remind us that South Africa’s inclusion in global scientific discovery and technological progress is critical, but remains in tension with its commitment to inclusive development.

Using the same conceptual approach, in Chapter 9 Petersen and Kruss add further insights to the question of alignment by evaluating the role of intermediary actors in strengthening a skills network. The empirical focus is the capital- and labour-intensive sugar sector, which contributes significantly to the economy and employment in impoverished rural areas. The case is directly relevant to understanding a skills regime that can promote inclusive development, because the sector experiences changing skills needs at the full range of basic, intermediate and high skills levels, so that it requires alignment with all levels of the post-school system. The analysis illuminates the interplay between actors at the macro-, meso- and micro-levels, and considers how intermediaries can be supported to strengthen skills development networks proactively.

In Chapter 10, Kruss, Simon Mcgrath, Petersen and Gastrow offer an alternative set of questions to the current way of thinking about higher education’s contribution to economic development, which are of relevance to the entire PSET system. They raise questions about the structure, agents, strategies and mechanisms that firms, universities or colleges use to build their dynamic interactive capabilities to promote effective skills development in diverse economic sectors with specific technological challenges. Through a comparative consideration of two empirical case studies (located in astronomy for
the SKA, and the automotive sector), the authors highlight the complex ways in which higher education can be inserted into skills development networks and focus on spaces for strategic agency.

Towards new interventions?

In acknowledgement of the complexity of the task, we gather a diverse set of approaches and insights for the role that skills planning can play. Although education and skills are widely recognised as equalising forces, there has been limited impact on reducing inequality in South Africa. We argue for a broader, more complete understanding of the actual impact of technology on skills demand, suggest current institutions that need to be reframed to ensure more successful skills development outcomes, and describe the need to understand the network of actors and capabilities that are available, or must be built, to ensure that skills lead to more equitable and successful outcomes.

Viewed together as a set of conceptually informed empirical analyses, the chapters in this book can thus point to the multidimensional interventions required to bring about change towards inclusive growth and development. The conclusion reflects on the conceptual and methodological contributions of each chapter, to more explicitly draw out insights for policy. Such research potentially adds approaches and models that are more appropriate to understanding the skills and development challenges of a highly unequal, mid-level economy. In going beyond an emphasis on the state, space is created for interventions on the part of education and training institutions, intermediary agencies and firms, as well as government at various levels, to bring about the desired change.
CHAPTER 2

Skills planning for South Africa: Getting the questions right

John Buchanan

Laissez-faire was planned; planning was not.
(Polanyi 1944: 141)

The tradition of all dead generations weighs like a nightmare on the brain of the living.
(Marx 1969/1852: 398)

The formulation of a problem is often more essential than its solution …
(Einstein & Infield 1966/1938: 92)

One of the outstanding political achievements of the late 20th century was the relatively peaceful transition to democracy in South Africa in 1994. The fact that a functioning democracy and strong independent judiciary operate two decades later is just as remarkable. However, success in the field of formal civil and political rights should not blind us to remaining problems. As Mashele and Qobo note, South Africa’s greatest challenge is to ‘negotiate the difficult tensions that still mark [its] transition from the apartheid past’ (2014: 200). Crucially, the underlying trajectory of economic development based on deep-seated and deepening inequality survives. The country remains one of the most unequal in the world. The economy is still dependent on a limited number of bulk commodities for export earnings, primarily controlled by a small number of multinational firms. More significantly, a wide range of economic and social problems persist because the gains of economic growth are not widely shared and labour supply still exceeds labour demand by a huge margin. Formal unemployment has persisted at levels of around 25 per cent for decades. On a broader measure, the underutilised labour force approximates half the nation’s population aged 15–64. The post-apartheid policy regime has favoured the emergence of a numerically significant but relatively small ‘expanding racially mixed middle class’ (Chisholm 2004, cited in Motala & Vally 2010). As predicted by Alexander in 1992, this is the legacy of a power-sharing arrangement involving Afrikaner and African nationalism in which dénouement has been achieved at the expense of the urban and rural poor (Alexander 1992, cited in Motala & Vally 2010, and 1994).

This situation is the outcome of a complex mix of ‘objective’ and ‘subjective’ factors. Objectively, it was never going to be easy to change the deep-seated trajectory of exclusionary social and economic
development built up over decades of apartheid. Opening up the South African economy to full integration with global economic and financial flows was also going to be a challenge for a government committed to redressing longstanding inequality. Global financial-market players are, at best, indifferent to fairness in economic development. At worst, they are positively hostile. That said, such objective factors are constraints on, and not absolute determinants of, policy choices. What has exacerbated the South African situation since 1994 is that, as Ashman et al. (2014: 67) note, ‘the government has adopted a confusing and shifting array of policy perspectives’ (see also Bhorat et al. 2014a; Bhorat et al. 2014b). There has been consistent interest in fundamental change and redistribution, supported by new approaches to industrial policy. Against this, however, mainstream economic agencies – internationally, like the IMF, and nationally, like the Treasury – have successfully neutered such initiatives in the name of so-called competitive neutrality and eschewing government’s ‘picking of winners’. The end result has been the continuation of the underlying economic structures of the old order with a modernised, financialised appendage. The country is governed by a policy regime best characterised as neoliberalism with South African characteristics. As Bhorat et al. (2014a) have shown, this regime is buttressed by a tacit social coalition involving government, big business and the mainstream national unions. At its core is the redistribution of economic rents, the core of which are generated by the ‘minerals-energy complex’ – a core inherited from the apartheid era (Fine & Rustomjee 1996). No serious foundations have been created for a fairer economic trajectory based on different, more sustainable and employment-intensive sources of growth, in which the gains would be more widely shared across society.

It is now widely recognised that neoliberal policy regimes are unsustainable. Amongst former adherents of the neoliberal creed, such as the World Bank, the IMF and the OECD, the problems are recognised as serious (ILO, OECD & World Bank 2014). Left unchecked, deepening unfairness in economic and social life saps support for liberal democracy more broadly. These international agencies now advocate more inclusive trajectories of economic development based on an effective minimum wage and collective bargaining arrangements and redistributive tax and government expenditures. Amongst more thorough-going critics, the assessment is sharper. Writers such as Krugman (2012), Stiglitz (2012), Piketty (2014), Bowman et al. (2014) and Atkinson (2015) argue the 30-year neoliberal experiment has failed. For researchers in this tradition, public policy must set priorities for economic and social renewal free of dogmas about the alleged superiority of so-called small government, the pursuit of arbitrary macroeconomic targets and the supposed necessity for markets in every sphere of life – social and economic.

While it is clear that the neoliberal experiment has failed, it is currently unclear what comes next. Recent political developments in the USA and the UK (Trump’s ascendency and Britain’s exit from the EU) have highlighted the ability of right-wing nativist movements to harness widespread dissatisfaction with neoliberal globalisation. As just noted, however, more inclusive visions and policy prescriptions for the future are also emerging. This chapter is a contribution to this latter tradition. It is concerned with just one policy domain: skills planning. Skills planning on its own can do little to solve South Africa’s problems. However, without it, no solution to them will be possible. The central question of this chapter is: How can skills planning contribute to helping South Africa make the transition from its apartheid past?

The chapter has been written for three audiences: first, those responsible for overseeing the development of South Africa’s workforce – principally government and other officials responsible for post-school education and training (PSET); second, researchers and students interested in labour markets and education, especially the connection between the economy and qualifications. Finally, the material below also draws on and contributes to the literature concerning the development of human capability and will be of interest to any readers and researchers in this area. While the chapter is motivated by the highly practical issue of skills planning, it is informed by Keynes’ key insight that there is often nothing more practical than a good theory.
In its short history, democratic South Africa has developed a rich research tradition concerned with workforce development, involving labour market and education researchers from a wide range of disciplines. A key feature of this tradition is the close connection between university-based researchers and policy-makers. The networks associated with this tradition have helped formulate, implement and evaluate South Africa’s distinctive post-apartheid education and skills regime. What is particularly attractive about this tradition is the openness of this policy research community to engagement and debate with data and insights from overseas. The report prepared by the Joint Initiative on Priority Skills Acquisition in 2007 provides a good consolidation of the material and issues in the first decade of development (Daniels 2007). The 2016 report and associated symposium, Skills Supply and Demand in South Africa, produced by the Department of Higher Education and Training (DHET) and the Labour Market Intelligence Partnership (LMIP) are indicative of the deepening sophistication of this tradition (Reddy et al. 2016). The sad fact remains, however, that more than two decades after the formal end of apartheid the South African labour market continues to be defined by three stubborn problems:

- Persistently high levels of unemployment (lack of jobs)
- A large proportion of work that is insecure, low paid and low skilled (quality of jobs)
- Limited labour flows that compromise both individuals’ careers and the economy’s capacity to successfully engage with rapidly changing circumstances (mobility between jobs).

Allied to these defining features is a painful paradox: that despite an abundance of labour, employers continue to report skills shortages as a barrier to growth. Such a situation commonly excites the following questions: What are the nature and scale of such skills gaps? And how can education and training institutions better qualify people to fill them? This way of defining the skills planning problem is unhelpful. Key deficiencies of this approach are that projections are rarely accurate, and education and training systems work to different rhythms than those of the labour market. It is more useful to define the challenge as follows: How can individuals and organisations best be equipped with the ability to navigate uncertainty – that is, to nurture adaptive capacity by deepening the development of human and organisational capability? This has implications for both long-run and short-run priorities. A focus on the broader notion of the development of human capability has an added advantage: it could play an important role in helping to break the current enduring trajectory of economic development based on deepening inequality.

This chapter outlines a more useful set of questions for skills planning for the future – not just as an important aspect of education and skills policy, but also to help South Africa make the transition from its apartheid past. The next section outlines the categories that guide the analysis. Particular attention is devoted to the notions of ‘skills’ and ‘planning’ when thinking about workforce development. Consideration is then given to the key realities that skills planning is required to engage with in contemporary South Africa, especially the large-scale imbalances in the labour market (un- and under-employment) and the legacies of the general education system. This is followed by reflection on the three key questions needed to better engage with these realities:

- Planning for what?
- Planning about what?
- Planning with what?

The chapter then argues that responses to these questions cannot be provided independently. Instead, policies and practices concerning these matters coalesce around a relatively small number of skills planning regimes. In countries like South Africa and Australia, only two types of skills planning regimes are realistically available. These are defined as either a productivist–competency standards regime or a capabilities–powerful knowledge regime. The chapter also outlines the key features of a transition regime that can enable movement from the former to the latter. It concludes by highlighting the need to move beyond a gap approach to making skills planning an integral element of changing the
trajectory of the South African economy, based as it is on deepening inequality. Even if this does not occur, a capabilities–powerful knowledge skills planning regime would leave a better legacy in the population than the current education and skills regime, which still has many of the hallmarks of a system preoccupied with outcomes and not with powerful knowledge and the creative, analytical content of both general and vocational education.

**What categories should guide ‘skills planning’?**

Any approach to managing the uncertainties associated with meeting changing skills requirements is guided by notions of skills and allocative mechanisms. This section draws heavily on Buchanan et al. (2017b), especially pages 4–6. In much contemporary thinking, skills are commonly regarded as taking one of two forms: general (generic or employability) skills and specific skills. Allocative mechanisms are often conceived in binary terms: markets or planning. The limitations of these traditional approaches are becoming increasingly evident.

**Beyond general and specific skills**

When thinking about the changing skills requirements, and planning in light of these changes, it is useful to distinguish between three types of skills. In addition to general and specific skills, noted above, there are also transferable skills. Stevens (1999) defines these as skills that are valued by more than one employer, but are not applicable to all. Recent Australian research has explored the nature of transferable skills, given the capacity they provide to individuals and firms to adapt to rapidly changing circumstance (see Wheelahan et al. 2015 on vocational streams; Alphabeta 2016 on job clusters). As Alphabeta have noted: working in one job is, on average, good preparation for moving onto 13 different types of other jobs (Alph Beta 2016). Transferable skills are not the same as generic or employability skills. These terms are also of limited utility. Typically, they refer to things like problem-solving, communication and collaboration skills conceived in content-free terms. This is both unhelpful and unrealistic. For example, successful problem-solving in a childcare centre requires domain knowledge very different to problem-solving on an oil rig (Buchanan et al. 2018). As was noted above by researchers like Young (2014), and considered in more detail in later sections of this chapter, knowledge content is important for education and skills development. The concept of transferable skills, as used in this chapter, respects this necessity and notes the need for the transmission of coherent bodies of knowledge for the development of expertise that can be used in a variety of settings.

**Beyond ‘markets’ versus ‘planning’**

We live in an era where certainties – old and new – are unravelling. With the fall of the Berlin Wall in 1989 and the disintegration of the Soviet Union in 1991 it appeared that in the dispute between markets and planning as rival foundations for economic development, the superiority of markets had been established. Yet, within less than two decades, the free-market model displayed equally unsustainable tendencies. The Great Recession of 2008–09 revealed that weakly regulated financial markets – the assumed exemplars of free-market efficiency – could take the global economy to the brink of collapse. It was only after 20 of the world’s leading national governments (the newly formed G20) mobilised approximately a third of the world’s GDP that total financial collapse was averted.\(^1\) This coordinated government intervention involved large-scale bank nationalisations, loan guarantees for those banks remaining private, and direct stimulus measures to revive consumption and investment in the world economy. When considering approaches to nurturing social and economic development, clearly the issue is (as indeed it always has been) much more than simply ‘markets’ versus ‘planning’. The challenge is more nuanced: How can

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both of these work – in combination with other coordination mechanisms in civil society – to support desirable and sustainable trajectories of economic and social development?

A recent OECD (2016) report notes in its subtitle that modern policy approaches to understanding training demand entail ‘assessing and anticipating changing skills needs’. The challenge is not so much better workforce planning (in the old manpower planning sense), but rather planning for how the workforce is developed and redeveloped over time, building its capacity to adapt to ongoing change.

Given these findings, in this chapter the notion of planning has the following features:

- The critical issue is not so much making precise predictions about the nature of future labour demand and then mobilising resources to meet them. Rather, it is about identifying effective ways of understanding changing skills requirements and preparing effective responses concerning uncertainty. Indeed, one of the guiding assumptions of this chapter is that we need to increase our capacity to manage uncertainty better – not predict the future as such.\(^2\)
- Effective responses require the design and resourcing of effective institutional arrangements. This is likely to involve a blend of market, state and civil society mechanisms. Just what combination will be optimal depends on the following: the political-economic and social situation of interest, the objectives of priority interest (at large and in the labour market) and the capacity of institutional arrangements available to implement priority policies.

The rest of this chapter explores each of these latter issues in turn and provides pointers on how they can be applied in the current South African situation.

**What are the key realities that skills planning must engage with?**

Devising effective approaches to skills planning cannot be done in the abstract. It must be guided by sensitivity to the current and unfolding situation in the domain (country, sector, region) of interest. Room does not permit consideration of the full range of relevant matters. Excellent analyses of the multifaceted nature of the key challenges have been provided by many South African social scientists (for example, Mashele & Qobo 2014). Several scholarly networks have performed exceptionally detailed and thoughtful work on the economy in general, and the labour market and skills development in particular. Two that are associated with the work of Bhorat and Fine are especially helpful. See, for example, Bhorat et al. (2014a); Bhorat et al. (2014b); Bhorat et al. (2016); Fine and Rustomjee (1996); Ashman (2015); Ashman et al. (2014); Ashman and Pons-Vignon (2015). The key challenge for skills planning in contemporary South Africa is a painful paradox: despite there being an absolute abundance of labour and (for a developing country) relatively high levels of investment in education, employers continue to report skills shortages as a barrier to growth. A brief consideration of both aspects of this paradox provides the setting around which we can consider the three core skills planning questions noted above: planning for what, about what and with what?

**‘An abundance of labour’: The scale and nature of the labour market challenge**

The fundamental facts of the South African labour market are summarised in Table 2.1. Like any developing country, the defining feature of this labour market is the high levels of unemployment, a large

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\(^2\) This way of formulating the key issue emerged from a number of meetings of the Steering Committee Guiding the New South Wales (NSW) Vocational Education Reform Research Collaboration (VERRC) in late 2016 and early 2017. This form of words was devised by Graeme Plato, then executive director of the NSW Skills Board and now deputy director general of the NSW Department of Industry.
The striking feature of the South African experience post apartheid is the degree to which these aggregates have remained relatively fixed. This is not to say people have been fixed in these categories continually. Flow data indicate people move between these states. The core reality, however, is that, while democratic South Africa has become integrated into the world economy and relative macroeconomic stability has been achieved, these ‘successes’ have been achieved by maintenance of an economic development model that has done nothing to seriously improve the number of jobs relative to population growth and even less to improve the quality of jobs.

**Skills shortages: Specific gaps and deficit in core capabilities**

Employers in any country are rarely happy with the level of available labour relative to their demand for specific skills. South African employers are no exception. Complaints about the lack of skilled professional, managerial and technical grades of workers are particularly common (Daniels 2007; World Economic Forum 2016). This is, however, a second-order problem compared to the basic cognitive and analytical capabilities of huge proportions of the South African population.

At first appearance the problem is vast and clear. In January 2016 the national Minister for Basic Education was quoted as saying: ‘If 25 per cent [of students] fail [end of school exams] we must have sleepless nights … This is akin to a national crisis.’³ A year later *The Economist* ran a widely reported story about ‘South Africa having one of the world’s worst education systems’.⁴ The evidence cited included the following:

- Of pupils who have attended school for six years, 27 per cent cannot read.
- South Africa consistently comes last or second last out of 76 countries included in the OECD’s Programme for International Student Assessment.
- Data from the Trends in International Maths and Science Study (TIMMS) yield similar results.

The problem is not one of expenditure. The article in *The Economist* noted that as a proportion of GDP South Africa spends one of the highest amounts on education of any country in Africa. The article cited problems such as corruption in the school system, a lack of accountability of teachers and principals,

<table>
<thead>
<tr>
<th>Labour force status</th>
<th>Percentage of the labour force</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employed</strong></td>
<td></td>
</tr>
<tr>
<td>Formal: permanent</td>
<td>38.6</td>
</tr>
<tr>
<td>Formal: non-permanent</td>
<td>13.9</td>
</tr>
<tr>
<td>Informal</td>
<td>21.9</td>
</tr>
<tr>
<td><strong>Not employed</strong></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>26.6</td>
</tr>
<tr>
<td>Discouraged workers</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Source: Stats SA (2016)

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⁴ South Africa has one of the world’s worst education systems. Why it is bottom of the class? *The Economist*, 7 January 2017.
and a failure to address matters of poor teacher quality and low attendance. These problems have not just been noted by financial journalists. A comprehensive study by Taylor and Shindler (2016) reached a similar conclusion. It highlights that the problems are not confined to basic primary and secondary schooling – it pervades the system from early childhood education and vocational education through to higher education.

Closer scrutiny of the literature reveals, however, a more complex set of processes at work. One important strand of research literature makes the simple but important point that it is hard for education to flourish in a situation of deep and deepening inequality. As a country with one of the highest levels of inequality in the world, it is unsurprising that South Africa has one of the worst educational outcomes (Wilkinson & Pickett 2009: 103–116). As Chetty (2014: 99) has noted, average outcomes are misleading. South Africa does not primarily suffer from having a low average standard – what it has is a highly polarised distribution. ‘When the literacy achievement scores of Grade 6 were disaggregated in the Western Cape, four out of five children in the former white schools were reading at Grade 6 level, while in black schools, only four in 100 were reading at grade level’ (WCED 2004, cited in Chetty 2014). As with the labour market, formal equality of opportunity to participate means little where the opportunities to flourish are so unequal. Chetty is blunt: many ‘poor black youth are being asked to learn in contexts of humiliation, betrayal and disrespect’ (Chetty 2014: 99). Motala and Vally (2010: 7) are more clinical. They note that ‘non-educational “externalities” … affect classroom practice’. As a result, learners are not ‘indistinguishable except by their schooling abilities’ alone (Motala & Vally 2010: 29). For them, the key features of the education system as experienced by ‘the poor and poor communities’ are lack of infrastructure, ‘lack of teachers in critical subjects, poor or non-existent learning materials, indefensible approaches to teaching and learning’ (Motala & Vally 2010: 6).

The last matter listed by Motala and Vally (2010: 6) – ‘indefensible approaches to teaching and learning’ – highlights that it is not just legacies of race and class inequality, but also core educational practices that are contributing to the current situation. The roots of this can be traced to what were regarded at the time as exciting and ambitious proposals for a new approach to education and skills development relevant for the new democratic republic. The apartheid regime had been associated with a much hated, top-down-driven Bantu general education system for black learners. Intermediate technical skills had been, primarily, the preserve of apprenticeship-based trade and allied technical training arrangements, which excluded most black people. To escape these negative legacies, education and training were reconstructed around outcomes-based approaches to cognitive, behavioural and technical skills development that would be open to all, instead of systems based on giving access to specialised knowledge to only the privileged few. For basic schooling, this took the form of outcomes-based education (OBE); for technical education it took the form of occupational standards and competencies-based (as opposed to content and time served) training (Allais 2012a). All education and training was (and is) formally coordinated and recognised through a National Qualifications Framework (NQF). As Young and Gamble (2004: 7) have noted, both OBE and the NQF ‘represent the radical replacement of syllabus-based, institution-led approach to educational reform by an approach based on outcomes or standards.’ In theory, both offered universal access to qualifications, but, in reality, both reduced access to the knowledge needed to be effective citizens and adaptable workers. To put the matter bluntly, while motivated by progressive aspirations to open up education to all, the end result of a purportedly modern, inclusive approach to education has been to lock many South Africans out of access to powerful knowledge (Allais 2012c). Allais (2004) notes that this perverse outcome has arisen from three sources. First, quality education and training cannot be ‘designed down’ starting only with standards. Issues of curriculum and pedagogy are important in their own right and need distinct recognition as important elements if quality education is to be achieved (Allais 2004: 12–13). Second, a preoccupation with standards diverts
attention from key determinants of quality: ‘well-designed learning programs and well-prepared teachers who can teach the required knowledge’ (Allais 2004: 14). Finally, the preoccupation with standards is marred by conflicts over processes and policies (Allais 2004: 15–20). This latter problem has also been noted by labour economists such as Daniels (2007: 7). In a paper on the unresponsiveness of the South African system to skills shortages, Daniels argued that this latter reality constituted a major bottleneck for the entire skills development process in the vocational education system.

Michael Young of the University of London’s Institute of Education, one of the world’s leading sociologists of education, was involved in the initial reform process. He has endeavoured to make up for the damage that he, in part, contributed by legitimating the core design principles of the post-apartheid South African education system. His recent reflections on this experience are worth quoting at length:

So they created, with some help from naïve well-wishers like myself from Europe, Australia and NZ, a broad framework of values for a racially ‘integrated’ education system and left teachers in Black schools free from what had oppressed them under apartheid – a highly specified top-down curriculum.

But, of course, the teachers did not know what to do with the freedom – most Black teachers had received barely any post-school education and the only experience they had was of following instructions from white administrators; it was hardly surprising that the schools slid into chaos that they are still, 20 years later, struggling to overcome. In this context, it gradually dawned on me that there is far more to emancipation than a combination of a critique of the past, experience and democratic values – important though as they are. Education is a specialised activity, like medicine and law, and what was needed was knowledge of curricula and pedagogy and knowledgeable teachers – even if as in South Africa, some of that knowledge was associated with the hated apartheid regime. (Young 2014: 8)

The apparent paradox of an abundance of labour coinciding with recurring skills shortages is, therefore, not a matter of poor implementation of an essentially sound system. It is, rather, a systemic, not incidental, problem with deep roots in South Africa’s distinctive political economy and its distinctive approach to education and training. As Allais has noted, ‘skills shortages’ and alleged labour market inflexibilities are commonly asserted in media and policy circles as the leading causes of unemployment. She argues, however, the converse: ‘the inadequacy of the South African social security system, high levels of job insecurity, and high levels of inequalities, make it almost impossible to develop robust and coherent skills development’ (Allais 2012c: 639).

How can skills planning help?

Understanding the factors accounting for the apparent paradox is one thing. Successfully engaging with them to redress the problems is another matter entirely. Recent studies of leading emerging economies like China and India (Liu & Finegold 2017), recently industrialised economies like Singapore and South Korea (Sung & Raddon 2017) and advanced industrialised nations like the USA and the UK reveal no country is currently finding it easy to manage similar challenges. Skills planning alone cannot make up for deficient labour demand or inadequacies in education and training systems. Better skills planning is, however, an essential ingredient in a policy mix concerned with social and economic renewal. Indeed, without it no solution will be possible.

There has been no shortage of interest in skills planning in post-apartheid South Africa. However, Allias et al. (2017) note that these initiatives are better understood as involving political and policy
posturing – not effective planning as such. A number of specific skills problems have been successfully addressed, but these have been more akin to a plumber unblocking a part of drainage system. These limited successes do not represent effective approaches to successfully meeting changing skills requirements across the board. In reflecting on international experiences, Allias and her colleagues (2017) argue success in skills planning is associated with two distinct policy regimes. The first regime consists of coordinated market economies, like those of Germany and Denmark, where employers and unions act in concert with government agencies to define and meet changing skills needs. Countries like Singapore and South Korea provide an alternative, state-led model. Here government agencies actively nurture and shape industrial development. Ensuring that workforce development strategies complement planned or guided investment decisions is integral to these countries’ models of growth. South Africa lacks the history of state–civil society relations of places like Germany and the state capacity of places like Singapore and South Korea.

Is there no alternative to muddling through and focusing most attention on unblocking particular problems as they emerge? Our analysis in the first two sections of this chapter provides important pointers concerning the critical questions that need to be addressed. Questions associated with the skills gap approach to skills planning miss the fundamental point: the challenges are far more profound than identifying skills gaps and then recalibrating education and training institutions to fill them. The issues requiring consideration run far deeper. Three questions need particular attention: Planning for what? Planning about what? And planning with what?

The first question concerns objectives. What is education and training primarily concerned with? Is it about producing more efficient workers, or is it about developing whole people – flourishing as well as productive citizens? Regarding the role of skills in the broader mix, is a concern with skills conceived as an accommodating or defining matter? In other words, are skills expected to support other objectives like growth? Or is a concern with the development of human capability one of the defining coordinates

### TABLE 2.2 Questions that define the core elements of skills planning

<table>
<thead>
<tr>
<th>Elements and threshold questions</th>
<th>Guiding questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives: Planning for what?</td>
<td>1. Is education and training primarily concerned with developing &lt;br&gt;• efficient workers? &lt;br&gt;• the whole person? &lt;br&gt;2. Is education and training’s role in the broader policy mix: &lt;br&gt;• accommodating? &lt;br&gt;• defining?</td>
</tr>
<tr>
<td>Skills and occupational structures: Planning about what? (how skills requirements are defined)</td>
<td>3. What is the nature of the framework(s) that define and underpin the &lt;br&gt;• development of occupations? &lt;br&gt;• determination of workforce development priorities?</td>
</tr>
<tr>
<td>Institutional capacity: Planning with what? (data analysis, decision-making and implementing priorities about what skills to develop where and when)</td>
<td>4. How appropriate is (are) the (se) framework(s) for meeting changing skills requirements?</td>
</tr>
</tbody>
</table>

5 Allias et al. (2017: 23) suggest that developing countries today would be better off developing new models and approaches that draw on the lessons from the corporatists and development state models. Unfortunately, they provide few pointers on what these are or how they should be applied in South Africa’s case.
of economic and social policy more generally? The second question – planning about what? – has to do with how skills requirements are defined. What notions of skills and occupations guide thinking and practice on how skills are understood? Are they essentially defined by employers’ immediate skills requirements or is attention devoted to defining and nurturing occupations based on transferable skills? The third question – planning with what? – concerns institutional capacity. This concerns issues of how data are used, analysed and inform decision-making. What is the nature of the framework(s) defining and underpinning these? How appropriate is (are) the(s) framework(s) for meeting changing skills requirements? Table 2.2 summarises the threshold issues that need to be considered if we are interested in developing more effective approaches to skills planning in places like South Africa and Australia.

Improving skills planning is not simply a matter of providing the best response to each question considered in isolation. Indeed, responses to these questions cannot be settled independently. Rather, they are connected, and the clusters of responses constitute distinct skills planning regimes.

What types of skills planning regimes are open to South Africa?

Table 2.3 summarises three types of skills planning regimes most relevant to countries like South Africa, the UK, New Zealand and Australia, where vocational education systems have been remodelled in recent decades around competency standards as the prime point of reference, and which lack the legacies and capacities of corporatist and developmental states.

As matters stand, skills planning in South Africa is best characterised as a productivist–competency standards regime. Its key features can be described as follows.

The productivist–competency standards-based regime

- **Planning for what?** At the core of this regime is a notion of highly flexible individuals. They are primarily conceived as economic beings whose prime asset is their human capital: general (as developed by the basic education system) and specific (as required for particular industries and organisations). The foundations for this are well-developed generic skills, especially problem-solving, collaboration and communication, which are themselves underpinned by the basics of sound literacy and numeracy. Education and skills policies are primarily there to support a broad policy mix, currently preoccupied with growth, macroeconomic balance and the development of competitive markets. Social security policy is directed at removing the absolute worst excesses of poverty from the system, but deepening inequality is tacitly accepted as the price paid for maintaining the integrity of the rest of policy mix.

- **Planning about what?** In principle, responses to changing skills requirements are achieved by equipping people with the competencies needed for specific jobs. The entire skills system is designed around defining what these are in outcomes terms.

- **Planning with what?** There is a huge official machinery that designs, registers and assures the quality of competency standards and associated qualifications. Tripartite industry bodies called Sector Education and Training Authorities (SETAs) oversee day-to-day operations and, on the basis of industry analysis about changing skills needs, guide resources to ever-changing priorities. A range of education and training providers then, in theory, meet these needs.

There have been criticisms of the key features of regimes of this nature, almost since their emergence. A particularly comprehensive critique and alternative approach has come from researchers and policy-makers drawing on the capabilities approach to social and economic development, in general, and the importance of knowledge in the curriculum, in particular. Its key features can be summarised as follows.
### TABLE 2.3 Different skills planning regimes potentially open to countries with a neoliberal institutional legacy

<table>
<thead>
<tr>
<th>Element and threshold question</th>
<th>Type of skills planning regime</th>
<th>Possible transition regime&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objectives:</strong> Planning for what?</td>
<td><strong>Productivist–competency standards based regime</strong></td>
<td><strong>Capabilities–powerful knowledge based regime</strong></td>
</tr>
<tr>
<td>• Nature of policy mix: Education and training to support a broader growth with equity policy mix.</td>
<td>• Nature of policy mix: Development of human capability the defining feature of the policy mix.</td>
<td>• Nature of policy mix: Development of well-educated people a key element of an inclusive growth strategy.</td>
</tr>
<tr>
<td>• Prime skills policy concern: Producing efficient workers or potential workers.</td>
<td>• Prime skills policy concern: Nurturing human flourishing.</td>
<td>• Prime skills policy concern: Development of productive, flourishing citizens.</td>
</tr>
<tr>
<td><strong>Skills and occupational structures:</strong> Planning about what?</td>
<td><strong>Skills content defined around notions of generic skills and specific competencies required for particular jobs.</strong></td>
<td><strong>Skills content defined around expertise and mastery of substantive analytical and vocational domains knowledge.</strong></td>
</tr>
<tr>
<td>• Skills content defined within the vocational domain, areas are defined at various levels of generality (vocational streams or job clusters, specific occupations and particular jobs).</td>
<td>• Skills content defined within the vocational domain, areas are defined at various levels of generality (vocational streams or job clusters, specific occupations and particular jobs).</td>
<td>• Identify limited number of common underlying capabilities currently implicit in competency standards dispersed across thousands of qualifications.</td>
</tr>
<tr>
<td><strong>Institutional capacity:</strong> Planning with what?</td>
<td><strong>Prime institutional priority is design, registration and quality assurance of qualifications and associated competency standards.</strong></td>
<td><strong>Overall priorities set by national facilitative/advisory body.</strong></td>
</tr>
<tr>
<td>• Standard-setting bodies (such as SAQA&lt;sup&gt;b&lt;/sup&gt;, 12 NSBs&lt;sup&gt;c&lt;/sup&gt;, 100+ ETQAs&lt;sup&gt;d&lt;/sup&gt;; industry mediators (SETAs).</td>
<td>• Content devised by relevant communities of trust for particular vocational streams/domains.</td>
<td>• Quality in the development of skills built around a limited number of quality anchor institutions.</td>
</tr>
<tr>
<td>• Providers deliver services to ‘the standards’ in any way that works.</td>
<td>• Quality in the development of skills built around a limited number of quality anchor institutions.</td>
<td>• Improve coordination amongst all the elements of the current system.</td>
</tr>
</tbody>
</table>

<sup>a</sup> This column outlines a regime that could facilitate movement from a competencies-based regime to one based on capabilities. Further details are provided in the following paragraphs.

<sup>b</sup> South African Qualifications Authority

<sup>c</sup> National standards bodies

<sup>d</sup> Education Training Quality Assurer
The capabilities-powerful knowledge regime

Planning for what? This regime is informed by a notion that concern with human flourishing should not be incidental to, but rather define, the key objectives of economic and social economic policy. As writers such as Sen (1999) and Nussbaum (2006) have asked: What is the use of economic growth if people do not live lives they value and have reason to value? Sen has concisely noted both what is similar and distinctive about the different approaches:

At the risk of oversimplification, it can be said that that the literature on human capital tends to concentrate on the agency of human beings in augmenting production possibilities. The perspective of human capability focuses, on the other hand, on the ability – the substantive freedom – of people to lead the lives they have reason to value and to enhance the real choices they have. The two perspectives cannot but be related, since both are concerned with the role of human beings, especially with the actual abilities that they achieve and that they acquire. But the yardstick of assessment concentrates on different achievements. (Sen 2007: 99)

It is important to appreciate that, for the capabilities approach, policy is not just concerned with flourishing individuals conceived as isolated entities; ensuring resources are there to make this possible is just as important. At their most basic, resources include things like decent housing, adequate food and security.

Planning about what? Linking with the ‘powerful knowledge’ school, this approach is concerned with things like the capacity to reason independently and having expertise in some domain, which gives people agency, not just in the labour market but in life more generally. The capability for problem-solving is often best acquired in the context of mastering specific disciplinary, trade or professional expertise (such as having something substantive to contribute to a team). In the realm of workforce skills and vocational education, the challenge is identifying domains of expertise that allow for transferability between various jobs within an occupational domain, job family or cluster. The case of care work provides a good example: instead of breaking qualifications down for different specialisms, like aged care, drug and alcohol support, disability support and individual support worker, attention should be given to identifying matters relevant to the underlying vocational concern with care work. For this approach, skills planning prioritises identifying just what these broader vocational streams or job families are and identifying the communities of trust associated with defining appropriate curriculum, pedagogies and qualifications.

Planning with what? Central to this regime of skills planning is support for anchor institutions as sites for developing and delivering quality curriculum and pedagogy. Education and training are not just something that result in an achieved output; quality of inputs is critical to creating qualified people with widely trusted and respected credentials.

Which regime engages more effectively with the realities of the labour market?

In 1998, James C Scott published his seminal study, Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed. His central argument is that many modernising programmes – from both government and business – are informed by mechanistic, linear thinking. Efficiency is assumed to emerge where economic and social arrangements are reorganised on more formally ‘rational’ bases. Scott’s work is based on close analysis, inter alia, of schemes directed at improving agricultural efficiency by the introduction of modern, more abstractly rational production methods in both market- and state-dominated societies. He shows that such schemes have often failed to recognise the distilled
wisdom of seemingly untidy, outwardly chaotic peasant farming practices. These practices, however, often represent generations of practical learning about how to use land productively and sustainably. The implication of his analysis is that the challenge for policy is to work with the best of the spontaneous social order, and not assume that the application of abstract rationality will inevitably yield superior results that are sustainable.

Scott’s mode of reasoning is helpful for understanding why productivist–competency standard based skills planning regimes are yielding ever-growing problems and why reasoning informed by the capabilities–powerful knowledge approach is likely to be more effective. This is because the latter engages with reality and does not assume skills can be rationally broken down into atoms (units of competence) and reassembled into linear flows of learning and labour, which is the core assumption of the productivist–competency standards approach. Following Wheelahan (2018: 5–13) and Buchanan et al. (2017), the problems of current skills planning regimes in places like South Africa and Australia include:

• an expanding number of qualifications as employers complain of skills shortages;
• a disconnect between the qualifications people have and the work they perform;
• the emergence of major quality problems, as ‘funding-model entrepreneurs’ exploit weak quality standards to fleece the system.

These problems reflect more than failures of implementation. At root is an unhelpful notion of skills and how skills are developed in flows of learning and labour. A recent Australian study examined these issues in four sectors: finance, care work, electrical engineering and agriculture (for a summary, see Wheelahan et al. 2015). Under current arrangements, pathways in these sectors are defined in linear terms. Figure 2.1 summarises the kinds of flows as defined by those defining competency standards and devising qualifications in the productivist–competency standards-based regimes. In Australia, qualifications progression starts at Certificate I and goes to PhD, with lower-level certificates (I–III) covering the first two boxes in each of the rows, and Certificate IV, diplomas and degrees corresponding to higher-order occupations.

**FIGURE 2.1 Stylised pathways in Australia’s productivist–competency standards-based skills system**

![Table showing stylised pathways in Australia's productivist-competency standards-based skills system](image-url)
Work done by Yu et al. (2012a, 2012) examined how people actually flowed through these domains, using Australian longitudinal data gathered from 2000 to 2009. In total, data from 6,726 individuals informed the analysis. This research found that very few people’s trajectories in the labour market corresponded with the flows as represented in Figure 2.1. The situation in primary industry was typical. Within the data, 691 people had worked at some time in this sector during this decade. Cluster analysis revealed these people could be grouped into one of six broad categories, shown by the rows in Table 2.4.

There is a lot of information summarised in Table 2.4. In a nutshell, the table reveals two fundamental realities:

- While formal education structures assume qualifications and occupational progression, segmentation is the stark reality.
- Segmentation does not necessarily mean stasis; it often involves horizontal churn within the labour market and movement into and out of the labour market.

**TABLE 2.4 Workers who spent any time in agriculture, basic segments and distribution of time in key occupational categories within those segments, Australia 2000–09**

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Sample (%)</th>
<th>Proportion of time as …</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Farmer/farm manager</td>
</tr>
<tr>
<td>1. Farmer/farm manager</td>
<td>249 (36.0)</td>
<td>72.6</td>
</tr>
<tr>
<td>2. Professional</td>
<td>62 (9.0)</td>
<td>5.1</td>
</tr>
<tr>
<td>3. Trade</td>
<td>63 (9.0)</td>
<td>5.9</td>
</tr>
<tr>
<td>4. High-turnover manual roles</td>
<td>182 (26.3)</td>
<td>5.6</td>
</tr>
<tr>
<td>5. Other low-/ semi-skilled roles</td>
<td>79 (11.4)</td>
<td>4.8</td>
</tr>
<tr>
<td>6. Not in labour force</td>
<td>56 (8.1)</td>
<td>6.2</td>
</tr>
<tr>
<td>Total</td>
<td>691 (100)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Yu et al. (2012: 33)
Note: Several occupational categories have been left out to keep the table manageable. The columns excluded are vocational education and training (VET) activity, higher education study, professionals and technical/trade workers. Full details in Yu et al. (2012: 33.)

**TABLE 2.4 Workers who spent any time in agriculture, basic segments and distribution of time in key occupational categories within those segments, Australia 2000–09**
These realities are important. Despite primary industries accounting for only 3 per cent of the Australian workforce, there are over 130 separate qualifications for this sector, 60 per cent of them at Certificate III and below. Considerable time is devoted to defining standards for specific subsectors and jobs. No attention is given to the reality of labour flows. Work informed by the capabilities approach starts from a different point. It is concerned with equipping people with the capacity to adapt to changing circumstances. In this domain, the common capabilities can be helpfully characterised as concerning rural operations – a set of capabilities relevant to a variety of roles. From work done with the sector over many years, this includes:

- at least some knowledge of the sector’s structure and operation (basic agribusiness knowledge);
- an understanding of key sustainability practices to help maintain and improve farm yields;
- a good understanding of how to use machinery and undertake routine maintenance;
- an understanding of production systems, including irrigation and fertilising skills;
- basic animal, land, plant and crop science.6

Qualifications giving people a broader range of capabilities in areas like those listed would support workers moving into construction, local government and mining, as well as different subsectors in agriculture. The design principle is concerned with giving people the capacity to adapt on the basis of deeper capabilities, rather than accumulating units of competence acquired arbitrarily as employers need them. As such, a capabilities approach engages much better with the realities of flows of learning and labour than does the formal, linear rationality underpinning the productivist–competency standards-based regime.

How can movement to a better skills planning regime occur?

As matters stand, a capabilities–powerful knowledge regime is yet to emerge in any English-speaking country with a productivist–competency standards-based training regime inheritance. It is important, therefore, to consider how movement from current arrangements to something more coherent and desirable could be achieved. The key elements of such an approach are summarised in the last column of Table 2.3. This material summarises lessons from recent Australian experiences directed at getting Australia’s vocational educational system to a better place.7

Over the past decade a number of efforts to support vocational education reform initiatives informed by this analytical tradition have been piloted. In addition to engaging with the Australian vocational education policy community at large, two cases of concrete action warrant brief reflection. The first builds on a longstanding relationship within the agricultural sector, especially dairy farming. The second is a 3-year collaboration involving vocational education and labour market researchers with the New South Wales government, the largest state in Australia. From these experiences it is clear that there are at least two distinct pathways to reform. The first involves efforts to find capabilities in common in broadly defined vocational domains like care work and rural operations. Initial promising work in the latter area occurred amongst employers and training providers involved with agriculture, construction and local government in the Narrabri area of north-west New South Wales (NSW) (Buchanan et al. 2017a: 449). Success here has been constrained by parties determined to block the formation of effective communities of trust around more encompassing qualifications. Peak-level custodians of the current system – especially peak-level bureaucrats in government and employer bodies – have been particularly resistant to change. Not all government officials are obstructive. An

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6 For more details, see Power and Buchanan 2013.
7 The material in this section has been taken from Buchanan, Wheelahan et al. (2017: 17–20), and more extensive details about these pathways can be found there.
alternative pathway to reform has involved enlightened government officials, and could be characterised as led by government officials. This approach has drawn on methods of data science to identify commonalities across a fragmented system. This draws on modern approaches to cluster analysis based on text analytics. Clusters of similar qualifications have been identified through these methods, to provide a prima facie agenda of change that is data- and not personality-driven. Instead of positively trying to win consensus for change, this approach shifts the onus: why not rationalise qualifications along the lines suggested by the data and modern methods of data science? Both strategies are still being trialled. In coming years, it will be interesting to see if it is possible to move from a productivist–competency standards regime to a capabilities–powerful knowledge approach. As matters stand, however, even moving to a transition regime like that summarised in Table 2.3 is proving challenging. Without decisive leadership at national level, ‘the tradition of all dead generations weighs like a nightmare on the brain of the living’ (Marx 1969/1852: 398).

Time for a new skills settlement?

How can skills planning contribute to helping South Africa make the transition from its apartheid past? This chapter has provided some leads for researchers as well as government officials interested in this question. Labour market and education researchers have much to contribute. In a nutshell, they can help identify what the elements of a capabilities–powerful knowledge skills planning regime would look like under South African conditions. In this endeavour, researchers versed in the capabilities approach have a critical role to play. They are important, as this approach offers a very clear frame of reference for social and economic policy that moves attention beyond concerns with ‘growth’ and ‘efficiency’ as commonly defined. Instead, the capabilities approach highlights the importance of creating arrangements that allow people to live lives they value and have reason to value. Capabilities researchers also need to be open to extending their traditional concerns. In dealing with working life issues, people do not need only abstract abilities associated with things like generic employability skills; they need something more tangible, relevant and distinctive that they can identify as a domain of expertise. In this chapter this has been referred to as capability in a stream vocational expertise – or cluster of occupations. Just how these domains are to be defined requires much more research.

This chapter also has major implications for policy-makers. As the recent OECD report on Getting Skills Right: Assessing and Anticipating Changing Skills Needs (2016) has noted, there is no ‘science of skills planning’. Its potential role in early 21st-century South Africa is that it could provide an important focal point for reconfiguring a number of important realms of policy, especially those concerning education, training and employment. The painful paradox of abundant labour coinciding with ongoing skills shortages is not just a continuation of the trajectory of apartheid-era economic development based on systemic, deepening inequality and subsequent neoliberal policy prescriptions that have failed seriously to engage with this legacy. The productivist–competency standards-based regime of skills development has also been a contributing element. The challenge is not, therefore, simply better implementation of sound policies. Rather, the challenge is to devise a new skills settlement based on shared understandings concerning the threshold questions: Skills planning for what, about what and with what? To this we should also add the question: Involving who? As Bhorat and his colleagues (Bhorat, Cassim et al. 2014; Bhorat, Hirsch et al. 2014) have noted in recent times, and people like Alexander (1994) and Chisholm (2004) in earlier times predicted: South Africa’s political-economic trajectory is based on a social settlement between Afrikaner and African nationalism, supporting a small but growing mixed-race middle class at the expense of the urban and rural poor. It is time those excluded from this settlement – the unemployed and those involved in the informal sector – became active participants in developing a new trajectory.
Achieving such change will not be easy, but it is not impossible. Over a short 20 years, democratic South Africa has nurtured one of the best traditions in the world of linking scholarly researchers with practitioners in the skills planning field. This is a great legacy to build on. While there are major problems in skills planning practice, the ability to understand, evaluate and devise new arrangements is there. And within the current arrangement there will be islands of excellence and success in a sea of mediocrity. These will be great assets to identify and work with. Ideally, establishing a better skills planning regime will contribute to a better trajectory of political-economic development at large, but its success is not dependent on change in the broader policy mix. Moving to a workforce development regime built around deepening human capability and equipping the population with powerful knowledge is an important achievement on its own. South Africa has faced bigger challenges in the past and successfully navigated them. It can do so again in the future.
NEW ANALYSES OF WORK, OCCUPATIONS, INSTITUTIONS, EMPLOYABILITY AND RESPONSIVENESS
In Part 1 we argued that supply-side planning needs to draw from different assumptions on the relation between skills supply and demand. Part 2 aims to illustrate how simplistic understandings of the skills supply and demand relation are not only inaccurate, but often unable to direct meaningful interventions into and adequate solutions to the real problem of skills needs in workplaces and society more broadly, as we try to address issues of development, poverty and inequality.

The chapters in Part 2 draw from conceptual approaches not conventionally used to understand skills supply and demand at the intermediate level. All argue that it is essential to investigate what the broader cultural workplace and educational patterns are to which intermediate-level work and training relate. In other words, the research acknowledges that work is not simply a technical exercise, but something that is performed in a site or context, with a particular history, familiar rituals, set habits, patterns of communication and training and development pathways (Gamble 2016b).

Angelique Wildschut and Tamlynne Meyer, in Chapters 3 and 4, focus on dynamics and influences within the workplace, drawing theoretically and conceptually from literature on the sociology of work and professions/occupations, to highlight how employing an occupational lens can illuminate the real impact of work change on the knowledge and skills required for a domain of work. These two chapters point to the concept of occupation as socially constructed, and caution against its simplistic application in supply-side planning.

In Chapter 5, Wildschut draws on research to start linking a consideration of educational processes within workplaces as important to understanding the mis/match between current forms of training and workplace requirements. This work looks at the micro-level, to how changes to an interlocking set of contexts has an impact on different knowledge types, and thus on the knowledge bases of artisanal work. The study highlights how focusing on the variations in actual work, education and training, and labour processes in large and small enterprises can provide a solid basis for supply-side planning.

In Chapter 6, Volker Wedekind more explicitly investigates the connection between formal educational institutions and workplaces, thus addressing questions of alignment or disconnection between labour market demand and skills development at the meso- and micro-levels. The chapter demonstrates the ways in which policies, organisations and practices become institutions that have regulatory, normative and cultural-cognitive elements. A key message is that trying to shift the responsiveness of training programmes to employment needs requires an understanding of, and interventions in, all three of these institutional realms.

These chapters contribute a contextualised understanding of the drivers of change to skills supply and demand, and also shed light on the ways in which this information should be understood and employed as labour market intelligence. As occupational and educational contexts increasingly shift and are predicted to shift even faster, such information becomes pertinent for credible skills planning practice and policy.
CHAPTER 3

Work change, occupational milieus and their impact on skills requirements

Angelique Wildschut and Tamlynne Meyer

As changes occur they must be examined and understood at three levels of analysis: 1) work and the individual practitioner, 2) organisations and other institutions in which the work is embedded, and 3) the economy and society as a whole.

(NRC 1999: 13)

The growing gap between the skills being produced and those required by individuals, firms and industries, and society at large represents an unsustainable cost to South African growth and development, and remains a vexing policy problem. A more credible institutional mechanism for skills planning has been touted as a critical resource to inform policy interventions aimed at better aligning skills supply and demand. Over the last five years, a consortium led by the Human Sciences Research Council (HSRC), called the Labour Market Intelligence Partnership (LMIP), has conducted extensive research towards this effort.

At the same time that we are looking for more systematic and stable frameworks to predict the skills we require and to plan education and training responses, we are facing complex changes to the nature of work, with uncertain implications for skills demand. While there is wide-scale acknowledgement that work change impacts on skills requirements, the empirical evidence base around how the skills demands of individuals in particular occupations are affected is very small and contested (Burke & Ng 2006; Burns 2007; Heerwagen et al. 2016). We argue that this is a critical gap in information, which should feed into a more credible skills planning approach.

In this chapter we deal with the assumptions around work change and its implications for skills demand more closely. We share evidence from a study that assessed the changing nature of work and how this affected the demand for artisanal skills within firms across different industry sectors. The research drew theoretically and conceptually on literature on the sociology of work and professions/occupations. We employed an occupational lens to focus on the impact of work change on different elements that comprise the scope of practice of artisans in three trades (at the micro-level). Critical to this focus was also the evaluation of changes to the broader occupational milieus and identities of artisans as an occupational group (at the meso-level). This chapter focuses more on the data emerging from the latter analysis and considers the implications for skills requirements.
For example, our study finds that in some cases, due to the limited capacity of firms in specific sectors to uptake technologies, the demand for artisanal skills remains largely unchanged. In particular firms within other sectors, the demand for artisanal skills has been affected by the organisation of work to such an extent that, even within one trade, it can vary from one department to the next within firms. We also found that hiring practices and education and training in some workplaces, and for particular trades, might mean that firms are less likely to want to invest in the training and employment of artisans – opting rather for specialised in-house training of less qualified workers with minimum levels of skills and competencies.

Drawing on the insights from this research we argue that we need to build our empirical understanding of organisational and occupational cultures within workplaces. Back in 1999, in a review of available literature on the changing nature of work, the United States National Research Council (NRC) asserted that, while work is significantly influenced by social and economic choices and decisions about how to pursue an organisation’s strategies and missions, analysis often ignores the organisational, social and institutional context in which work takes place. This is a criticism that has not been sufficiently addressed in recent research and approaches to the identification of skills demand and resultant skills development interventions in South Africa (Gamble 2016b; Wildschut et al. 2015).

Before discussing the evidence in more detail, we briefly outline the theoretical approach and describe the three empirical cases that constituted the study. This informs our engagement in Part 3, where we consider implications for the skills planning exercise.

**Understanding changing organisational and occupational cultures and the implications for skills**

Many have recognised that key changes to work will impact on skills demands, to various degrees. The increasing extent and pace of globalisation, the impact of technology (automation and mechanisation) (Hilton 2008a, 2008b), changes in the nature of employment (from full-time to shorter-term, contract-based jobs) (Kalleberg 2009), the bigger role played by organisations (Muzio et al. 2011), and less hierarchical and standardised forms of work organisation (Kalleberg 2000) are all examples.

However, an examination of available literature indicates, firstly, that the knowledge base around the relation between work change and skills demand is quite contested (Green 2012; Hilton 2008a, 2008b; Maclean & Ordonez 2007). There are those who predict work change will have radical implications for the skills and knowledge required by, and levels of autonomy expected for, current and future workers (Acemoglu 2003; Berman et al. 1998; Levy & Murnane 2004). At the same time there are those who remind us that the impact of work change on skills requirements is intensely moderated by different firm settings and sizes, management choices, the power of unions, wage levels and sectoral factors which might, in fact, leave skills demand unchanged (Appelbaum et al. 2003; Kerka 2001; NRC 1999).

Secondly, the knowledge base is small and spread across a range of disciplines (sociology, ergonomics, political science, economics and education) (NRC 1999). The studies thus tend to have differing levels of inquiry and focus, translating to a limited empirical base to direct decision-making and policy intervention to address types of skills development needs that might derive from work change.

Du Toit et al. aptly sum up this complex relationship between work change and skills demand, while also pointing to the nature of the research gap in this regard at a national level:

> Technological and knowledge development determines the potential for change in the organisation of work and production. Against far-reaching changes on a global scale, the question is to
what extent these changes are likely to be replicated in South Africa. Answering this question concretely will require in-depth study of different industries and types of economic activity. (2017: 4)

Our approach to the study was informed by literature on the sociology of work and professions/occupations, to speak directly to this gap in research.

An approach informed by the sociology of work and professions/occupations approach
The study of structural changes in work and its underlying knowledge bases, identities and linkages to occupational description has traditionally been problematised in the disciplines of sociology of work and occupations, and the sociology of professions. While the former could be summarised as ‘the application of the principles and concepts of sociology to … occupational life and people at work’ (Maclean & Wilson 2009: lxxv), the latter focuses specifically on professions. The justification for this is that, as a type of occupational group, professions manage to wield particular forms of privilege, power and status in relation to wider society, the market and the state, and this requires continued investigation.

The field initially focused on the definition of profession and the characteristics and traits constituting a profession, although this has been much criticised. Over time it has become conceptually more sophisticated and diversified. And so, even while the focus has been on a specific occupational group (professions), the literature has built up an extensive and strengthening empirical and theoretical base that offers lenses to deal with very critical questions around work that societies all over the world are grappling with at present, such as the meaning and purpose of work (Arnold et al. 2007; Dik et al. 2013), its relation to other institutions (the market, society and the state) (Fournier 2000), the quality of types of work (Gallie 2013), post-bureaucratic forms of work organisation (Hodgson 2004), increasing precariousness of different types of work (Gill & Pratt 2008) and diversity in workplaces (Parvis 2003).

We were informed by these general studies on professions and work, but because we were interested in assessing change to a particular scope of work (artisanal work), we drew from the literature that dealt with boundaries at work and how these are maintained and changed. This allowed us to assess shifts and changes to an occupational domain of work. The concepts of boundary work and boundary objects (Gieryn 1983; Star & Griesemer 1989), as well as the professions literature that dealt with the notion of jurisdiction (Abbot 1988, 1995; Fournier 2000, 2013; Freidson 1989, 2001; Lamont & Molnar 2002; Lewis 2012) were particularly useful for our conceptualisation of the notion of occupational boundary, which we foregrounded in the main project analysis. Here we conceptualised the elements that would constitute an occupational domain of work, and through coding the interview data for evidence of change in these elements, we could assert whether changes to an occupational domain of work had taken place or not. Two related papers deal more comprehensively with the findings from that analysis (Wildschut & Meyer 2016a, 2017), while also going into more detail on the conceptualisation.

In addition, the scope of practice of any work is impacted significantly by the context within which those sets of skills and competencies are enacted. That is why an important element of the study was an investigation and analysis of the occupational milieu within which the scope of practice would be carried out. This analysis relied on a combination of interview data and contextual overviews that included labour market analysis and organisational document reviews.

1 While contributions to this debate are also notable from the sociology of knowledge/education, this tends to focus more on the implications for curriculum.

2 Jurisdiction is about ‘displaying what a profession or occupation knows (its system of abstract knowledge) and connecting that to what the profession or occupation does (its labour practices)’ (Lewis 2012).
The approach draws into the discussion the notions of occupational contestations, identity, work and organisational decisions and practices (culture) that are playing out in workplaces, with sometimes very profound bearing on the demand for skills from particular occupational groups. We argue that this offers a useful way to approach and engage with work change and its implications for skills demand.

Three case studies

The project was designed as a set of case studies of key occupational groups in a focus field of practice and industry sectors. Three trades in three industry sectors (mechatronics trades workers in the automotive sector, millwrights in the metals sector and electricians in the mining sector) formed the empirical cases.

For each case we conducted occupation-specific literature reviews, organisational document reviews, labour market demand-and-supply analyses, and individual interviews. We interviewed 96 participants across 5 occupational categories: human resource (HR) professionals (12), engineering professionals (23), technicians (10), artisans (34) and apprentices (17), in the Eastern Cape, North West and Gauteng provinces of South Africa. These focus provinces were selected on the basis that the automotive value chain is predominantly in the Eastern Cape and Gauteng, mining in the North West and metals in the Gauteng region. Qualified artisans and apprentices were the foci, but because change occurs relationally, related occupational groups (engineering professionals, HR professionals and technicians) were also included in the sample. Each case provided data on the occupational milieu and labour market, boundary work between occupational groups, boundary objects used to contest domains, and occupational identities in the specific field and sector.

Changes to occupational milieus and impacts on the artisanal skills required across three case studies

The cases were purposively selected to allow us to investigate artisanal trades undergoing different facets of change. One is a new and emerging multidisciplinary field of practice recently recognised as a trade (mechatronics in the automotive sector). This represents the higher end of intermediate skilling, as the mechatronics trades worker qualification is at NQF Level 5 (traditional artisanal qualifications are at NQF Level 4), and its practice is evaluated in a high-technology sector. The second case is a traditional trade having to function in more technology-driven work contexts (electricians in the mining sector), but in a sector that is struggling economically. The third is a high-status trade, but it is also a scope of practice having to contend with the implications of increased application of technology (millwrights in the metals sector) in a sector that is in decline.

When we consider the employment data per sector, we see interesting shifts in occupational structure that form an important background for interpreting the qualitative evidence.

The South African automotive sector

The automotive sector in South Africa is the largest manufacturing sector, contributing 7.5 per cent to the country’s GDP and 12 per cent of all manufacturing exports (Le Gueren 2017). While the sector undertakes very limited product innovation locally, it remains a key role-player and global leader in vehicle manufacturing. Most of the sector is owned by multinational corporations, incorporating South Africa into the global automotive market. This holds implications for the sector to maintain and improve competitive capabilities, adhere to international standards and keep abreast with technology and innovation.
The South African automotive industry includes vehicle production and assembly, auto parts or components production, retail, distribution and servicing. Beyond its direct contribution, the sector has substantial multiplier effects across the South African economy, with a number of service and other support sectors feeding off the industry. The industry is characterised by a producer-driven value chain comprising a collection of vehicle assemblers that operate with a string of upstream component manufacturers (Garisch & Meyer 2015). The bulk of the value chain is currently made up of seven light vehicle assemblers (the original equipment manufacturers, or OEMs), with a primary production focus on passenger and light commercial vehicles – all multinational corporations. The value chain for the industry is illustrated in Figure 3.1.

The sector has experienced profound change in the last few decades: from unskilled and low-level skills to high-technology and professional skills, and from predominantly manual labour to highly automated production processes. As such, in comparison to many other industrial sectors in the country, the automotive industry is considered at the forefront of knowledge, skills and innovation. Figure 3.2 indicates employment in the sector according to the main occupational groups.

**FIGURE 3.1 Automotive value chain**

Source: Garisch & Meyer (2015)
for 2008 and 2017. Over the period, the employment of artisans (CRT workers) have declined (9 per cent between 2008 and 2017). There has also been a significant increase in the employment of plant and machine operators and assemblers (PMOAs) (17 per cent). Currently, PMOAs constitute the biggest proportion of sectoral employment (39 per cent), a position held by artisans a decade ago (when they represented 27 per cent of sectoral employment). This is a significant shift in the occupational structure.

The changes to the occupational structure are aligned with the expected impact of increasing automation. This requires a larger group of individuals who perform oversight, quality control and management tasks (such as professionals), as well as individuals who do not need a very high level of skill to perform their job duties (such as PMOAs). Judging from the trends in the data, it is also possible that the fragmentation of artisanal work might be increasing. This would allow the substitution of certain tasks or components within a job to lower-paid semi-skilled or unskilled personnel. This does seem to be the case in both the automotive sector and the metals sector (see Figure 3.3), where the decline of employment of CRT workers is accompanied by an increase in the employment of PMOAs. This information suggests low and even declining levels of demand for artisanal skills in this sector.

FIGURE 3.2 Occupational group share of employment in the automotive sector in South Africa, 2008 and 2017

Source: Authors’ calculations based on Stats SA (2008, 2017)3

3 Statistics South Africa (Stats SA) gathers information on the national labour force via annual and quarterly surveys (referred to as the Labour Force Survey [LFS] or Quarterly Labour Force Survey [QLFS]). The major occupational category where the employment of artisans is recorded is called crafts and related trades workers (CRT workers).
However, as the automotive sector has been defined as one of a few high-technology sectors (Kraak 2009) within the broader South African economy, it might present a very skewed view of the impact of sectoral trends on the demand for artisanal skills. We now briefly describe the factors at play in our second case, in metals beneficiation, one of the more resource-based sectors of the economy.

The South African metals sector

The metals sector was particularly hard hit by the economic crisis of 2009. While there has been positive growth in some of the sub industries, in the main it is a sector that is struggling to recover, particularly the metal, metal product, machinery and equipment sub industries.

Figure 3.3 indicates the employment in the metal sector according to the main occupational groups for 2008 and 2017. Alongside the overall reduction in employment in the sector, there have also been notable changes to its occupational profile. The technical and associated professional categories have increased their share of total employment from 6.3 to 9.1 per cent, while elementary occupations have experienced a decline from 10.6 to 9.2 per cent. At the same time, the managerial component increased from 8.3 to 10.5 per cent, and while CRT workers experienced a decline in representation (from 40.6 to 34.9 per cent), they still constitute the biggest proportion of employment in the sector.

Figure 3.3 Occupational group share of employment in the metals sector in South Africa, 2008 and 2017

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legislators, senior officials and managers</td>
<td>8.3%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Professionals</td>
<td>3.4%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Technical and associated professionals</td>
<td>6.3%</td>
<td>9.1%</td>
</tr>
<tr>
<td>Clerks</td>
<td>7.4%</td>
<td>9.6%</td>
</tr>
<tr>
<td>Service workers and shop and market sales</td>
<td>1.5%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Crafts and related trades workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant machine operators and assemblers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary occupation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on Stats SA (2008, 2017)

The LFS uses the Standard Classification for Occupations, which groups occupations into nine major groups. Figure 3.3 thus disaggregated employment in the metals sector according to these nine major groups.
Similar to the wider manufacturing sector, technology is increasingly being used to reduce the size of the labour force in the metals sector. A range of reasons are offered by employers, which reflect perceptions around the increasing cost and unreliability of labour, on the one hand, and the increase in quality and consistency that is possible through the latest technology, on the other hand. The process of mechanisation and greater capital intensity tends to increase the need for technical and managerial skills – both of which have risen proportionally over the period from 2008 to 2017 in the sector. As noted earlier, it appears that a fragmentation of artisanal work might be taking place, although not to the same extent as in the automotive sector. The ratio of CRT workers to semi-skilled machine operators has reduced from 1.9:1 in 2008 to 1.4:1 in 2017 in the metals sector. Before we consider how and whether these sectoral trends translate to the need for particular artisanal skills, we describe the conditions in another critical resource-based sector in the country, namely mining.

The South African mining sector

South Africa may no longer be a leader in gold and diamond mining, but it is still the largest producer of valuable minerals such as platinum, manganese and chrome, and is the third largest producer of coal. The industry is a major foreign exchange earner and gold accounts for approximately 33 per cent of exports. With a number of areas still to be explored for mineral deposits, South Africa’s mineral dominance is thought to be far from exhausted, suggesting that this area will continue to benefit the country’s current account balance (trade and exports) and remain a significant source of employment.

Confidence in the sector suffered great losses in the wake of the prolonged 2009 strikes and labour unrest at Lonmin and Marikana mines, which had tragic outcomes. A tracking report of the mining sector in 2013 stated that the uncertainty resulting from the strikes contributed to ‘South Africa [being] perceived internationally as a country that is unstable from a regulatory and labour perspective’ (Deloitte 2013). According to a Price Waterhouse Coopers mining report, ‘Labour cost percentages vary from above 60% (of total operating costs) for the deep-level conventional mines to below 30% (total of operating cost) for those companies that mine predominantly opencast’ (PWC 2010). This combination of disincentivised investors, extended labour unrest and a continued move to drive down labour costs has prompted current owners such as Anglo American to explore various options, from increasing mechanisation in labour-intensive operations, to outright sales of those operations with high labour costs. This not only has implications for the number of employees that the mining sector can absorb in future, but it also means an increased requirement for and reliance on technology-based skills sets.

Mining contributes about 18 per cent of the country’s GDP. However, as a global player facing competition from other mining economies, such as South America and Australia, concerns are that there is a need to skill workers to operate within a context where the challenge is to mechanise faster in order to remain competitive (Moodley 2013). Recognising this need, training authorities such as the Mining Qualifications Authority (MQA) and companies that employ artisans have acknowledged the urgency for continued artisan development.

Trades workers still constitute the largest proportion of the sectoral workforce. As shown in Figure 3.4, in 2017, trades workers comprised 31.4 per cent of employment, which is consistent with their proportional share of sector employment in 2008 (only 1.3 per cent decline). While there has been a notable decline in the employment of PMOAs (−4.3 per cent), at the same time there have
been increases in the employment of elementary workers (5.1 per cent) and clerks (3 per cent). This change in the occupational profile is slightly different to the other sectors, where the decline in artisanal employment was accompanied by an increase in employment of PMOAs. In this mining sector the major shift has occurred between PMOAs and elementary occupations (see Figure 3.4).

From the occupational analysis above, it seems that the sector has maintained the employment of artisans, shedding employment primarily in the occupational category of PMOAs and employing more elementary workers. The analysis of employment data thus suggests a stable demand for artisanal skills, while job fragmentation appears more likely at PMOA level.

In sum, taken together across the three sectors, the occupational profile shifts do not appear to suggest a growing demand for artisanal skills in general, and we were unsure of what to expect with regards to the demand for specific artisanal skills. In the following chapters we share some high-level findings per case.

**FIGURE 3.4 Occupational group share of employment in the mining sector in South Africa, 2008 and 2017**

![Bar chart showing occupational group share of employment in the mining sector in South Africa, 2008 and 2017.](chart.png)

Source: Authors’ calculations based on Stats SA (2008, 2017)

**Nuanced implications for artisanal skills demand**

While it is clear that work has undergone various forms of change over the past two decades, the impact on skills levels is not straightforward. As will be illustrated, very nuanced implications for artisanal skills demand were apparent in this study, depending on sectoral, organisational, field of practice and other factors.
Growing and highly differentiated demand for mechatronics trades workers

Many technical processes and products in the area of mechanical and electrical engineering show an increasing integration of mechanics with electronics and information processing. This integration is between the components (hardware) and the information-driven function (software), resulting in integrated systems called mechatronic systems. Figure 3.5 illustrates the integrated interdisciplinary basis of mechatronics.

Mechatronics thus combines highly technical and knowledge-intensive fields, such as traditional electrical, electronic, mechanical and computer engineering. It involves the ‘computer control of an electro-mechanical system’ (Wolff & Luckett 2013) to result in ‘intelligent functions and features’ (Lyshhevski 2002) that were not possible or cost-effective before.7 Mechatronics skills have been recognised as critical to sustaining our global position as well as to grow and develop the automotive sector (merSETA 2011) in South Africa. In the context of the critical future role, a dedicated mechatronics qualification at the vocational skills level was instituted, along with recognition as an artisanal trade in 2012 (DHET 2012). As illustrated by the assertions of a respondent: ‘[Y]our basic electrician does not cut it anymore because he now also has to service your robot … he has to understand basic PLCs and programming because all of the jigs and fixtures are nowadays running off PLCs’ (Engineer).

The mechatronics case is a perfect example of where global technological innovation and developments, especially computer-based technology such as Supervisory Control and Data Acquisition (SCADA)

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7 ‘Mechatronics involves finding an optimal balance between the basic mechanical structure, sensor and actuator implementation, automatic digital information processing and overall control, and this synergy results in innovative solutions’ (IFAC Technical Committee on Mechatronic Systems 2006, quoted in Isermann 2007: 2).
systems, human–machine interfaces (HMIs) and programmable logic controllers (PLCs) have transformed the work environment and production processes quite significantly, as confirmed by this respondent:

> Basically all your companies these days are going the automation route ... everything has gone more software/hardware-based ... interlinked or integrated. You’re getting a lot of PLC computer-based integration with your hardware components and stuff that you’re running on your production line and stuff. (HR professional)

Increased levels of automation are consistently perceived as having resulted in a profound impact on the knowledge and skills required from artisans in the automotive sector. For example, as is illustrated by this respondent: ‘The type of person or artisan that we need in th(is) type of environment is a person that is multifunctional – whether it’s robotics or systems, mechanical, electrical or whatever. And that’s why we’ve chosen the mechatronics qualification’ (HR professional). (The respondent goes on to explain that this qualification focuses on programming and robotics.)

Particularly for mechatronics artisans, the perception that they need to broaden their interdisciplinary knowledge base and improve their higher-level conceptual/theoretical knowledge, analytical thinking and reasoning was a general trend. Respondents saw these aspects as critical in assisting artisan-level functionaries to adapt to the shift to systems-driven and more automated production processes underpinned by the integration of hardware and software. This stands in stark contrast to the almost total reliance of artisans, traditionally, on situated or practical knowledge obtained through long years of on-the-job experience. In all, such a shift towards a greater or a deeper and wider understanding of the changing nature of the automotive sector production environment holds critical implications for artisans to remain relevant, competent and effective in an increasingly automated future.

While this was the overall sentiment across the case, we did find variation in skills requirements for mechatronics trades workers between and within firms. Firstly, it appears that assembly plants are the least affected, as work processes still rely heavily on manual operations, such as fitment of completed components. Here the type of skills required from mechatronics trades workers was very different from firms in which automation was significant. Secondly, even in firms where the automation of production lines has taken root, the impact of automation appears most pronounced in body and paint shops, where robotics is the order of the day. Here, mechatronics trades workers would be required to employ much higher-level skills. It was evident that the performance- and competence-based internal promotion of artisans to technician-level posts in automated or high-technology departments was established workplace culture across all companies in the sample. The perception that this infringes on the traditional scope of practice of artisans is illustrated by the assertions of a systems engineer respondent, who bemoaned the trend of artisans ‘being taken away from focusing on what they are qualified in’ and being asked to do what is ‘entirely a technician’s job’.

In sum, the case confirms a general decline in the employment of artisans in the sector. This is accompanied by a general requirement for artisans who are employed within the sector to possess higher-level skills. With regard to the need for mechatronics skills at artisanal level, particularly, the evidence suggests a demand that is likely to grow. This demand, however, is affected by the type of firm and the extent to which automation is incorporated in the production processes and related organisation of work in different departments within firms.

**Sustained demand for millwright skills**

The work of millwrights includes constructing and maintaining heavy machinery used in industry, using hand and power tools, and directing workers who are engaged in these activities. Millwrights...
also need to understand blueprints and technical instructions, in order to assemble machinery. The millwright may also need to use lathes, milling machines and grinders to make customised parts or repairs. The tradition of building skills and applied engineering knowledge upon which the millwright trade was founded resulted in high demand for these artisans during the Industrial Revolution (circa 1760 to 1840). Their skills were a natural fit for managing the increasingly advanced technologies and machinery that were being developed. In many respects then, the trade is seen as the oldest trade related to engineering as well as the forerunner of modern mechanical engineering.

Modern standards of practice for millwrights direct the kinds of skill requirements, such as working within precise limits or standards of accuracy with a wide array of precision tools. Their work at present is also influenced to a large extent by technological innovation, with increased computerisation and automation of production processes seen to affect most profoundly the electrical component of their work. The role of the PLC is notable, in that it represents a significant change to production processes that were previously manually controlled. An HR professional indicated that ‘your new technology is more computer-based. I mean you’re looking at PLCs, you’re looking at HMs’. Electrical installation of equipment also forms part of a millwright’s responsibilities, and, because of the increasingly automated nature of industrial machinery, knowledge of electronics.

In this case, we find that, while there is increasing automation driven by fast-paced technological innovation and developments globally, the sector’s and country’s absorptive capacity for such technology plays a key role in actual artisanal skills requirements. It emerged through the interview data that, for the range of firms interviewed, their capacity to absorb this technology was very limited in the metals sector. So, while modern technologies are increasingly being implemented in different organisations, this takes place alongside the continued utilisation of older production equipment. A respondent in the metals sector explained:

Some of the equipment is almost as old as I am ... with older equipment like that, it’s really difficult ... that stuff is in such a state that if it’s working you don’t go there. You don’t go and touch it, don’t turn that screw. You leave it ... we’re trying to modernise the plant, but to do that we can only do small portions at a time, because it’s very expensive ... and a timely exercise. (Technician)

Based on this context, many respondents agreed that millwright skills are critical in the transition to newer production processes, to maintain ailing production infrastructure (which would require the machining of parts, as often the machines and parts are not made anymore). Thus, within the South African metals sector, traditional machining skills remain in demand, in addition to the electrical/electronic integration skills that millwrights possess. As a respondent asserted, ‘the millwrights know about the interlocking of the electrical with the mechanical functioning, and pick up on the nature of problems, whether hydraulic, mechanical or electrical’ (Engineer).

This case illustrates that the infrastructural realities of the South African labour market means that, for quite some time into the future, the practical, more traditional maintenance skills of millwrights will continue to be in high demand. The nature of the production sectors in the country suggests such skills to be critical in the transition to more modern forms of production.

Another important aspect with a bearing on the demand for millwright skills in the metals sector is the fact that, in most firms across the metals sector, the organisation of work has remained largely intact. We find that the organisation of work has tended to reinforce the traditional scope of practice for artisans, making it very difficult for them to cross traditional occupational boundaries, even if they are interested in expanding their technological skills and knowledge.
Occupational boundaries are clearly set up, with technicians and engineers – as the purveyors of knowledge and expertise – positioned above artisans. As indicated by a millwright, ‘technicians and the engineers must be able to communicate with the millwrights and other artisans and transfer knowledge to them’ (Artisan). Another respondent indicated the same hierarchy:

The artisan is working in the grease ... artisans are physically on the floor doing nuts and bolts ... kindly referred to as, ‘on the tools’. The professional is doing the calculations and the draft, the project work. The technician is analysing trends (and) programming PLCs.’ (HR professional)

The organisation of work, as expressed through organograms and work schedules, clearly reinforces this hierarchy in daily work practice, defined in the following manner by an engineer:

The system technicians ... are the guys looking after the PLC. And then below them are the instrumentation technicians. They (are) looking at lower levels – more like the valves and temperature control and that kind of stuff. Below them we get the millwrights. And then, below the millwrights, you actually get the fitters and the rest of them. (Engineer)

This hierarchy was similarly confirmed by a respondent who outlined the different occupational group responsibilities towards finding a solution to a work-related problem: ‘The artisan will go first to attend to a problem. If the problem is too complex, he will call out a supervisor or a technician. If they cannot solve the problem, the branch manager comes out, accompanied by an engineer’ (Technician).

The order in which each occupational category has to take responsibility suggests the level of complexity in relation to solving problems. An artisan’s function is regarded as the most basic in the hierarchy, and the more difficult the job gets, the higher the skills set required. Occupational position in the hierarchy is not only determined by the stage at which they are called into the job process. The hierarchy is also defined by who performs which task, effectively locking individuals into occupational categories through the tasks they are required to perform. This is constantly reinforced through the organisational culture within metals firms, as illustrated by this respondent, who alluded to practices in the workplace to ensure that different occupational groups understand their position in the organisation of work in the firm:

We’ve got second-year engineers and we’re doing a competition for them ... to let them understand their role clarifications. You have to design a circuit for some purpose and you’ll give it to the engineer and he will go and sit and do that design, then he will give that to the technician who will go and build that circuit now, and he will give it to the artisan to go and put it into the machine. (HR professional)

The hierarchies, as set out in work plans, define the scope of work and the responsibility that each occupational group undertakes. Firstly, artisans are mainly involved in maintenance and fault-finding, while engineers are involved in planning, designing and other management functions. Secondly, while artisans work with their hands, relying on industry-standard toolboxes and a check-list of tasks designated by the supervisor or foreman to complete their job, engineers do more of the thinking work and use computers in the course of their work. The tools or equipment, and the subsequent work this allows them to do, serve to categorise the occupational groups and essentially become the definition of status accorded to each separate group. It appears that millwrights have very poor access to the technologies that would transform their work, and the traditional organisation of work reinforced by such workplace discourse also tends to limit access to these technologies to technicians and professionals.
In this case, we find two factors contributing to a sustained and largely unchanged demand for millwright skills. Firstly, the low absorptive capacity for new technologies in the sample firms mean that, although global trends might suggest otherwise, millwright skills remain in high demand. These firms do not have the kind of capital to switch rapidly to new technologies and so have to maintain production with ailing infrastructure. Secondly, the organisation of work still relies on traditionally defined boundaries between different occupational groups and this keeps the scope of practice and requisite skills of millwrights largely unchanged.

Having considered both high-technology and resource-based sectors, to illustrate how work change has affected the demand for specific artisanal skills, we turn to a very traditional artisanal trade in a sector that is strongly driven by efforts to bring down the cost of labour: industrial electricians.

### Signs of declining culture to develop artisans

Electricians in the mining sector – typically referred to as industrial electricians – are responsible for tasks such as installing, testing, repairing, and maintaining electrical equipment. Since electrical equipment is more common than ever before, industrial electricians are in relatively high demand. While basic electrical knowledge is essential to excel within this industry, those electricians who are exposed to newer technologies involving computer-based systems, such as PLCs, will have an advantage. Industrial electricians who specialise in robotic repair are especially in demand. In South Africa, training institutions award a national certificate for electrical trades under the following specialisations, which take into cognisance the different types of mining: metalliferous, opencast, surface coal, surface diamonds, underground coal, and underground diamonds. The main change affecting the work of an electrician appears to be the shift from electrical to electronic work.

The occupational milieu of electricians in the mining sector remains characterised by a history of racial and gender inequalities. The South African mining sector has a complex social history, embedded in the political system at the time of apartheid. A review of this history illustrates how the industry contributed to the racial division of labour in the country, preserving skilled and intermediate level work for whites. In addition to racial tensions, the pressure to reduce labour costs is a constant source of turbulence and assertions of inequality. Many are of the opinion that this legacy actually contributes to increasing moves towards mechanisation and job fragmentation in the sector.

As with the millwrights’ case in the metals sector, a high proportion of respondents in the mining sector were of the opinion that the sectoral demands for electricians’ skills have not changed significantly over the last few years. For example, an engineer was dismissive of the changes in technology affecting the work of an electrician. He believes that, despite the technological changes, the scope of electrical work remains essentially the same: ‘Not in the mining industry, no. We’re still there to make sure that the machines are operating. Whether it’s new technology or old technology, I don’t think that really has changed, the essence of what we need to do and how’ (Engineer).

Another respondent maintained that the impact of technology on the skills required from electricians have been minimal:

> There’s been technology that came through, but not much. It brought a bit of new dimensions, and the guys get trained, understand, but it doesn’t bring much of the change, if you look at the skill component of electricians, a lot of stuff still remains the same, there’s going to be only modifications here and there but it doesn’t change the basics of the trade itself. (Artisan)

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8 Up until the 1950s, vocational training was focused on addressing and maintaining white interests (Badroodien 2004a; Webster 1994) and black Africans were regarded as a source of cheap labour.
While the mining sector exhibits some of the trends highlighted in the metals sector, it serves as the best example of how a growing trend of subcontracting and outsourcing of certain production functions has a direct bearing on the demand for intermediate-level skills. Of especial concern in the sector is the use of outsourced services in order to cut costs. Respondents described how, as a cost-cutting measure, the mine now contracts out all new installations and other projects that used to be undertaken by artisans:

So there’s a company outside, you call them in, they come in, they look at the things what you need to do. So that skills are dying out ... Yeah, contractors are pulling in, especially when you do big, major jobs. (Artisan)

Basically, artisans are no longer responsible so much for new installations, you know, and that is sad, because that is where you actually learn, new installations. All of those things, your projects, etc. gets outsourced to contracting companies. (HR professional)

Another respondent further emphasised that this practice is negative, because it leads to narrowing and fragmentation of the traditional scope of artisanal work:

While the suppliers carry out the major installations artisans are relegated to simply carrying out the maintenance work thereafter. This raises concerns about the skills development of the electricians in the mining sector, one of which is considered to be installations ... it would appear that skills are being diluted and lost in this process [of subcontracting functions like installation]. (Artisan)

Another sentiment is supported by another respondent, who stated that ‘technology has been more harmful than good and ... contribut[es] to the de-skilling of artisans’ (HR professional). There are thus strong perceptions – firstly that artisanal work has not been affected dramatically by technology in the mining sector, and secondly that, where there has been an impact on the scope of work, it has been negative. Most respondents were of the view that this illustrates low commitment on the part of firms in the sector to invest in the training of artisans now, and likely into the future.

With such nuanced and, in some instances, seemingly contradictory trends in the demand for artisanal skills across these cases, what lessons can be drawn for skills planning?

**How the need for artisanal skills in three industry sectors has been affected**

This chapter outlined some of the key elements of the occupational milieus underlying the work of artisans in particular trades, and how these mediated changes to the nature of work. We found simultaneous and diverging trends, concurring with the conclusion that

the most fundamental contrast [in the South African labour market] is the widening gap between the developed sector (capital-intensive industries, where investment focuses on maximum efficiencies, advanced technology and labour replacement), and less developed sectors (less capital-intensive industries continuing to rely on semi-skilled labour that have become uncompetitive on a global scale). (Du Toit et al. 2017: 4)

The mechatronics case would align most closely with this conclusion, in that it illustrates a quintessentially high-technology sector that is increasingly demanding managerial and professional skills, with a decline in employment in intermediate occupations. The impact on the demand for mechatronics
skills at the intermediate level, however, appears to be limited. Not only did the interview data confirm a high demand for the mechatronics skill set, that demand was also found to be highly differentiated within and across firms in the automotive sector.

However, the cases of the millwrights and industrial electricians could be characterised as being closer to the opposite end of the spectrum. These cases show that, within struggling resource-based sectors of our economy, the demand for artisanal skills is intensely affected by the extent to which firms can absorb new technologies. While changes to the nature of production at a global level might suggest a decline in the demand for traditional millwright skills, in South Africa such skills seem to be critical in the transition to more modern forms of production. Even in firms where new technologies are being implemented, there appears to be limited scope for millwrights to broaden and deepen their contribution to workplaces, as the traditional organisation of work has remained largely intact.

The case of electricians, on the other hand, highlights in a slightly different way how the occupational milieu mediates the demand for artisans. Here, sectoral hiring and training practices suggest a higher propensity for firms to hire less skilled employees, instead of investing in growing artisanal skills as a core constituency of its occupational profile. In this regard, concern was expressed that such trends not only affect the demand for artisanal knowledge and skills in the sector, but can result in a further deskilling of artisans. This, accompanied by a dwindling workplace culture to support and invest in the holistic skills development of artisans, does not bode well for the future of artisans in the mining sector.

While the evidence draws only from an evaluation of artisanal work, the study findings highlight a set of critical points to inform policy-making and to make interventions that better align supply and demand. Work change is complex and its relation to skills demand is not a linear process. The social and economic choices faced by firms and individuals are critical drivers of skills demand and are thus important to understand and input into skills planning policy and decision-making. At the very least, and in accordance with similar assertions from Cappelli (2003, 2008), interventions aimed at addressing the skills development needs of a particular occupation should draw from a clear investigation of the drivers of demand in that particular industry sector and the particularity of firms constituting that sector. In other words, the planning exercise needs to take into account that the demand for skills will be affected just as much by social choices and employer decisions about how to organise work (Kalleberg 2009) as it is expected to be affected by work change.

Informed theoretically and conceptually by literature on the sociology of work and professions/occupations, some of the findings discussed in this chapter highlight the value of focusing on organisational and occupational culture in order to achieve a nuanced understanding of the skills that firms require. The chapter aims to illustrate the types of insights that are possible when working towards a labour market intelligence system that recognises issues such as the organisation of work, skills, scopes of practice and occupational identity as key to understanding supply and demand.
CHAPTER 4

The boundaries of artisanal work and occupations in South Africa, and their relation to inequality

Angelique Wildschut and Tamlynne Meyer

Since its transition to a democracy in 1994, the South African economy has been characterised by low levels of economic growth. Recent data indicate a steadily growing labour force (from 13.8 million in 2010 to 15.1 million in 2014) (StatsSA 2010, 2014). The rate of employment creation has not kept up with this expansion and the official unemployment rate rose from 24.9 per cent in 2010 to 25.1 per cent in 2014 (Stats SA 2010, 2014). Besides high levels of unemployment, the country suffers from rising household income inequality (Reddy et al. 2016). As previously disadvantaged population groups (Africans, coloureds and Indians/Asians), youth (aged 15–34 years), and women have poorer outcomes in the labour market, these social groups also bear the brunt of material deprivation and poverty.

Within this economic and labour market context, the South African government has focused on initiatives to improve job creation, and also to raise the overall skill levels of the country. Previous attempts, such as the Accelerated and Shared Growth Initiative (Asgisa) in 2004 and the Joint Initiative on Priority Skills Acquisition (Jipsa) in 2006, have contributed to understanding constraints on economic growth, of which the shortage of intermediate artisan and technical skills was identified as critical (DHET 2013a; Mukora 2009). Consequently, a key skills development focus since 1994 has been improving access to artisanal skills and occupations.

The government is committed to promoting artisan development; 2013 was declared the ‘Year of the Artisan’ (DHET 2013b) and in the following year this was upgraded to a ten-year focus when the ‘Decade of the Artisan’ (DHET 2014) was declared. In 2014, an estimated 14 000 artisans were produced per annum. The goal of the campaign was to increase this number to 1 000 more per annum, producing 30 000 artisans per annum by 2030, as outlined in the country’s National Development Plan (NDP) (DHET 2014).

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1 Employing race as an identifier is contentious, but these classifications remain important to track transformation in the country.

2 In many countries the term ‘artisan’ is used to describe a craft worker associated with traditional art or handwork. In South Africa, the notion of artisan is strongly related to a particular type of industrial work and skills are strongly associated with manual work.
Under apartheid, skills development opportunities were systematically denied to black South Africans, leading to a legacy of skills underdevelopment among the majority of citizens (Office of the Presidency 2010). This is particularly so for artisanal work and skilling in South Africa, which suffers from an exploitative history, linking it to slavery, its use as a social engineering tool under apartheid (Wedekind 2013b), its association with a limited set of trades and technical occupations (Akoojee et al. 2013), and its low status in comparison to professional qualifications and work (similar to the European experience).

It is clearly economically and socially important for the country to improve access to such work and training. Taking stock of the current situation, some successes are worth noting. Under the auspices of Jipsa, the country experienced a substantial increase in the training of artisans, from a low of 5 600 per annum (based on 2000–06 figures) to 10 100 per annum (based on 2006–09 figures) (Office of the Presidency 2010). Looking at more recent figures, the system for artisanal skills production in the country remains small (see Table 4.1) in comparison to participation in other forms of education and training (for example, 983 698 in higher education in 2013, and 396 819 in further education and training [FET] in 2011) (Sheppard & Ntenga 2015), but it has grown.

Assessment between 2005/06 and 2009/10 also concluded that the system provided greater access to training for a wider proportion of the South African population in terms of race, age and sex (Kruss, Wildschut et al. 2012). However, more recent indicators show a rise in mean age for entry and completion of artisanal learning programmes, raising the question of whether opportunities for youth are worsening (see Table 4.2).

A cursory glance at artisanal employment in the formal labour market between 2008 and 2015 also indicates some successes. While employment contraction characterised the milieu of artisans in South

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**TABLE 4.1 Registration and completion of artisanal learning programmes in South Africa, 2011/12–2014/15**

<table>
<thead>
<tr>
<th>Artisanal learning programmes</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
<th>Percentage change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry</td>
<td>24 415</td>
<td>21 849</td>
<td>27 670</td>
<td>28 302</td>
<td>16%</td>
</tr>
<tr>
<td>Completed</td>
<td>14 023</td>
<td>15 277</td>
<td>18 110</td>
<td>14 389</td>
<td>3%</td>
</tr>
</tbody>
</table>

Source: Authors’ own calculations based on DHET (2016)

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**TABLE 4.2 Change in indicators of access for participation in artisanal learning programmes in South Africa between 2009/10 and 2014/15**

<table>
<thead>
<tr>
<th>Race % black</th>
<th>Gender (F:M)</th>
<th>Age (mean age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entered</td>
<td>72%</td>
<td>86%</td>
</tr>
<tr>
<td>Completed</td>
<td>67%</td>
<td>78%</td>
</tr>
</tbody>
</table>

Source: Adapted from Wildschut et al. (2017)

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3 Statistics South Africa (Stats SA) gathers information on the national labour force via annual and quarterly surveys (referred to as the Labour Force Survey [LFS] or Quarterly Labour Force Survey [QLFS]). The major occupational category where the employment of artisans is recorded is called crafts and related trades workers (CRT workers).
Africa during this time,\textsuperscript{4} we find declining levels of inequality based on race. The underrepresentation of African workers and the overrepresentation of coloured workers persist in artisanal employment, but both the extent of over- and underrepresentation have decreased (see Figure 4.1).

Youth aged 15–34 represent a third of the SA population and it is important to ascertain how this group is faring in terms of access to artisanal employment. We find a positive growth rate for this group (42 to 44 per cent), driven largely by growth in employment of the 25–34-year-old subgroup (see Figure 4.2). This is well below comparable figures (2014) for the employment of the broader youth group (15–34) nationally (54.8 per cent), which itself is extremely low. Overall, this points to limited growth in opportunities for youth to access artisanal employment.

Gender inequality persists in artisanal employment and has even strengthened over the last few years (see Figure 4.3). This is in line with the South African LFS data in 2011, which put the overall representation of women in artisanal employment at 10 per cent. Across the four main subcategories of artisanal employment, women are best represented in the category of ‘other craft and related trades’ (41 per cent), with the remaining three categories having male representation well above 80 per cent: precision, handicraft, printing and related trades (83 per cent); extraction and building trades (96 per cent); and metal, machinery and related trades (97 per cent) (Wildschut et al. 2015).

\textsuperscript{4} Declining mining and agricultural sectors, with low growth in employment in the construction sector and combined with an economy with a strong bias towards high skills, has meant the greatest formal and informal employment losses in the labour market have been for CRT workers between 2008 and 2015.
While access to artisanal training has improved over the past decade, it is concerning to find participation in the labour market to be constrained for particular social groups. Kruss et al. (2012), using a tracer study methodology, confirmed that, while the apprenticeship system can effectively support transition to stable employment, those who are least likely to experience positive employment outcomes and most likely to experience more complex ‘zig-zag’ trajectories are women, those with low socio-economic status, those who are African and those with low educational levels.

What is it about artisanal occupations that make them a more acceptable route for men or white people? Moreover, even after overcoming barriers to employment, why do certain groups of individuals continue to suffer inequalities in terms of career progression, remuneration, representation or even treatment in employment?

the workplace? In other words, how is inequality set up and maintained in day-to-day work contexts? Answering this question requires less of a focus on the quantifiable manifestations of inequality in the workplace, which tend to characterise much of the literature, and more of an attempt to uncover the processes serving to exclude and include particular social groups in relation to artisanal work and occupations. Towards such an exposition, this chapter draws from a study conducted between 2012 and 2016, which attempted to understand artisanal milieus and identities in South Africa.

**Literature review: Concepts and theory**

Here we briefly explain the theoretical underpinnings of the main concept used for the project investigation, but also start contextualising the contribution of this study to the literature. The project considered artisanal milieus and identities and was interested in how the notion of ‘artisanal’ was both understood and delineated from other forms of work.

We drew most explicitly from the sociology of work and professions literature (Evetts 2003; Fournier 2000) in adopting the concept of occupational boundaries. Professions are occupations that have been successful over an extended period in claiming exclusive right to offer certain services and perform certain tasks for society. The contestation of occupational domains is an issue that has been explored extensively in the literature, which is seen to deal most directly with boundaries in the world of work and the relation of boundaries to occupational description (Lamont & Molnar 2002). Particularly notable is the work of Abbott (1988, 1995) and Freidson (1989, 2001) as well as Star and Griesemer (1989) and Gieryn (1983). Here key concerns have been the specificity of knowledge bases (Eraut 1985; Gieryn 1983), the link between knowledge and boundaries (Carlile 2002), work organisation and the division of labour, the skills underpinning different occupations, the tasks and objects associated with an occupational scope of practice, as well as the linkages to identity formation.

Fournier (2000) asserts that establishing and maintaining a domain of work requires the successful contestation and erecting of occupational boundaries, which would allow control over knowledge and/or practice domains in a labour market. Lewis (2012) makes a similar assertion when stating that jurisdiction is about displaying what a profession or occupation knows (its system of abstract knowledge) and connecting that to what the profession or occupation does (its labour practices).

We conceptualise an occupational boundary as created by successfully claiming a system of abstract knowledge and linking this to distinct labour practices and, in so doing, delineating a domain of work belonging to a particular occupational group. To represent the system of abstract knowledge, we select the concepts of skills and knowledge. Many argue that it is inappropriate to distinguish between knowing and doing. While we agree with this sentiment, in this study we do make a conceptual distinction to differentiate between what an artisan is expected to know and do. In using the two concepts of skills and knowledge, we highlight the symbolic relevance and discursive work that is critical in establishing disciplines and knowledge domains and their relation to occupational description. To represent labour practices, we select the concepts of tools, materials and organisation of work (see Figure 4.4). As illustrated in Gamble, work can be described as a labour process that comes about through the relation between the division of labour (or the way work is organised), the tools or technology used and the materials used... this three-way relation was the traditional way of separating one trade from another... [and] the value of understanding work in this manner remains undisputed’ (2016b: 5).

Figure 4.4 illustrates the conceptualised occupational domain of work of artisans in relation to that of technicians, as well as the elements comprising such domains.
We argue that such a conceptualisation and study approach start to address some of the theoretical and methodological gaps that have been identified in relation to the concept. First, the conceptualisation offers the opportunity to link more closely the work on social identity and boundaries – often cited as a weakness in the literature (Lamont & Molnar 2002). Second, it contributes to the research on boundaries in the workplace by illustrating the role that less well-known occupations can play in perpetuating inequality. In this conceptualisation we do not view the creation of boundaries as a fixed or end state, but as a process that is subject to being changed by a range of elements that constitute a domain of work. We see this conceptualisation as moving beyond Freidson (1989) and Traynor (2009), but also draw attention to the interaction between the objective and subjective dimensions of boundaries between occupations.

**Design, methods and sample**

As the project was concerned with what constitutes an occupational domain of work, but also how this is delineated from other domains of work, it was designed as a set of case studies of key occupational groups in a focus field of practice and industry sectors. Qualified artisans and apprentices were the foci, but related occupational groups (engineering professionals, human resources [HR] professionals and technicians) were also included in the sample. The case studies consisted of occupation-specific contextual overviews, organisational document reviews, labour market demand-and-supply analysis, and individual interviews.

The sample consisted of 96 participants: 12 HR professionals, 23 engineering professionals, 10 technicians, 34 artisans and 17 apprentices. Each interview was conducted on site and followed a semi-structured format. The interviews were recorded and professionally transcribed verbatim. The transcripts were uploaded onto Nvivo software (version 11), which was used to code the data.
CASE 1: MECHATRONICS TRADES WORKERS IN THE AUTOMOTIVE SECTOR. Mechatronics combines traditional electrical, electronic, mechanical and computer engineering. In South Africa, a dedicated mechatronics qualification at the vocational skills level has recently been instituted, along with its recognition as an artisanal trade. Engineering professionals, technicians and artisans are the current mechatronics functionaries, although they would have been trained as generalists. One can thus make a distinction between artisans who are working in the area of mechatronics but qualified in a traditional trade (electrician or fitter and turner) and mechatronics apprentices who are being trained as the ideal functionaries to work in this field at the vocational skills level.

CASE 2: MILLRIGHTS IN THE METALS SECTOR. The work of millwrights includes the construction and maintenance of heavy machinery used in industry and electrical/electronic installation of equipment. Millwrights must be able to dismantle and overhaul machinery and equipment and have a thorough knowledge of the load-bearing capabilities of the equipment they use, and of the blueprints and technical instructions to assemble machinery. The main occupational groups functioning in this area are technicians, millwrights and other generalist artisans (fitters and turners and electricians). Over the last few years, the work of millwrights has been heavily influenced by changes to the electrical component of their work.

CASE 3: ELECTRICIANS IN THE MINING SECTOR. These are typically referred to as industrial electricians. Their job involves testing, repairing and maintaining electrical equipment. Within the mining sector, electrical work and training include baseline risk assessment, basic panel wiring, fault-finding and installations, as well as working with components that make use of newer technologies, such as electronics and programmable logic controllers (PLCs). The main groups functioning in this field of practice appear to be electrical apprentices, qualified artisans and electrical engineering professionals.

Three dimensions of coding per case were done by at least two researchers to enhance reliability. Firstly, the descriptive data were classified, linking demographic data to each transcript, so that when quotes were coded at a particular node/theme, this information was included. Secondly, in relation to the project objectives we coded for instances where the elements constituting an occupational domain were described. Lastly, as social difference emerged as being critical to constructing an occupational domain of work, we coded systematically across all cases for instances where participants, when asked to describe their work as well as the work of artisans, alluded to aspects such as race, gender, language and age. We coded for specific terms associated with each of these four key variables (see Table 4.3), using the Nvivo query search function.

This allowed us to determine how many participants made reference to a code, as well as how many references were coded in relation to a particular aspect. At this stage we amalgamated certain codes that had a close relation, such as ‘old’ and ‘older’. Finally, we collapsed all the individual codes into the broader social difference variable. For example, the parent node/theme of age consisted of coding under seven child nodes/codes (‘young’, ‘younger’, ‘old’, ‘older’, ‘age’, ‘generation’, ‘youngsters’), and 48 quotes were coded under this theme. We then worked with this final set of data. Table 4.3 reflects the logic of the coding on social difference. The coding strategy thus involved both open and axial coding (Strauss & Corbin 1990).

This chapter focuses on key findings emerging from the cross-case analysis, as, due to space limits, we cannot delve into the nuance emerging from each case. We do, however, reference the case and occupational group information in the data presented.
Findings: The construction of boundaries between occupational groups in South Africa

Race, gender, language and age emerged as important bases upon which occupational boundaries are constructed and contested in the South African context. All occupational groups contributed towards maintaining this structural inequality in terms of access to artisanal work. We would not have expected that asking individuals to describe their work and how it relates to that of another occupation would
include reference to social difference, and this speaks critically to the pervasiveness of inequality in access to artisanal work and occupations in the country.

The gendering of artisanal work

One basis upon which an occupation is constructed by gender is a biological discourse, which concentrates on women’s physical capacities (size, shape, strength) to assert that certain work tasks are more appropriately performed by males (Messing et al. 2000). While this discourse was most explicitly illustrated in the case of electricians in the mining sector, a gendered discourse was found to construct the notion of artisanal work across all cases.

Some claims plainly assert that artisanal work is for men, while others allude to the physical inability of women to do artisanal work. For example, in response to women’s increased entry into artisanal work, one participant stated, ‘... if we select the wrong people what you will have in the system will always be the wrong people ... and we’re struggling now with the women ...’ (HR practitioner: Automotive sector). Another participant in a different sector indicated, with reference to women working as artisans, ‘... it’s a man’s world’ (Artisan: Mining sector). Yet another participant shared the same view: ‘They’re [referring to women] probably not interested in manual labour’ (Artisan: Automotive sector). Another participant in the same sector elaborated:

I had three of them [referring to women] just trying to hold one spanner and I had to call the other guys just to go and do it so they can see how you do it and after the guys showed them how to do it their biggest problem was that they couldn’t pick up a spanner. (Artisan: Automotive sector)

A participant in another sector alluded to women’s inability to do certain tasks associated with artisanal work, due to their size:

The only problem I find with women is when you come to heavy equipment, like switch gear and that, you know ... where a lady was doing what we call ‘phasing’ and then there was a problem but she was like this [referring to small]; now this switch gear that she needs to move is about that [referring to big] size. (Engineer: Mining sector)

Assertions that women are better suited to perform some kinds of artisanal work as opposed to others contribute to maintaining such a gendered discourse. Here, the perceived weaker strength and smaller size of women is used to argue that, if women work as artisans, they are better suited to certain artisanal trades. This phenomenon, referred to as internal segregation (Crompton & Lyonette 2011; Glover & Kirton 2006), can lead to women’s concentration in lower-status specialisms within an occupation.

We find, for instance, an artisan in the millwright’s case who stated, ‘I cannot see a lady doing a millwright’s job. Electrician’s job, yes, but not a millwright ...’ (Artisan: Metals sector). Another elaborated:

The petite ladies ... that’s coming in there, they even smaller than what you are and then they come as a millwright and I mean they cannot even handle a sixty pound hammer ... so at the end of the day, né, they’re depending on somebody else to do that for them and that’s where the other hassles also come in. That’s why ... I cannot see why they let the guy, let the ladies go into. I figure

5 New mining legislation, such as the Mineral and Petroleum Resources Development Act (No. 28 of 2002) and the Broad-based Socioeconomic Empowerment Charter for the South African Mining Industry (the Mining Charter) not only prohibit the exclusion of women but also require companies to actively change the demographic profile of their workforce by setting targets (Botha 2016).
the electricians don’t have that heavy tools to handle, so the electrician side I would say yes, but millwright, I don’t. It’s a big no … then you go over to that problem-solv[ing] … they battle with it because they’re depending on somebody to assist them. (Artisan: Metals sector)

Another way in which this discourse is maintained is reference to women’s reproductive responsibilities when talking about work. Much literature has shown that, because women have to take time off due to pregnancy and child-rearing, this makes them less desirable to employ and train in comparison to men (Rao et al. 1999). This is part of the discourse around artisanal work, where, in response to a question about recruitment, a participant asserted; ‘… so, we’ve wasted so much money in this year, on the trainers, on the equipment … just because you couldn’t condomise’ (HR practitioner: Automotive sector).

Safety and hygiene also emerge as a real challenge for women in the mining sector, and their assertions also point to the impacts and true measures of women’s access to participation in artisanal work. One participant stated ‘… so, if you needed to go to the bathroom, you need to find a very dark spot there and you must trust someone very much to watch out for you’ (Artisan: Mining sector). Another participant elaborated:

Working conditions for women underground are very hard and they have to walk long distances (three kilometres) with heavy rescue pads attached to their hips. The environment is also not good because it has confined spaces and sometimes there is no water or you have to walk far for the water and you get dehydrated … imagine you are a woman … Would you ever have kids? (Artisan: Mining sector)

Mclean and Rozier, in their study of male physical therapists, note ‘typical “masculine identified” descriptors include: knowledgeable, intelligent, problem-solver, analytical, assertive, hands-on, independent, skilled diagnostician, efficient, and technically competent’ (2009: 300). Phrases such as ‘hands-on’, ‘technically competent’ and ‘skilled in diagnostics’ were often used when participants were asked to describe the work of an artisan.

Ageism and the racialisation of artisanal work

Historically, artisanal training and employment were the preserve of white males. This was underpinned by legislation such as the job and wage Colour Bars (Webster et al. 1994), which, between the late 1800s and early 1900s set a ceiling on the wage for African labour and prohibited the employment of Africans in skilled and supervisory labour. This historical legislative, political and economic context contributed towards a very strong occupational culture6 that perpetuates the perception that artisanal work is best suited to white males, albeit in less overt ways.

What makes this significant for present-day considerations of the notion of artisanal work is that, given South Africa’s history, the current dynamic between artisan and apprentice will most likely be described by the two attributes (white/male), meaning that one is most likely to find an older white male artisan having to mentor and teach a younger black male apprentice (Wildschut et al. 2015). While we expected the relation between qualified artisan and apprentice to be described by this dynamic, we did not expect it to emerge as important for describing the work of an artisan.

We found the discourse tended to portray white and older artisans as committed and delivering better quality work in comparison to younger and black artisans. One participant claimed that ‘white

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6 Here we refer to occupational culture as the shared values of members of an occupational group, manifesting in behaviours and practice at work (Johnson & Koh 2009).
artisans are inclined to stay at the plant and are loyal’ (Engineer: Metals sector), and another asserted that younger artisans are of poorer quality: ‘The older generation followed the previous longer training route to become an artisan. After an 18-month training programme, young artisans are not always mature enough to face up to the working environment....’ (Engineer: Metals sector). A participant in another sector also conformed to this discourse in claiming that, the guys that are qualifying these days, a lot of them I’d say they’re not as good as what I think they should be’ (Artisan: Mining sector).

The intersection of race and age to construct the notion of artisanal work results in an occupational culture that is often experienced as negative and unwelcoming to new entrants into the occupation. There were many instances in which older, experienced artisans (likely to be white) were seen to be reluctant to assist younger artisans (likely to be black). An apprentice stated, ‘... I can say they [older artisans] are selfish [be]cause they don’t want to share the information, they just want to keep them to themselves’ (Apprentice: Mining sector). Another participant supported this, stating that some older artisans do not respond well, often being unwilling to assist, when being approached for help by young artisans:

I mean they know the guys are busy and sometimes they’re rude because they know, listen why I’m not a teacher I didn’t study teaching I studied electrical, why you ask me, and that’s really that’s the answers you get from the people especially the older artisans ...’ (Engineer: Automotive sector)

Some assert this to relate merely to generational and not racial conflict. One participant indicated that older artisans tend to be resistant to change and their response to younger artisans is based on the fact that they feel their job security is threatened:

No, I don’t take it personally but it’s one of those things where the guys have a resistance to change and they’re used to ... old ways and they feel that if a new guy comes in, he’s going to change that and change that. And some of them, they’ve seen hundreds of changes, so they’re just like that. The other factor as well, it’s their own personal growth. (Artisan: Metals sector)

Another participant echoed this sentiment, pointing out that ‘there’s always a fear he’s gonna take my place, so what I have to destroy him before, he’s here to take my job ...’ (Engineer: Mining sector). But others maintain that racism remains strongly entrenched in the workplace:

... first thing: Let’s say, you know racism, they’ll always be there in the mines. There’s lots and lots of white people so, somewhere, somehow, yeah, they won’t treat you nicely ... (Artisan: Mining sector)

The culture here, it’s something because the way I check it, here ... we still have that mentality, that this is black, this is white, this one he can get this, this one he can get this. We still have that mentality ... (Artisan: Metals sector)

The findings around the role of language reiterate the intersection of race and age as delineating access to artisanal work.

**Language discrimination in artisanal work**

Language discrimination can take various forms in the workplace, but generally refers to unfair treatment of an individual or group based on the characteristics of their speech, such as accent, size of vocabulary and syntax. It can also involve a person’s ability or inability to use one language instead of another.
Central to artisanal training is a close mentoring and supervisory role played by a qualified artisan, which, as explained before, in the South African context is most likely to be an older white Afrikaans-speaking male having to teach a younger black male who speaks an African language such as isiXhosa or isiZulu. This not only affects the acquisition of skills, but also highlights how a range of descriptors of social difference can intertwine to affect true access to artisanal training and employment.

In this regard, a participant described, for example, the language dynamic that might arise between an artisan and their apprentice:

We have a country full of diversity, so sometimes things you say in Afrikaans ... this guy maybe he is Xhosa he doesn’t understand Afrikaans ... So communication is coming in the in-between language, English ... I’m fortunate I know a bit of Sotho and Tswana so I can communicate well. (Artisan: Mining sector)

Another participant acknowledged the difficulties of communicating across language barriers and how this might make it difficult for some artisans in the workplace. He was very aware that being able to speak Afrikaans, in referring to ‘their language’, put him in a position of advantage in relation to other black artisans: ‘I will say there’s a difference but in my case it was different. You know, I’m actually from the Free State ... I grew up with white people. I can speak Afrikaans. I know how they are so I’m used to them’ (Artisan: Mining sector).

The language barrier also contributes to the construction of younger black apprentices as being less capable. Many participants showed awareness of being labelled as lazy, because they do not always understand what older artisans are saying, especially when they communicate in Afrikaans: ‘But on the workshop ... it’s when our boss, he is used to talk Afrikaans, forgetting that some of the others they don’t understand, go out not hearing what he’s said, going home he’s lazy or he is afraid to ask hey man can’t we use this language’ (Artisan: Mining sector).

Another apprentice shared his experience: ‘Sometimes you’ll find that you don’t understand ... maybe that person speaks to you ... or more especial [ly] when it comes to that part of a language because some of the staff ... I’m Xhosa and the other one is Lungu [referring to whites] and other one is coloured – so some of the words you might not understand the way he does understand them ... Because a Xhosa guy won’t understand exactly ... maybe he’s speaking Afrikaans – I won’t understand some of the words ... So, sometimes it becomes a problem because ... let’s say there’s a breakdown – say something in Afrikaans – of which I have to think about it – what is he saying or asking? ... Sometimes you go and come back – no I was saying this. Maybe he was saying that over the walkie-talkie [radio] – so you didn’t understand that thing, what was he saying? As you try to answer: What are you saying? ... [then you hear the person saying] this guy is stupid or all those funny things – you see?’ (Apprentice: Automotive sector).

The evidence highlights how inequality in true access to artisanal work and occupations still occurs in workplaces.

**Engaging with the findings: Discussion and conclusion**

The study sought to understand artisanal occupational milieus and identities in South Africa during the study period (2012–16). The focus was to determine what constructs the domain of artisanal work and how this is delineated from other domains of work. Analysing the discursive practice between different occupational groups in the workplace highlighted how gender, age and language continue to construct the notion of artisanal occupation and its related domain of work. We argue that this contributes to the exclusion of women, youth and those who do not speak English as a first language.
Finding social difference to inform the construction and contestation of occupational domains of work is not a novel contribution. Research on the economic and social relations of work has considered a broad range of inequalities and how these transpire across a range of occupations in organisations (Greckhamer 2011; Griffiths & Lambert 2011; Weeden 2002). However, while we appear to have a good understanding of the quantitative manifestations of such inequality (Adesina 2000; Sheppard 2012), there are still gaps in our understanding of the implications of inequalities in occupations (Bol 2016). We also still know much less about the sociological relevance of the perpetuation of inequality at work and how such inequalities are enacted in daily work practice (Tholen 2016). While the sociology of professions deals with such issues more explicitly across a range of professions (Saks 2015; Svarc 2015), acknowledged gaps remain, due to a lack of investigation into less well-known professions and an often Eurocentric perspective on the sociological study of professions and professionals (Adams 2015).

There is some South African literature dealing with inequalities in the labour market, but even this tends to reinforce the shortcomings of the international literature, by leaning towards the quantitative and focusing on the sociological aspects of inequality in more established professions (Marks 1994; Walker 2003, 2005). The historic occupational closure of most professions to African people and women has resulted in a racial and gendered skewedness to the labour market, but less is known about occupations that are not viewed to be professional.

We would argue that this chapter contributes to the outlined literatures by, firstly, highlighting how inequalities are enacted in less well-known occupations and domains of work, and, secondly, supporting the importance of continuing to uncover the bases upon which inequalities manifest in the workplace, with the aim of transforming these in a meaningful way.

Studies that more explicitly explore boundaries in the workplace are important for South Africa. Additionally, as societies across the globe face either strengthening and/or new forms of inequality, it will be critical for scholars concerned with the social and economic relations of work to do three thing. Firstly, they should continue to advocate for and revisit the understanding of key empirical constructs, such as work and occupations (Hatton 2015; Kalleberg 2009; Kurtz 2009; Standing 2009). Here, the concept of boundaries might be particularly useful in uncovering change, but so would continuities, as evidenced in the more recent proliferation of papers considering occupational jurisdiction, borders and professional boundaries (Gough et al. 2014; Haite 2012; King et al. 2015; Kroezen et al. 2013; Lewis 2012; Miller 2014). Secondly, it is important to continue to uncover and attempt to understand how social closure mechanisms play out in different labour markets. Thirdly, we should assist in broadening our gaze from research into inequality in the more traditional professions to other less well understood occupational groups, because, as this study has shown, these can also play a critical role in perpetuating and strengthening inequalities.
CHAPTER 5

Work futures for artisans and technicians

Angeliqe Wildschut

To attract young people to the trades, South Africa declared 2014–24 as the Decade of the Artisan, using the slogan ‘It is cool to be a 21st-century artisan’. To achieve this goal, the 2013 White Paper for Post-School Education and Training (PSET) acknowledged that, even though

[i]n areas of work such as the artisan trades, apprenticeships have traditionally been the pathway to qualifications ... the apprenticeship system has been allowed to deteriorate since the mid-1980s, resulting in a shortage of mid-level skills in the engineering and construction fields. Re-establishing a good artisan training system is an urgent priority; the current target is for the country to produce 30 000 artisans a year by 2030. (DHET 2013c: xvi).

This chapter argues that, as we attempt to establish a ‘good artisan training system’, we first need to ask: What knowledge and skills does an artisan need in the 21st century? The answer, which lies in the changing nature of work itself, is key to informing the development of responsive training systems, as well as their curricula and assessment. Consequently, we need to understand work itself, its organisation and the diagnostics and problem-solving found in the work of artisans and technicians. The chapter draws on one of the Labour Market Intelligence Partnership (LMIP) studies under the research theme of understanding changing artisanal milieus and identities. The study took the changing nature of work as its central theme and sought to put forward an evidence-based argument for how to prepare artisans and technicians of the future to be work-ready, drawing explicitly on the conditions and contexts of their work in different sectors and workplaces.

In each sector a focus artisan trade was identified. Sites/firms were purposively selected to illustrate the normative ‘types’ of firms to be expected in response to key changes to intermediate-level work over time. These distinctions also took into account the variation that might arise between small-medium and medium-large sites. This offered four categories for analysis and comparison across the industrial sectors. For small-scale firms, a distinction was made between those that focused on eco-friendly products or services or craft revival and those that focused on customised design and

1 Media statement by the Deputy Minister of Higher Education and Training at the launch of the Decade of the Artisan, 3 February 2014
2 This chapter draws extensively from the writing and analysis in four sector reports (Davidson 2015; Gallagher 2015; Garisch 2015; Spies 2015) and their related synthesis report (Gamble 2016b), prepared for the LMIP research theme that aimed to understand changing artisanal milieus and identities.
3 Boatbuilding (684907 boatbuilder and repairer), engineering (671203 mechatronics technician), film production (camera assistant), tourism and hospitality (681201 confectionery baker). Three of the trades studied are gazetted as trades for which artisan qualifications are required (Government Gazette, Vol. 566, No. 35625, 31 August 2012). At the time of the study none of the trades studied had a registered trade test in place yet.
production. For large-scale firms, a distinction was drawn between those that focused on specialised mass production and those that were technology-driven, with ‘flexible specialisation’ (see Figure 5.1).

In addition, the four case studies were designed as a series of interlocking areas of investigation (sector and company futures, workplace culture futures, work futures for artisans/technicians and artisanal qualification futures) to explore within and across each firm how changes to these contexts impact on the skills required from future intermediate-level work. The insights per firm could then be aggregated in different ways, for example by sector and/or firm size, or by looking at workplace culture or sector-specific findings across cases.

This chapter focuses specifically on the findings from the investigation into work futures for artisans/technicians. After sharing sector-specific findings, we abstract to offer recommendations for skills planning process and practice, with reference to intermediate-level skilling particularly. In the main, the conclusion is that skills planning can play a critical role in establishing a good artisan training system, if it draws more from examinations of the nature of the work process itself, rather than focusing on programmes and curricula that prepare people for work.

Some research vocabulary

In the ‘work futures’ investigation, researchers aimed to understand each site as a specialised context in terms of labour process and knowledge base. Researchers focused on the kind of problem-solving found in the specific labour process configuration, whether tending towards routine problems and predictable or standardised solutions or tending towards complex problems requiring new and innovative solutions. In addition to the labour process, this study focused on the issue of knowledge and how the knowledge bases required for problem-solving, diagnostics and fault-finding⁴ in particular trades may change in the future. Answers to these questions will be crucial for decisions about what the artisan and technician need to know and do in the 21st century, and thus what would need to be built into the future artisan training system.

A focus on the ‘labour process’

Work has been described in many ways, but it is useful to define it as a labour process that comes about through the relation between the division of labour (or the way work is organised), the tools or technology and the materials used (see Figure 5.2).

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⁴ These are considered key intermediate-level skills.
This three-way relationship was the traditional way of distinguishing one trade from another. Even though advances in technology and materials have broken down many of the original trade demarcations, the value of understanding work in this manner remains undisputed. The three-way relationship is the same in all labour processes, but each site of work has a particular configuration (work organisation–materials–tools/technology) that specialises the organisational context and stipulates the work roles within it. This is an important lens to examine work related to an artisan trade.

A focus on knowledge

The knowledge on which artisans and technicians draw, and what this means for apprenticeship (and by extension any other form of intermediate-level training), has been in contestation for a very long time. Since the start of large-scale industrialisation there have been major differences in approach. The English apprenticeship system, which centred round the workshop, favoured practical knowledge and was hostile to theoretical knowledge. European countries that industrialised later and needed to develop a competitive technical edge favoured a combination approach. From the start, theoretical training was offered in vocational and trade schools and systematic practical training was offered by employers (Germany) or in trade schools (France) (Deissinger 1994; Green 1995). Lundall (1997) notes the influence of both types of approaches on the South African apprenticeship system.

Accordingly, this study defined different kinds of knowledge (see Figure 5.3). Situated knowledge is viewed as knowledge based on doing and experiencing in the workplace. Formal knowledge has a more general scope than a specific workplace, and must be learned and understood rather than experienced. A second distinction refers to two different kinds of logic found in knowledge: a procedural logic and a principled logic:

- **Procedural logic** follows a sequential or step-by-step logic, which relates to a specific work context. Gamble (2016b) defines this as ‘how to’ knowledge. Procedures can also operate at a more general level that applies across contexts, for example international standards which may apply to work processes in different parts of the world. Gamble (2016b) defines this as ‘systems knowledge’.

- **Principled logic** establishes connections between parts through reasoning. A specific principle can be visualised and represented in a drawing as a ‘logical picture’ that shows the proportions between parts. Gamble (2016b) defines this as ‘craft knowledge’. A principle can also establish relations between abstract concepts at a general or universal level; then it is expressed in symbols or words. Gamble (2016b) defines this as ‘scientific knowledge’. Figure 5.3 shows the four types of knowledge, labelled K1 to K4.
K1 is knowledge that is acquired through routine work. Workers with a strong K1 base know how to do tasks in a particular work context. Regular work patterns provide the basis for this type of knowledge, with on-the-job training and mentoring as the modes of learning. K1 includes knowledge about technical aspects of a job, but also informally acquired knowledge about task management, contingency management, and client and workplace interaction (Stewart & Sambrook 1995: 96).

Whereas K1 applies to specific tasks or work performances, K2 operates at a general level. It often takes the form of general work procedures, documented as standard operating procedures (SOPs), which a business or enterprise puts in place to ensure that services and/or products are delivered consistently every time. SOPs may apply to occupational areas, departments, organisations or sectors as a whole. At an international level, technical committees of the International Organization for Standardization (ISO) draft international standards for quality management and quality assurance that apply to all participating countries. Systems knowledge may be represented by relatively straightforward step-by-step procedures, written in standardised formats and/or shown in flow charts. Systems knowledge is often contained in a manual and may be learned in the workplace or in formal external education and training settings.

K3 and K4 knowledge is represented as knowledge types required for innovation and unpredictability of end result with relation to work tasks. Since ancient times, the use of jigs, templates and other shape-determining systems as well as habits of work have been ways in which workers constantly tend to reduce the risk and increase the certainty in any task – to the extent that the risk has almost become invisible. Yet, the principle of uncertainty of the end result remains a critical criterion against which workmanship is judged (Pye 1968: 13).

‘Craft’ usually refers to a work process that is completely under the control of the worker from start to finish. It is for this reason that we often see craft knowledge exemplified in the use of sketches and drawings, which are used to show relationships between parts to form a ‘whole’. Marx’s famous words describe what happens in craft as well as in design:

*A spider conducts operations which resemble those of a weaver, and a bee would put many a human architect to shame by the construction of its honeycomb cells. But what distinguishes the*
worst architect from the best of bees is that the architect builds the cell in his mind before he constructs it in wax. At the end of every labour process, a result emerges which had already been conceived by the worker at the beginning, hence already existed ideally. (Marx 1976: 283–284)

In many trades, increasing mechanisation has diluted or partially destroyed the parts-to-whole nature of craft work. This does not mean, however, that craft work has disappeared completely from commercially driven enterprise. In many forms of work some operations have predetermined results and others are performed through the workmanship of risk, with part–whole relations not predetermined. It is for this reason that we find elements of craft work in all technical and professional work.

Scientific knowledge can be described in two ways: as pure science and as applied science.

The scientist’s goal is knowledge at its most general, and the use of highly abstract concepts, connected to experimental observation by complex logical and mathematical relationships, has greatly assisted this place. Knowledge in this form and at this high level of abstraction is not always able to serve the needs of practical action. What is implied here is the need for science students, having reached understanding at a high level of generality, to be able to climb down the ladder of abstraction and judge where to stop, i.e. recognise which level is most appropriate for their specific technological purpose. (Layton 1993: 10–11)

Thus, pure scientific knowledge is reworked to become usable to specific technological tasks and design. Scientific knowledge does not exist in ready-made form to map onto real-life problems. The level of abstraction must be readjusted to make it useful and applicable.

It is easy to see how these different kinds of knowledge relate to certainty and risk within the broader work context and/or labour process: the greater the need for certainty of the end result, the greater
the emphasis on standardised work performance through common work procedures. The greater the emphasis on innovation and design, the greater the need to work out new connections between parts, not by trial and error but through principled reasoning. Here, risk is inevitable, as the answers are not known beforehand. Work always has components of certainty and risk. Both kinds of work are present in all labour processes, and so the question is not whether 21st-century artisans and technicians need this kind or that kind of knowledge but what kind of knowledge combination will be needed for expert work performance.

The typology set out in Figure 5.3 thus provides the starting point for the knowledge base changes investigated in this study. In interviews with artisans, technicians and their supervisors, the researchers did not ask directly about knowledge, qualifications or curriculum. Instead, the researchers enquired about how artisans set about diagnosing and solving problems in their work settings, presently and in the future. Table 5.1 shows the kind of questions asked for present practice.

All responses were inputted into the software package SPSS and used to compute aggregate data to assess whether different knowledge types within a trade were used more frequently than others, or to aggregate this information across sectors. When the knowledge types are put together, they represent the knowledge base required for the diagnostics and problem-solving tasks undertaken by the artisans and technicians whose work was studied in each sector. Furthermore, as each respondent was asked to reflect on the current and future situation, it was possible to combine the average scores to depict what the current knowledge base is and whether and how this is predicted to change in the future, per artisanal trade and sector (see Figures 5.4–5.7).

**Knowledge base and labour process variations across cases**

Here, attention is drawn first to the average rating for the use of different knowledge types per sector. In addition to the average rating per knowledge type, it is also possible to reflect on the shape of the knowledge base per listed trade investigated in each sector. Second, the findings from the evaluation of the labour process in each sector will be shared. It is then possible to use these findings to raise some general insights useful for planning policy and processes around artisanal skills.

**The case of baking**

In the main, baking was found to be a highly mechanised and automated industry, with a more recent revival of artisanal baking and the introduction of informal baking complementing mass production. There are a few points to note from the graphical depiction of the present and future knowledge base findings for this trade (see Figure 5.4).

The knowledge base of this sector is restricted in terms of both breadth and depth. The strongest knowledge type found is K1, which refers to situated ‘how to’ knowledge, learned on the job and usually not written down. This knowledge type is seen to be used ‘fairly often’ (an average score of 3.5). It should also be noted how strongly the changes anticipated reflect the desire of the work force to have opportunities for formal training (as reflected in the widening of the bottom part of the figure). In other words, whereas currently K4 knowledge is seen to be used closest to ‘not at all’ (an average score of 1.2), this is predicted to move to a score of 2 (‘not often’). In this regard, Spies notes that presently ‘there is no trade test or any other method that allows a baker officially to use the title of baker’ (2015: 35). Similarly, while situated knowledge does not seem to form a large part of the current knowledge base, it is predicted that this will form a slightly larger part of the knowledge base in the future.
As indicated earlier, it is also important to take into account labour process variations to be able to fully understand skills needs deriving from work change. In this sector and across firm size, the research confirms a strong distinction between mass production and niche production for local and national markets. This leads Spies (2015) to identify five different occupational variants of ‘baker’ (see Table 5.2). Each type is described in terms of labour process variation. Even though some of these variants would now be classified as semi-skilled or unskilled jobs, all five variants are described to show that they originally derived from ‘baker’ as an artisanal category that has existed since time immemorial.

This represents a classic case of labour process segmentation, with the Type 4: Craft baker as the archetypal baker and Type 1: Industrial baking as an entirely objective, mechanised and/or automated organisation of production, overseen by a supervisor. The mass production industry would like to view the Type 2: Retail baker as similar to the Type 4: Craft baker, but work observation shows that the risk involved in a process of baking where everything is done by hand is far greater than processes using premixed ingredients and tools such as moulders and dividers, which remove handcraft, to assure a standardised result. The rejuvenation of the artisanal craft baker is a fairly recent niche market addition. Small market share and limited prospects of growth through product and business diversification characterise artisanal baking, but the craft baker remains the ‘gold standard’ of the baking industry.

The introduction of the Type 3: Informal baker is also a recent commercial innovation. Using cheaper materials and resembling craft at a surface level, the short duration of the training (a few days) is not comparable to the apprenticing relation that produces the Type 4: Craft baker. It is, however, a natural downward extension of industrial baking as a means of livelihood production and it holds great promise for self-employment and further entrepreneurial extension.

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**FIGURE 5.4 The knowledge base on which the baker artisan draws**

Baking (combined)

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### TABLE 5.2 Forms of labour processes found in the work of bakers

<table>
<thead>
<tr>
<th>Mass markets</th>
<th>Type</th>
<th>Division of labour</th>
<th>Tools</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1: Industrial baking</td>
<td>There is no baker. Supervisors lead different production teams of semi-skilled or unskilled workers and ensure that the baking process runs smoothly. Production teams monitor proper functioning of production equipment used during various stages of the mechanised process.</td>
<td>Baking is a fully mechanised process done through the use of increasingly sophisticated production equipment.</td>
<td>Basic baking materials of flour, water and yeast and a special cocktail of secret ingredients.</td>
<td></td>
</tr>
<tr>
<td>Type 2: Retail baker</td>
<td>The baker bakes some or all of the products sold or served at the business, including bread, croissants and confectionery. Some work is done by hand, with increased use of tools for shaping and baking products.</td>
<td>Ovens, proovers, mixers and tools like moulders and dividers</td>
<td>Basic baking materials of flour, water and yeast as well as premixed ingredients and freezer-to-oven products.</td>
<td></td>
</tr>
<tr>
<td>Type 3: Informal baker</td>
<td>The baker bakes bread and other products at home and sells to the township community. Everything is done by hand, from mixing ingredients to shaping and baking products.</td>
<td>Oven and possibly mixer</td>
<td>Basic baking materials of flour, water and yeast.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Niche markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 4: Craft baker</td>
</tr>
<tr>
<td>Type 5: Craft baker/owner</td>
</tr>
</tbody>
</table>

Source: Spies (2015: 25–27)
The case of boatbuilding

Boatbuilding is a sector in the process of setting up its first apprenticeship training programme, having previously imported formally trained and certified boatbuilders as well as relying on situated knowledge gained through on-the-job training. Thus, the recognition of boatbuilding skills at intermediate level is of recent vintage. Figure 5.5 illustrates that the knowledge base on which this sector draws is fairly evenly distributed, although, currently, not at a deep level. Future trends indicate that a combination of systems knowledge (K2) and formal scientific knowledge (K4) will be a requirement for work codified in SOPs and for meeting ISO standards.

It is anticipated that a closer integration of design with production and an emphasis on innovation will drive the knowledge base outwards and increase the need for formal, principled knowledge (K4). This will also provide the underlying basis for the high levels of formal technical procedural knowledge (K2) required in this export-dominated and globally standardised sector. Based on this expectation, it is envisaged that mathematics and science at Grade 12 National Senior Certificate (NSC) level will become vital as an entry requirement to skilled work at the intermediate level in this sector.

While the introduction of the first formal apprenticeship in the boatbuilding sector is linked to the occupational title of ‘boatbuilder’, Davidson (2015) identifies five occupational variants of ‘boatbuilder’ in a sector where there is a trend towards a closer relation between manufacture and design (see Table 5.3). The description of types again refers to labour process variation and degree of work autonomy.
As in the baking industry, boatbuilding covers a wide occupational range that shows the impact of mass production labour processes on artisanal knowledge and skills needs. Type 1 refers to narrow specialisation at the level of semi-skilled work. The traditional trades are represented by Type 2: Artisans, with marine contextualisation, obtained through extensive work experience, as an additional requirement.

Type 3: Technician is an emerging type brought about by increasing systems complexity through shifts towards technologies based on information and communications technologies (ICTs). Type 3 technicians have a higher level of autonomy but a smaller manufacturing scope than either Type 2 or Type 4. Working at a systems level, the work is more specialised and at the same time more restricted.

**TABLE 5.3 The labour process in boatbuilding**

<table>
<thead>
<tr>
<th>Type</th>
<th>Division of labour</th>
<th>Tools</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1: Assistant/semi-skilled worker</td>
<td>Follows instruction closely. Close monitoring at risk moments. Specialised to a task/function.</td>
<td>Works with hand tools on basic repetitive tasks.</td>
<td>Materials define the work.</td>
</tr>
<tr>
<td>Type 2: Artisan</td>
<td>Multiskilled, can do different tasks within a team context. More likely in a small company. Can apply knowledge and therefore can problem-solve in a new way.</td>
<td>Generally works with power tools and drawing interpretation. Moves within the industry.</td>
<td>General qualified artisan with on-the-job specialisation in boatbuilding. Contextual specialisation in marine environment e.g. marine carpenter, marine fitter, marine fabricator, marine pattern maker.</td>
</tr>
<tr>
<td>Type 5: Master boatbuilder</td>
<td>Business, production, technical and design oversight. Links work of all types.</td>
<td></td>
<td>Oversight of materials, quality and performance. Manufacture/design interface.</td>
</tr>
</tbody>
</table>

Source: Adapted from Davidson (2015: 20–23)
On-the-job experience and supplier training and re-training are considered vital. Type 4: Boatbuilder is also an emerging type that requires expertise in all aspects of boatbuilding processes. This type signals the continuation of the age-old craft of boatbuilding, but under conditions of advanced technology that require a formal knowledge base. Finally, Type 5: Master boatbuilder is a professional boatbuilder who has entered the industry from a related professional field, such as engineering, or from a business background. At this level, a key dimension of required understanding is the manufacture–design interface.

As stated before, historically this sector has not trained formally, and prior to 2006, certified boatbuilders were imported. The fairly recently registered yacht- and boatbuilding qualification is closely aligned with international boatbuilding curricula and offered as a learnership at NQF levels 2–4. The recent listing of boatbuilder and -repairer as a trade will introduce an apprenticeship and a formal trade test. Expectations are that a professionalisation process has commenced that will lift industry standards to a level where mathematics and science at NSC Grade 12 level will be standard requirements for formal entry to the sector. At the same time, on-the-job training and experience will continue to be highly valued.

The case of film production (trade investigated: camera assistant)

The film production sector was included in the study as an example of a vibrant emerging industry that holds promising potential for the future. In this sector the occupational category of ‘artisan’ is not used. However, training in the sector occurs in the mould of the apprenticing tradition, even though there is no formal artisan training system or trade test. A previous study described the sector as a young sector that caters for visiting film-makers as well as being in the process of developing a local industry. It is characterised by a relatively unregulated working environment and enormous diversity, ranging from small self-employed production units to high-level companies. Film crew members tend not to be employed by one production house but belong to a crewing agency’s pool and work on contract to various production houses. Work is seasonal with no guarantee of repeat employment when foreign production houses use South Africa as a regular location.

Training and learning resources and systems tend not to be formalised. All entrants, irrespective of whether they have prior formal qualifications, begin as runners or production assistants and remain there for at least one season to develop an overall sense of the production process. Fairly large production houses employ one or two trainees per shoot to shadow technical staff and take on about three volunteers per year who get paid. Small independent producers, who are often at the cutting-edge of production, seldom have the resources to train, although some offer unpaid internships to senior students from film schools. (Summarised from Gordon et al. 2007)

In line with the above description, Gallagher reports on a strong distinction between commercial film production for international content and community-based local content film production:

In recent years a host of community-based television production companies have emerged, responding to the viewing demands of particular constituencies, interest groups and human rights issues. These small sites have two main objectives: the production of local content on the one hand, and the training of aspirant film-makers who come from disadvantaged backgrounds without the means for formal education, on the other. Here, these film-makers are exposed to all aspects of film. (2015: 6)

5 Also cited by Gamble (2012: 23).
Investigation shows that much of the knowledge base at intermediate level is procedural and equipment-related (K2) (see Figure 5.6). As this is a freelance industry, camera assistants operate as independent contractors, responsible for their own training and for staying up to date with rapidly changing technologies. There is an expectation of growth in the formal knowledge base even though the predominant view is that it is practical exposure to all aspects of film-making (pre-production, production and post-production) that enhances technical expertise.

Film production has undergone fundamental technical changes in the last decade, with a shift from analogue to digital format. This involves the conversion of analogue content into a binary code readable by a computer. The shift from tape stock or film in analogue format, which is physically loaded into the camera, to digital cards which are placed in the camera, has revolutionised this sector. As can be seen from the graph, digitalisation, as a rapidly evolving technology, logically places an emphasis on formal systems knowledge (K2).

Further, based on the analysis and close investigation of the labour processes within the sector, it was possible for Gallagher (2015) to identify several occupational variants. Table 5.4 illustrates the variants and captures two very different components of the film industry. The study thus reports on the occupational titles of ‘first camera assistant’ and ‘second camera assistant’ in the commercial film sector, and on the occupational title ‘film-maker’ in the funding-driven local content sector. What connects the two occupational positions is that both represent the informal apprenticing tradition that characterises how skill formation occurs in this industry. Table 5.4 includes information about how different film production companies divide their labour and which tools they use.

In commercially driven sites, digitalisation has created new positions in the camera crew, such as that of the digital imaging technician and the data wrangler. The digital imaging technician is the camera department crew member who works in collaboration with the director of photography on workflow.
<table>
<thead>
<tr>
<th>Film-maker type</th>
<th>Division of labour</th>
<th>Tools and/or materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Funding- and resource-driven companies focusing on local/regional content with emphasis on training of aspirant film-makers from disadvantaged backgrounds</strong></td>
<td><strong>Type 1A:</strong> Composite film-maker (all-rounder); production of local content in a small site</td>
<td>A composite film-maker, this artisan has all-round expertise and is responsible for all foundational aspects of film-making in pre-production, production and post-production. As the site is small, the degree of digitisation evident is dependent on the funding available. A mixture of old and new technology is used. As composite film-making skills are required, conception and execution are clearly combined. Film-maker is able to use own initiative and operates with a high degree of autonomy.</td>
</tr>
<tr>
<td><strong>Type 1B:</strong> Composite film-maker (more specialist focus); production of local content in large site</td>
<td>The composite film-maker in a large site has increasingly expanded expertise and primarily operates the camera and post-production editing of footage. Film-maker performs some aspects of pre-production, production and post-production but tends to focus on one aspect of film-making more than others. The degree of digitalisation evident is dependent on resources available. As composite film-making skills are required, conception and execution are clearly combined. Film-maker is able to use own initiative and operates mainly independently.</td>
<td>Camera gear, sound gear, lighting gear, editing suites, sound mixing equipment, web and social media</td>
</tr>
<tr>
<td><strong>Commercially driven sites focusing on international content</strong></td>
<td><strong>Type 2A:</strong> Camera assistant (all-rounder); production of international content in a small site</td>
<td>Camera assistant acts as an assistant to the camera operator or the director of photography. Performs production duties but can from time to time perform post-production duties. Full digitisation and latest technology are evident. Conception and execution mainly separated but can be combined. Limited decision-making but higher risk due to participation in duties beyond that of camera assistant. Limited autonomy, falls under management of camera operator/director of photography.</td>
</tr>
<tr>
<td><strong>Type 2B:</strong> Camera assistant (more specialist focus); production of international content in a large site</td>
<td>Camera assistant has specialist knowledge and main duties are those of assistant to the camera operator. Work takes place within multiple camera crew teams. Strictly production – no contact with camera while in operation. Full digitisation and advanced technology used. Conception and execution entirely separated. Autonomy and decision-making not evident. Limited risk due to presence of video technician and digital imaging technician.</td>
<td>Dollies, trolleys, lenses, notebooks, pens, electronic clapperboards</td>
</tr>
</tbody>
</table>

Source: Adapted from Gallagher (2015: 35–36)
camera settings, signal integrity and image manipulation to achieve high digital image quality and to meet creative goals. The data wrangler position was created as a support role for managing, transferring and securing digital data acquired on set via digital cinematography cameras. The work of the camera assistant has been profoundly affected by these new positions (Gallagher 2015: 7).

Significantly, film production is the only sector where a conscious redress strategy was encountered in response to a need for scriptwriting and film-making that deal with local and regional content. There is also a direct connection between such initiatives and strong government support for the sector in the form of incentives and/or rebates. Local content film-making (and training) reproduces the contours of traditional craft models, in the sense that ‘all-rounder’ film-makers are developed in the full cycle of pre-production, production and post-production. Like the baking sector, the film production sector is effectively divided into two distinct subsectors, each responding to a different market and with no continuity between them.

The case of mechatronics

Mechatronics (in engineering), which provides technical services and maintenance in an automated workplace environment, was found to have a deeper knowledge base than all the other sectors (see Figure 5.7). The anticipation of an increase in technological complexity is indicated through a strengthening of the formal scientific knowledge base (K4) and a decline in ‘how to’ knowledge’ (K1). At the same time, there is a strong emphasis on increasing automation and computerised control of production processes, which foregrounds formal systems procedures (K2).

**FIGURE 5.7 The knowledge base on which the mechatronics artisan draws**

<table>
<thead>
<tr>
<th>Mechatronics engineering (combined)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craft knowledge (K3)</td>
</tr>
<tr>
<td>'How to' knowledge (K1)</td>
</tr>
<tr>
<td>Systems knowledge (K2)</td>
</tr>
<tr>
<td>Formal scientific knowledge (K4)</td>
</tr>
</tbody>
</table>

Source: Gamble (2016b: 37); see also Gamble (2016a)
Despite the changes predicted, the knowledge base remains remarkably stable. This could be attributed to engineering being an occupational field regulated by strong occupational demarcation, based on formally acquired qualifications, but also a newly emerging field of practice, where current knowledge would be closest to future expectations.

The graph reflects the most complex knowledge base out of the four sectors investigated, in that all four types of knowledge are utilised evenly in diagnostics and problem-solving. Future trends indicate that the knowledge base will continue to be stable and that drastic change is not anticipated.

When considering the labour process, Garisch (2015) found an occupational split between artisans and technicians involved in technical services and maintenance. A new trade of mechatronics technician (OFO Code 671203) has been designated, with qualifications at technical and vocational education and training (TVET) college level. This trade is intended to slot in on a level above the traditional trades, but below that of professional automation technicians. Table 5.5 names the different types and describes them in terms of the fault-finding and problem-solving in technical services and maintenance required in an automated engineering workplace.

### TABLE 5.5 Types of mechatronics work at intermediate level

<table>
<thead>
<tr>
<th>Type</th>
<th>Division of labour</th>
<th>Tasks and responsibilities (reflecting type of tools and/or materials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1: Engineering artisans</td>
<td>These artisans make up the first line of defence with regard to fault-finding and problem-solving in cases of breakdowns, whether caused by equipment failure or error. If they cannot fix the problem in a prescribed period, it is escalated to the next level in the hierarchy of technical and professional personnel. In conventional engineering workplaces, where production is based on electro-mechanical systems, technical services and maintenance support functions are performed by either a dedicated electrical and mechanical artisan or in a combined fashion by a millwright or electro-mechanician. In theory, it is envisaged that a Type 2 mechatronics artisan will be sufficiently multiskilled and knowledgeable to perform functions in relation to the conventional electro-mechanical-aligned trades, as well as in relation to automation-related or computerised control functions associated with mechatronic systems, but at a lower level than that at which the automation or mechatronics technician operates.</td>
<td>Tasks are practical and hands-on, in relation to installation, maintenance servicing and repair of the electrical and mechanical components of production machinery or equipment.</td>
</tr>
<tr>
<td>Type 2: Mechatronics technician (OFO Code 671203)</td>
<td>The proposed new mechatronics technician is intended to slot in at a level above the traditional trades, replacing such artisans, but below that of professional automation systems-aligned technicians. In theory, it is envisaged that a Type 2 mechatronics artisan will be sufficiently multiskilled and knowledgeable to perform functions in relation to the conventional electro-mechanical-aligned trades, as well as in relation to automation-related or computerised control functions associated with mechatronic systems, but at a lower level than that at which the automation or mechatronics technician operates.</td>
<td>A mechatronics trade test has not yet been registered. The closest related registered trade of relevance is that of dual-trade millwright or electro-mechanician (OFO Code 671202), the trade focus of which spans electrical and mechanical systems, but which falls short on the automation or software side. This technician will have a working knowledge of programming and software-related aspects, e.g. understanding error codes on the programmable logic controller (PLC) and conducting computerised diagnostics, but will not actually do programming.</td>
</tr>
<tr>
<td>Type</td>
<td>Division of labour</td>
<td>Tasks and responsibilities (reflecting type of tools and/or materials)</td>
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</tr>
<tr>
<td>Type 3: Automation technician</td>
<td>This is a generic term used in relation to persons holding a national diploma in automation-related engineering, for example, mechanical, electronic, electrical or mechatronic engineering. Project work: Some project work follows on root cause analysis, but most projects are reportedly self-initiated following approval from the relevant supervisor or manager in support of production optimisation. The technician is responsible for all planning and management, including purchasing of components, and programmatic aspects. Project work comprises the bulk of the technician's work and is essentially programmatic-related. Conducting independent research is reportedly becoming a key requirement. Testing new equipment for functionality and adherence to predetermined specifications: whether integration between the field device, the PLC and the Supervisory Control and Data Acquisition (SCADA) system (remote network-based ‘pro-active’ fault detection). Continuous monitoring and analysis of production and operations equipment and processes-related performance data of individual machines and overall systems and network contexts, to ensure that the production line runs at optimal levels. Fault detection, root-cause analysis, problem fixing and reporting in major breakdowns. This involves scrutinising logs and performance data relating to equipment and processes.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from Garisch (2015, 28–30)

Two crucial differences distinguish mechatronics from the other three sector studies. The first is that mechatronics refers to technical services and maintenance functions, and not to direct production functions. It is thus not an area of work that is directly susceptible to the impact of mass production processes on the division of labour. The second is that the engineering sector has long been regulated by formal technical and trade qualifications. Workers are only allowed to do what they are qualified to do. Work demarcations thus follow formal qualifications, and the boundary between an artisan with a trade qualification and a technician with higher education qualifications is strictly maintained. For this reason the emerging type ‘mechatronics technician’ (listed as OFO 671203) is a contentious issue in the sector. At the sites visited, the dominant view is that mechatronics technicians (NQF Level 6) set the industry standard and that to function successfully in an automated engineering environment, the ‘artisan of the future’ should be qualified at technician level (NQF level 5 or 6) (Garisch 2015: 45).

Occupational variations in artisanal and technical work

Perhaps not surprisingly, overall the analysis shows that formal scientific knowledge is currently used to a limited degree, if at all. However, in all sectors there is an expectation that formal knowledge will become a necessary ingredient of technical complexity and a resource of the future. In certain instances, trends are aspirational rather than actual.

In the main, the key findings point to shifts in the types of knowledge on which diagnostics and problem-solving at artisanal and technician levels draw, and how this, combined with labour process variations, can have significant labour market implications. There is evidence of shifts towards predictable...
standardised work and a shift towards unpredictable risk work. Sectors either move in one direction only, or they display both trends simultaneously. The latter leads to a mix of upskilling and downskilling. As illustrated by the labour process findings, the effect of patterns of upskilling and downskilling is that no sector offers only one version of the designated trade or specialist occupation studied. In each sector, at least two or more variants and/or subvariants co-exist. Artisans and technicians in all sectors diagnose and solve technical problems, but there are marked differences in the knowledge on which they draw to do so: differences in type, depth and breadth of knowledge.

It is the assemblage of types that shows how an occupational field becomes fragmented and diluted, but also how it rejuvenates and reconstitutes itself in response to a combination of market demand and a retrospective yearning for occupational rootedness (Shatto & Shaw 1982). This has a significant impact on training and skills development pathways.

A demand-side view on work and qualifications futures for artisans and technicians

By examining the nature of the work process itself rather than programmes and curricula that prepare people for work, this study took a demand-side view to inform skills planning for future artisans and technicians. The study selected four very different sectors for investigation, including established as well as emerging sectors, large and small enterprises, sectors with established qualification pathways for artisans and technicians and sectors where training is mostly informal and provided on the job. What do the findings tell us about skills planning that can inform artisan training systems for the future?

Craft apprenticeships as a common thread

While the engineering or metal trades are typically the focus of investigation for artisan training, it is important to note the trends in the other three sectors. The sector study in mechatronics (in engineering) indicates an upward shift in the conceptual knowledge base of mechatronics-related artisan-type work, to move it towards specialisation at the technician end of the engineering spectrum, and away from the traditional artisanal trades. However, the common thread in the other sectors is that each one, in its own way, still values a craft model based on all-round expertise and control of work, from start to finish. In baking, a designated ‘baker’ almost does not exist any longer, and yet a recent research study identified a need expressed by production supervisors for a stronger occupational identity, which may be accomplished through reconnecting with the experience of craft baking (Tennison 2014). In boatbuilding, the boatbuilder as a person who requires expertise in all aspects of boatbuilding is emerging strongly as a preferred work and training model, in an industry where production and design are moving closer together. In film production, the model identified for the training of aspirant film-makers is, similarly, one of all-round expertise. In the commercially driven part of this sector, an ideology of craft as all-round expertise continues, even as digitalisation has restructured the industry and downskilled what were previously regarded as artisan-level jobs.

The implications of the continued value attached to all-round expertise are worth considering, in terms of the importance this places on apprenticeship as mode of learning. These findings are in line with international findings on the continued positive image the general public and employers hold for ‘apprenticeship’ as a means of work readiness preparation (Maguire 1999). This is valued, despite the decline of opportunities for all-round expertise and a definite downskilling trend towards routinised work. Studies have also found that employers believe that employees do not feel the same sense of occupational identification and ownership when apprenticeships are ‘repackaged’ or replaced by alternative forms of training (Fuller & Unwin 2001).
In addition, considering the simultaneous up- and downskilling trends of artisanal work across different sectors raises the importance for skills planning to support and contribute to developing a diversified system with multiple entry and exit points and different types of delivery. Single artisanal trade qualifications will not be sufficient, given the empirical trends. They will run the risk of being positioned at too high a level, in educational terms, for young people who have completed or dropped out of school with low levels of educational attainment; alternatively, they may produce too low a level of expertise to satisfy the work needs of industry.

Two key insights for planning emerge from these conclusions:

- **Return to apprenticeships:** Evidence of a continued employer belief in the value of all-round expertise makes it feasible to suggest a return to apprenticeship as the main mode of delivery towards artisanal qualifications at intermediate labour market level.
- **Introduce a foundational apprenticeship in all sectors:** Foundational apprenticeships need not be tied to cutting-edge technology and equipment and need not require NSC pass marks in mathematics and science. All workers should be able to enter through a process of recognition of prior learning. Successful achievement at this level will signal a baseline of knowledge and skills available to the sector. A foundational apprenticeship could be followed by an intermediate and/or advanced apprenticeship with more stringent entry requirements, to provide sectoral progression pathways and developmental opportunities.

As in other countries, this study has shown work-related knowledge and skills to be complex and multifaceted, involving different and sometimes contradictory dimensions. It has illustrated how an understanding of labour process variations and their impact on diagnostics and problem-solving at the intermediate level provides a solid basis for supply-side planning that does not take an ‘imaginary curriculum’ as starting point but refers to actual work processes and their differences in large and small enterprises and different sectors.
**CHAPTER 6**

**Curriculum responsiveness and student employability: An institutional analysis**

*Volker Wedekind*

Education organisations are under constant pressure from policy-makers, political actors and the public to make their programmes responsive to the needs of the economy and society. In contexts of social change and where broader economic and societal issues such as high rates of unemployment are prevalent, this pressure is heightened, in part because of what Grubb and Lazerson (2004) have dubbed the ‘Education Gospel’ – that is, the faith that education can solve intractable economic and social problems. Typically, education organisations are expected both to provide a quality educational experience and to make their offerings relevant and informed by the needs of employers. The degree to which they succeed is very often measured in terms of the extent to which students who participate in the programme are deemed to be employable. However, exactly what employability means is widely contested, and there is a debate as to how much education organisations and their programmes can affect student employability (Taylor 2005; Watson 2014).

This chapter contributes to that debate by exploring the ways in which different types of qualifications and programmes lead to different employment opportunities. The focus is not on the educational content and process as much as on the way the various actors in the labour market (specifically the students and the employers) make sense of the qualifications.

This chapter draws on case study data from a project that sought to understand the relationship between student employability, curriculum and organisational responsiveness at a range of different South African education and training organisations. What emerges from the cases is that responsiveness and the way those responses impact on employability vary greatly and are contradictory in some respects. I argue that, to make sense of the diverse ways in which responsiveness works and the ways in which organisations enhance the employability of their students, an analysis is required of the ways in which educational qualifications and processes become institutionalised.

An institutional perspective goes beyond thinking in terms of policies, educational practices or curriculum, but rather examines the ways in which policies, organisations and practices become institutions that have regulatory, normative and cultural-cognitive elements (Scott 2014). I argue, through the analysis of the case studies, that the employability of graduates of education programmes is largely affected by the degree of institutionalisation of the education organisations and their practices, and

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the students’ and employers’ understandings of those practices. Before discussing the case studies, I briefly outline the concepts of employability and responsiveness, and then provide an overview of the key features of institutional theory and how this can be applied to understanding educational organisations and their interaction within political, economic and educational systems.

Employability and curriculum responsiveness

The concept of ‘employability’ has become central to debates about education over recent decades. Closely linked to the notion of employment, it places the focus of attention on the individual rather than the systemic or structural features of being in or out of employment. The question as to what makes a person ‘employable’ focuses attention on the skills and attributes that an individual has that make them an attractive prospect in the labour market, and consequently poses questions about both the individual’s responsibilities in gaining and demonstrating these skills and attributes and the role of education or training organisations in imparting the knowledge, skills and values that students need (Frankham 2016; Watson 2014; Wedekind 2014).

A particular focus in the literature has been on expandable sets of transferable and/or soft skills, apparently central to people becoming employed and staying in employment (Taylor 2005). These vary from common process skills, such as problem-solving, to being able to communicate and act collegially in an organisational environment (Curtis & McKenzie 2002).

Problems of unemployment are increasingly attributed to the failure of the individual to be employable, rather than to a structural feature of the economy at a particular moment. Consequently, the success of education organisations in achieving employment outcomes for their graduates is used as a measure of the value of the programme and its curriculum (and by implication the organisation itself) (Cremin 2010). While there is a growing literature that problematises the concept of employability, there are few signs that its central role in shaping education policy is diminishing. Employability is viewed as a measure by which universities should be judged and ranked, and significant resources are focused on ensuring that graduates gain the elusive employability skills (Frankham 2016).

The central concern of the project on which this chapter is based is how education organisations respond to the challenge of employability. It examines the relationships between education organisations and employers, particularly how organisations adjust their curricula to ensure that their students gain the skills that make them employable. The project team developed a notion of responsiveness, building on the work of Gamble (2003) and Moll (2004) that explores the variety of curriculum drivers that education organisations have to engage with in order to shape their curricula. While the dominant pressure on educational organisations is to make their curricula more responsive to the needs of industry and commerce, both Gamble and Moll argue that responsiveness has to be understood as being broader than that. Moll (2004) points to the need to be responsive to factors such as the disciplinary community that generates the knowledge, the needs of the student and wider community needs, while Gamble argues that education providers must assert their role as educational interpreters of the signals from the economy, market and community (2003: 69).

The conceptual framework for the project (Wedekind & Mutereko 2016a) thus understood curriculum responsiveness as interacting with five drivers: (1) employers (as drivers of both demand and supply with regard to labour and education and training); (2) students/workers/job-seekers; (3) policies and regulations; (4) societal and environmental issues; and (5) the internal dynamics and resources of education and training organisations. These drivers of curriculum responsiveness describe a more complex interaction between curriculum and qualifications, on the one hand, and the degree to which these enhance students’ employability in the labour market, on the other hand.
However, as will be shown from the case studies, recognising the multiple drivers of responsiveness still did not adequately explain the variation in the ways in which qualifications and other educational programmes were understood in the labour market. The patterns varied greatly from case to case.

In order to explain these variations, it is necessary to understand the degree to which these educational programmes or the organisations which offered them were or were not institutionalised. To do this it is necessary to briefly describe key aspects of institutional theory as it has developed in sociology, political science and organisational studies (Lowndes & Roberts 2013; Mahoney & Thelen 2010a; Scott 2014; Thornton et al. 2012).

Institutionalism

The concept of an institution is slippery and there is no single definition that has emerged as the standard. In everyday language, the term ‘institution’ is often used interchangeably with ‘organisation’. Yet it is also understood as something more than, or less than, an organisation, in the sense that a particular practice or pattern of behaviour (such as a tradition) can be referred to as an institution (Dacin & Dacin 2008). This can be a specific practice within an organisation or a wider social practice like the institution of marriage.

In addition, most definitions of institutions emphasise the durable, reproducible and change-averse characteristics of institutions (Palmer et al. 2008). Organisations, on the other hand, are the objective formal structures that are comprised of rules, regulations and procedures. Organisations may also become institutions when they are ‘backed up by societal norms and the enforcement capacities related to them’ (Streeck & Thelen 2005: 12). Particular practices within organisations can also become institutionalised. In contrast to organisational analysis (which usually focuses on the technical environment – that is, on tasks, functions and regulations), an institutional analysis is broader and encompasses overarching social forces, such as the expectations, norms and standards of the people in the organisation (Kraatz & Zajac 1996).

There are various schools of institutionalism, and the field has developed significantly since the foundational studies of the late 19th and early 20th centuries, but for the purposes of this discussion I draw on new institutionalism and the institutional logics perspectives which have been evolving since the 1970s (Lowndes & Roberts 2013; Scott 2014; Selznick 1996; Thornton et al. 2012). New institutionalism focuses on institutional rules, but also issues of legitimacy, and the degrees to which institutions develop similar structures and patterns in different contexts (Meyer & Rowan 1977). This approach attempts to provide a synthesis of the key strands of institutional theory in sociology, economics, political science and organisational studies.

In particular, I draw on the work of Scott, who defines institutions as follows: ‘Institutions are comprised of regulative, normative and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life’ (2014: 48). Scott (2014) describes three pillars of institutions:

- The first pillar is the most commonly understood and studied aspect of institutions, namely the regulative structure or system. Regulative structures or systems are ‘generally formal and explicit, legally sanctioned, and indicated by rules and laws, often enforced by the state’ (Palmer et al. 2008: 741). Because of their explicit nature, these structures are often assumed to describe the sum total of institutions.
- The second pillar of institutions is labelled as normative structures, which are legitimated through moral codes rather than laws or rules and are based on social obligations. They include both values (what is desirable or undesirable) and norms (how things should be done). Normative systems often give rise to roles, which define expectations for certain individuals. Normative con-
ceptions of institutions do not preclude formal rules, but generally institutional order is based on common beliefs and values.

- The third pillar of institutions is the cultural-cognitive dimension. These are based on shared, often taken-for-granted understandings of social reality. Scott’s use of the hyphenated concept points to the interplay between external cultural patterns and how these shape – and are shaped by – internal interpretive processes. In other words, institutions are shaped by, and shape, the patterns of feeling, thinking and acting of individuals, until these patterns appear to take on a solidity and permanence that may be mythical but is also often very stable.

While these three constitutive pillars of institutions can be distinguished and analysed and their varying organising assumptions unpacked, institutions often present overlapping logics. For example, the legitimacy of an institution is significantly strengthened if it finds expression in normative and regulative mechanisms, or if cultural patterns are aligned to normative expectations. Obviously, the opposite is also true, namely that institutions are weakened if there are contesting logics of other institutions at play in the same field.

Neo-institutional theories use the concept of field as ‘the domain within which a particular institution operates’ (Palmer et al. 2008: 742). In other words, a field consists of the ‘space’ within which a set of organisations interact with each other around a common meaning or symbolic system. These would not necessarily be similar organisations or actors, but rather actors that collectively make up a societal sector. Fields may overlap (such as the field of production in a particular industry and the field of education and training associated with that industry) and institutions may operate in more than one field.

Institutionalism has evolved into a well-established theoretical and empirical field of study. It has become central to a number of branches of the social sciences, including political science, sociology, economics, policy studies and business studies (Greenwood et al. 2008). Educational studies were foundational to the development of the theory, and focused particularly on the isomorphism of the international education system (Boli et al. 1985; Meyer et al. 1977). More recent work has included a focus on educational management (Meyer & Rowan 2006), and a well-developed body of work has emerged that applies the insights of the ‘varieties of capitalism’ literature from political science to the differences between different national skills systems (Busemeyer & Trampusch 2011; Mahoney & Thelen 2010b; Soskice & Hall 2001).

These political economy analyses of the differences between different forms of capitalism, particularly Anglo-Saxon deregulated market models and coordinated European and Asian examples, have provided a basis for understanding differences in the structure of occupations, and the relationship between education and training and the labour market (Moodie et al. 2013). In the South African context, this work has influenced researchers examining the skills system and critiquing policy such as the National Qualifications Framework (NQF) (see, for example, Allais 2012c; Kraak 1999, 2004b). This work focuses on the formal, largely regulative level and deliberately avoids non-formal, normative and cultural-cognitive dimensions. Understanding educational processes at a micro-level, from an institutional perspective, is not common in the education research literature.

Before exploring what institutional analysis brings to the understanding of curriculum responsiveness and employability outcomes for students in the case studies, it is necessary to describe the case studies and summarise their findings.
The case studies and general findings

Two sets of linked case studies, conducted by a team of researchers2, were located in the agro-processing and automotive manufacturing and maintenance sectors of the South African economy. The agro-processing set included studies of

• the role of the South African Sugar Association (Sasa) and Forestry South Africa (FSA) in education and training;
• the training of chemical engineers for both sugar and forestry industries;
• forestry-specific programmes offered at three universities and a specialised engineering programme sponsored by the paper and pulp industry.

The automotive manufacturing and maintenance set included studies of

• the curriculum and delivery of the National Certificate (Vocational) in Automotive Repair and Maintenance (NCV ARM);
• the skills needs of informal sector mechanics;
• the artisan development programme at a prominent automotive manufacturer;
• the mechanical, industrial and electrical engineering programmes at one university of technology;
• a heavy equipment manufacturer that had a well-developed apprenticeship and in-house training programme.

The broad insights from the case studies were synthesised in relation to the five curriculum drivers, and then discussed thematically.

In terms of employers, the key finding was that there was no single view as to what makes people employable and what employers’ responsibilities are in terms of training. Most critically, employers primarily based their valuing of qualifications on reputation and trust in the education organisation. Newly approved qualifications that were not known tended to be poorly regarded. General concern was raised about poor levels of general education and this was directly related to the ‘soft’ skills often associated with employability (Williams et al. 2016).

The case studies included a number of positive partnerships between employers and education providers and there was a general willingness by all parties to engage. There was also a question about how closely programmes should be aligned to a specific industry, as this may in fact limit employability and ultimately make the programme unattractive (this issue is discussed in detail in Wedekind & Mutereko 2016b).

Student needs varied across the cases. Structured programmes of support or simply caring lecturers made a difference. For most students, the greatest obstacles were material issues, such as accommodation, transport and food.

Policy (or lack thereof) framed the curriculum and in some instances constrained what could be achieved. For example, the requirements of the NQF made it difficult to combine different levels of knowledge and purpose in one work-oriented programme. Requirements for work-integrated learning (in the form of work placement) created blockages in the system that were beyond the control of education providers. Policy and regulations also facilitated coordination within a sector or industry, which made it easier to respond to skills needs. Whereas policy or regulations require a response based on compliance and threats of sanction, there are also social and environmental pressures and concerns that demand a response on the basis of an ethical and social justice imperative. For example, changing

2 The full team are acknowledged in the final report (Wedekind & Mutereko 2016a)
traditional raced or gendered patterns of recruitment or increasing awareness about wastage or workers’ rights might be important issues to include in curricula, but they may at times sit in tension with employer perspectives. However, we found that these issues do offer a vehicle through which wider generic skills can be taught.

The final driver that shaped curriculum was the organisation itself. A curriculum is always mediated by the capacities and resources available in the organisation and has to align with organisational procedures. Curriculum decisions are shaped by staffing needs, organisational systems and priorities, and strategic decisions such as cross-programme outcomes. Overall, the analysis of the case studies suggested that responsiveness is a complex interplay of multiple factors and not a simple correspondence between employer needs and programme delivery.

The findings from the case studies can be summarised as follows. Firstly, curriculum responsiveness needs to be understood as going beyond a simple one-way relationship with employers, where their needs are better reflected in the curriculum. Education organisations have to balance the full range of drivers that shape the curriculum and enhance or hinder the potential employability of the graduates. Secondly, however, while there were certain patterns that emerged from the case studies, there was also enormous variation in what types of programmes enhanced opportunities for employment and why. It was true that the cases showed that relationships between employers and education providers seemed to strengthen prospects for the graduates, but the nature of the relationships varied greatly from case to case. Furthermore, as has been found elsewhere (for example Moodie et al. 2013), programmes related to regulated occupations tended to provide students with clearer pathways into employment. However, while this finding was consistent across most instances, it was not always the case. As will be discussed below, some qualifications had no formal status but were nevertheless viewed as highly desirable by employers, while other qualifications that formally met all the criteria for employment and were regulated had no purchase in the labour market.

Similarly, the degree to which employers interact with education providers to influence curriculum varies greatly. Some of the employers provided very little direct input, others played a major role defining the curriculum, and in other cases the curriculum was shaped through dialogue. It is therefore not possible to draw any specific conclusions as to best practice.

Given these somewhat inconclusive findings, how, then, does one analyse what shapes patterns of behaviour? In the next section I will argue that drawing on neo-institutional theory provides a useful lens for making sense of what at times appear as anomalies in the data.

**Delving deeper: An institutional lens on the case studies**

In this section I will explore in more specific detail some of the examples from the case studies and draw on the three pillars of institutionalism discussed earlier (the regulative, normative and cultural-cognitive) to examine the ways in which the programmes in the case studies can be said to have become institutionalised, and what institutionalisation means for the employability of the students on those programmes.

**Sugar**

Sasa provides a good example of how a range of organisations and practices have become institutionalised in a way that ensures that actors within the various components of the system understand what is required for someone to be deemed employable in the sugar sector.
Sasa exists as a coordinating structure for the industry and includes the producers of the sugar crop (the farmers) and the producers of the sugar products (the millers) within one structure. Sasa and its affiliated organisations also play a direct role in the production of new knowledge by conducting research on various aspects of the sugar production cycle through the South African Sugar Research Institute (Sasri) and the Sugar Milling Research Institute (SMRI), and these organisations disseminate new knowledge through training programmes. In addition, the Shukela Training Centre (STC) provides direct training in technical skills to people working in the industry.

Over time, Sasa and the various entities and affiliates have become institutionalised at a number of levels. At a regulatory level, Sasa is fairly unusual as it is a statutory body governed by an Act of Parliament. This ensures that it has the authority to require that all players within the industry participate. Decisions about the industry, its skills needs and the training programmes and qualifications offered by Sasa are all understood and agreed upon by everyone through various formal structures. This regulatory environment is coupled with a shared historical understanding of the value Sasa offers its affiliates. Time and again, in interviews with various Sasa officials and role-players in the industry, the value of Sasa and the particular way the sugar industry is organised were stressed in a manner that went beyond the formal regulatory level. There is a normative dimension to how work roles are habituated within Sasa, and there is a history and culture referred to within the industry that have evolved over decades, since the foundation of the industry.

This shared understanding is reflected in the training processes within Sasa as well as the patterns of skills recruitment from outside the organisation. Central to the common understanding within the industry were the two certificated courses offered by Sasa. We were repeatedly informed in interviews with employers that ‘everyone in the industry’ understood that the junior and senior certificates offered by Sasa covered everything that people needed to know about the sugar cycle. Regardless of whether you were a farm worker identified by a farmer as a prospective skilled worker, a newly employed scientist with a PhD or a manager, everyone in the industry was assumed to have done the certificate. This even held true for people from sugar-growing regions in other parts of Africa. Yet these certificates had no formal status in the South African education system, as they had not been registered on the NQF. No one we interviewed, whether they were participants on the courses, course teachers or employers, seemed concerned about the lack of formal status. The response was always much the same: ‘Everyone in the sugar industry knows and recognises this, what difference does it make?’ When Sasa officials were questioned about their decision not to register the qualification on the NQF, it was explained that they had looked into it and had attempted to go through the process. However, a number of factors resulted in their decision not to go this route.

One influential factor was that the junior and senior certificates offered by Sasa do not fit the predetermined qualifications and levels of the NQF. When they tried to align the qualifications to a specific level, they found that their mix of knowledge and skills did not match the outcomes specified at any of the levels. The certificates were introductory, in part, and would therefore have to be at a fairly low level, but the content included some technical and scientific knowledge that went past that level.

Given that the majority of people had extensive experience in the industry or had prior academic qualifications, the student mix was complex. If the qualifications were registered at a higher level, admission could be constrained, as some participants would not have the requisite prior levels; complex recognition of prior learning procedures would therefore be required. If the qualifications were formally set at a lower level, it was feared that the certificates would lose the prestige they hold within the industry, which would undermine their value. Further, the certificate programme could not be neatly aligned to the 120 credits-per-year structure that all qualifications on the NQF followed.
The other alternative was to register the certificates as a series of unit standards, but this would fragment the logic of the sugar cycle that underpinned the curriculum. Ultimately, we were told, the certificate programme would lose more than it would gain if it were aligned, even though this meant that recipients could not carry credits into other qualifications and that the legality of offering the certificates was in question. However, even the certificates’ transferability did not seem to be compromised, as examples of students who had moved from sugar to other crop-based industries were cited as evidence that the certificates were recognised by employers outside the sugar industry. In this case, the certificates were not institutionalised through regulations, but were strongly normatively institutionalised.

Not all the courses Sasa offered operated outside the formal legal frameworks. The STC, a semi-autonomous training facility that offered courses in a range of fields, had to comply with the regulatory frameworks because many of the qualifications were not restricted to the sugar industry. For example, the training in trades such as boilermaker or electrician was undertaken at a registered training facility and trade test centre and graduates would have qualifications that met the generic standards, and not the sugar industry’s specific needs. However, given the dated nature of the national curriculum and the particular skills required by the sugar industry, the official curriculum was supplemented with modules that ‘plugged the gap’. For instance, because lifting equipment relies heavily on pneumatics, the mechanics’ training included this as part of the programme, even though the trade test did not require this. The centre director described the prescribed curriculum and assessment system as the minimum that needed to be covered, rather than the limits of what was covered. This enabled students to achieve the national standards, while the STC trained to the requirements of the industry and were able to be responsive. In this case, the institutionalisation functioned through a regulatory and normative process in a mutually reinforcing manner.

Forestry

The forestry industry provides a useful comparative example. FSA is a looser coordinating structure, based on voluntary participation and funded by contributions from its members. While it represents the owners of over 90 per cent of timber plantations, it does not have statutory status. It does not engage with training functions directly, but interacts with the training system to represent the industry on the chamber of the Fibre Processing and Manufacturing Sector Education and Training Authority (FP&M SETA) and directly with key education providers. Higher-level scientific skills and senior managers are trained via a specialised programme in forestry and wood science at Stellenbosch University. FSA is in regular contact with the university department and provides input into their curriculum development processes.

Intermediate-level forestry positions, such as foresters and siviculturalists, are trained in programmes offered at the Nelson Mandela University’s (NMU) Saasveld campus, a former forestry college that was incorporated into the Port Elizabeth Technikon in 1985 and subsequently into the Nelson Mandela Metropolitan University (now NMU) in 2005. The forestry programme at NMU has been the main skills pipeline into the forestry industry for decades, so much so that the term ‘Saasveld’ is a widely understood signifier for a specific level of training in the industry. In adverts for positions in various companies, Saasveld (and not the actual qualification) is specifically stated as a qualification prerequisite. Stellenbosch and Saasveld have become the institutionalised routes into the forestry industry from a normative and arguably cultural-cognitive basis. They signify a certain educational product that people in the industry know and understand (much like the Sasa certificates in sugar), in part because almost everyone in senior positions within the industry have come through these routes.

3 See http://www.forestry.co.za/general-information-about-forestry-south-africa/.
themselves. In this sense it is a value assumption, based on a shared understanding and trust, that is not linked directly to the specifics of the curriculum.

There are a number of other institutions (universities and colleges) in South Africa that offer forestry-related qualifications. These qualifications are technically the same as those that are offered via Stellenbosch and NMU in terms of name and level, and a desktop analysis of the curriculum and learning outcomes reveals very similar programmes. However, students who graduate from other institutions struggle to find work in the industry, while graduates from Stellenbosch and NMU are highly likely to find employment. What accounts for this phenomenon? When questioned about this, senior officials in FSA indicated that they were not properly consulted by the institutions about the need for the programmes, that they were not familiar with their offering and generally could not attest to the quality. Human resource (HR) recruitment officers and managers responsible for recruitment gave similar accounts. Some were not aware that these programmes were on offer and questioned why they were necessary, given that the historical universities provided an adequate supply for the system.

Essentially, the pattern of accessing qualifications from specific universities has become institutionalised through the historical patterns and the recurring interactions between FSA and the universities, and between employers and recruits. Over time, this has become a cultural-cognitive structure that reproduces a practice that is not regulated but is understood by the people working in this industry. The attempt to enter this field by education organisations that are not part of these cultural-cognitive understandings results in the failure of their students to gain a certificate that makes them employable, despite the fact that, at a technical level, this certificate is identical to ones offered elsewhere.

Paper and pulp
A further example from the forestry, paper and pulp industry highlights how institutionalised arrangements do change over time, and how institutionalised practices, such as those described above, potentially could be changed. The paper and pulp industry identified a gap in the supply of mid-level engineering technologists and technicians for the milling component of the industry and entered into a partnership with a specific university of technology to deliver a bespoke programme that trained graduates for these positions. It was felt by the industry that the general chemical engineering programmes at these levels did not focus enough on the specific processes involved in paper and pulp, and that there were benefits to training people in these processes. In many senses this programme was exemplary in terms of partnership arrangements. The curriculum was co-constructed between the industry body and the university, experienced staff were seconded from the industry to the university and paid for by the industry to teach on the programme, workplace experience was available, and students graduating from the programme were thus highly employable – in fact, they were all but guaranteed employment after graduation. In addition, the industry funded the majority of the students with a generous bursary scheme that ensured that they were able to attract the best students.

This arrangement had been in place for more than two decades and in that time had become institutionalised, providing a steady pipeline of skills into the industry. However, during the course of the research it became clear that this arrangement was no longer as stable as it once had been. A number of contextual and organisational factors had resulted in incremental adjustments to various components of the partnership that were starting to undermine its value. To start with, the partnership had been established when the industry was expanding and profitable. However, particularly after the global recession and the decline in the value of the currency, which resulted in increased input costs, the industry looked for

4 This case study is described in detail in Wedekind & Mutereko (2016b).
ways to cut costs. The partnership was expensive and not deemed core. One of the areas where savings were achieved was in the recruitment of students. Bursaries had historically been offered to academically strong students in their penultimate and final years at school. The process of recruiting from schools was dropped and the few remaining bursaries were made available to students after they were enrolled on the programme. This resulted in a gradual decline in the quality of the applicants (as measured by their school results), and so it increasingly became a fall-back option for those students who were not accepted into chemical engineering or those who could not secure other sources of funding.

The external economic circumstances were coupled with changes in the organisational environment of the university itself. The programme was established when the institution was still a technikon and industry linkages were central to the mission of the organisation, and work experience was the primary criterion for staff selection. However, once the technikons became degree-awarding institutions, and particularly after they gained university status, there was a shift in the organisational mission and culture. Staff members came under increasing pressure to engage in research and attain higher degrees, and the focus of student enrolment shifted towards degrees and postgraduate programmes. The status and value of the programme within the university declined and the pressure on staff to focus on research increased, resulting in a gradual devaluing of the programme.

The students’ own expectations of the programme had also shifted. In part, because the programme was no longer recruiting the highest achieving students at school level, the students that were enrolling were not necessarily committed to a career in the industry. The students interviewed all indicated that they were not aware of the programme or industry until they arrived at the university to register for other courses and were made aware of the opportunity. None of them had a strong preference to work in the paper and pulp industry. While the programme still ensured that students would have excellent prospects of employment, the fact that this was tied narrowly to one industry was viewed negatively by the students. A critical concern for the students was the fact that the programme, while recognised by the paper and pulp employers, was not recognised and accredited by the Engineering Council of South Africa (ECSA) and therefore did not provide possibilities for employment in occupations in other related industries.

The combination of a number of factors linked to the environment, the organisation and its internal dynamics, strategic decisions taken by the industry itself and the desire for longer-term mobility by the students had resulted in a shift in the normative and cultural-cognitive pillars of the institution. Thus, while the regulative dimensions remained constant, the shared understandings had shifted over time and weakened the institution.

Automotive repair and maintenance

The final example is from the automotive sector. A new qualification, the NCV ARM, was introduced to provide a foundational qualification for a range of occupations in the repair and maintenance side of the industry. The qualification had been registered on the NQF, was offered through public colleges and was being funded by the national Department of Higher Education and Training (DHET). However, we found that employers were either unaware of or uninterested in employing graduates with this qualification, despite the curriculum covering most of the knowledge and skills required for occupations related to vehicle maintenance. There appeared to be a complete disconnect between the organisations in the field of automotive repair and maintenance and the educational providers, the colleges. Unlike the examples cited above, the industry field was much less coordinated, with

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5 Technikons were vocationally oriented higher education institutions that offered industry-linked qualifications, much like polytechnics in the UK and elsewhere. These were changed into degree-awarding universities of technology in 2003.
When employers were asked about how they recruited, the pathways described were very diverse. Informal workshops usually recruited from friendship and kinship networks (Okoye 2018), as did many of the smaller firms. Larger firms continued to value the old apprenticeship pathway linked to a dated curriculum and a trade test. This was based on a normative and cultural-cognitive institutional understanding of how one enters the industry, built on shared understandings from the personal career paths of employers (much like the forestry example). With no regulations governing the field, it seemed that the NCV ARM had little prospect of becoming institutionalised as a route into the industry; consequently, the students were not regarded as employable. However, the large multinational corporations that had franchised service centres had begun to engage with colleges and the DHET around reworking the NCV ARM curriculum to better suit their needs, and there were signs that it might eventually gain acceptance in this sector as a basis for entry into a structured apprenticeship or for some entry-level positions. If this development were to materialise, the qualification could slowly gain recognition, and because many of the people working in smaller firms had received their training in the big companies, this pattern could become the institutionalised norm. However, this is a slow process, with the credibility of the qualification threatened by the lack of employability of graduates not locked into training pathways with the big corporate employers.

Each of the examples above illustrates the diverse ways in which qualifications and employers interact within specific fields. The degree to which the field itself is regulated and organisational actors’ interactions are formalised varies greatly. The status of the qualifications varies too, both in terms of their official legal standing and their normative (and cultural-cognitive) standing in the field. To conclude, the next section discusses what this institutional analysis means for thinking about policy and practice in respect of curriculum responsiveness and employability.

**Taking the institutional arrangements seriously**

This chapter has focused on the mechanisms that strengthen or weaken the ways in which practices become institutionalised. The approach shows some of the diverse ways in which employers, policymakers and education providers interact within a field and what the consequences are for the employability of students in that field.

The case studies highlighted the complex array of drivers that education organisations have to respond to. This signals the importance of recognising that a singular focus on the needs of employers is not necessarily desirable. Even if a curriculum is geared to the needs of employers, this does not, on its own, ensure that students are employable. What the analysis above suggests is that, for a programme or qualification to be successful at making students employable, it needs to be institutionalised in the specific industry or field. The ways in which a programme becomes institutionalised vary. It can happen through the making and enforcement of rules, such as in many professional fields, where a specific qualification is a requirement to practice. Often, over time, the rule becomes norm-based and there is thus little need for enforcement. This is the argument for greater regulation suggested by Moodie et al. (2013) in their examination of Australian vocational education’s links to different occupations. However, in a context such as South Africa, where the regulatory and enforcement capacity is weak, attempting to institutionalise through imposition is likely to result in outcomes such as the NCV ARM example.

Strong institutions are built gradually and are mutually reinforced through regulatory, normative and cultural-cognitive institutional processes, resulting in a resilience which is often difficult to change.
A number of the cases in the study point to this, with varying emphasis on institutional pillars. In the case of the sugar industry, the regulatory pillar is weak, but there is a strong normative and cultural-cognitive understanding. In the case of apprenticeships, the regulatory pillar is stronger, but it is also reinforced by deep normative and cultural-cognitive understandings. The nostalgia for the old apprenticeship-linked qualifications has little to do with their relevance today and seems primarily based on shared understandings amongst practitioners based on their own experiences. Attempts to reform this by trying to replace the linked National Accredited Technical Education Diploma (NATED) qualifications have been resisted to such a degree that regulatory decisions had to be reversed.

While resilience is a feature of institutionalised practice, this is not to suggest that institutions do not change (and weaken) over time (Mahoney & Thelen 2010a). Some practices that were institutionalised have become weaker (such as the paper and pulp example), and there are possibilities that qualifications such as the NCV ARM may become institutionalised in due course.

While it is clear that institutionalising a practice cannot be decreed overnight, recognising that the three pillars of institutions are mutually reinforcing suggests that strategies to reform educational programmes and deliver positive outcomes for students should target all three aspects. The drawing up and enforcement of regulations is the first level and is where policy-makers focus their attention. Promulgating new qualifications, putting in place quality assurance structures, encoding activities on qualifications frameworks and standardising curricula are all part of the regulatory machinery used to define an educational field. This is an important and necessary part of the process of building institutions. However, it is unlikely to succeed, or will take much longer to succeed, if this is done without taking the other pillars seriously. Ultimately, one should attempt to build upon existing normative and cultural-cognitive understandings or develop new understandings that ultimately do away with the need for regulation and enforcement. This may require that existing norms be challenged and replaced or reimagined, and that cultural-cognitive assumptions be recognised and challenged. This cannot be done by edict and requires a wider conversation amongst a range of stakeholders, including employers, unions, students and educators. These processes are much less predictable, and the ideas will be contested, but without these levels of engagement regulatory reforms will, at best, produce weak institutions. Because the process of institutionalisation is generally slow, building on existing institutions is likely to be easier than completely changing every aspect of an existing practice. If policymakers pay more attention to the shared understandings in particular industry fields (recognising, for example, traditions of apprenticeship, the names of qualifications that carry cachet, or which education providers are recognised), they could build on those understandings to strengthen existing institutions or progressively build new institutions.

An institutional analysis reveals a rather messy picture. The natural inclination from the perspective of the state is to attempt to impose order through regulation. In authoritarian and coercive contexts this may be possible, but it almost inevitably has unpredicted and unwelcome consequences (Scott 1998). In democratic, heterogenous and often more fragile states, top-down imposition is also unlikely to succeed, particularly when regulations are tied to short political cycles. Building deeper collective understandings cannot be achieved only at high levels. They require engagement at the level of the firm, union branch and student classroom. This is complex work, but the result will be institutions with resilience and longevity that ensure that training and education deliver real benefits for all.

Much more detailed sector-specific research work is required to understand the range of vocational pathways and how these can be strengthened. I would argue that an institutional perspective that focuses on the regulatory pillar as well as the normative and cultural-cognitive pillars offers a more productive lens for thinking about how the field, as a whole, can be strengthened to support education organisations, employers, and – most importantly – young people trying to access work opportunities.
NEW WAYS TO THINK ABOUT DESIGNING AND RESOURCING EFFECTIVE INSTITUTIONAL ARRANGEMENTS FOR SKILLS PLANNING AND DEVELOPMENT
National development policy challenges firms to upgrade their technology and innovate, so that they can become more productive and competitive in a global and national economy and create more jobs for sustainable and inclusive growth in the context of high unemployment. This means that the nature of the education, training and skills required is changing rapidly, challenging post-school education and training (PSET) organisations to be more flexible, adaptable and responsive.

In Chapter 2, John Buchanan posed an alternative model to the dominant one of skills development: to devise a new skills settlement based on ‘capabilities-powerful knowledge’ skills planning. Significantly, to respond effectively does not simply require credible data to predict future skills needs, but the ‘design and resourcing of effective institutional arrangements’ (Buchanan, this volume). The chapters in Part 2 provide detailed empirical evidence of how such ‘complex institutional arrangements’ operate at the interface of skilling in different sectors. Such a task is not the sole prerogative of government, but is shaped by the interests, actions and institutional arrangements of the private sector, the market and civil society organisations interacting at the meso- and micro-levels of occupational groups, the workplace, and education and training organisations.

A similar concern sparked the research on which the papers in Part 3 are based. The Labour Market Intelligence Partnership (LMIP) research team proposed a different, systemic and dynamic paradigm which shifts away from the current static and linear models of supply and demand. The empirical focus was on three sectoral systems of innovation (SSIs): sugar growing and milling in KwaZulu-Natal (Petersen 2015), automotive component manufacturing in the Eastern Cape (McGrath 2015) and astronomy and the Square Kilometer Array (SKA) nationally (Gastrow 2015).

In Chapter 7, Glenda Kruss and Il-haam Petersen set out the framework, and the following chapters use this in diverse empirical contexts. In Chapter 8, Michael Gastrow, Kruss and Petersen analyse the system of innovation and skills development elaborated in regard to the SKA, to illustrate the capacity to plan ahead to support learning and accumulate new knowledge and to grow a high-technology, frontier science sector in South Africa. In Chapter 9, Petersen and Kruss analyse the actors, networks and institutional arrangements in the sugar SSI, to illuminate the critical roles public and private intermediaries play in skills development. The research highlights the need for a move towards systemic thinking and suggests that coordination is crucial to bridge the gap between public and private objectives.

In Chapter 10, Kruss, Simon McGrath, Petersen and Gastrow compare all three cases to analyse the role of higher education in skills development. The research highlights the need to build the capabilities of universities to be interactive and innovative within organisations, networks and systems. This implies a skills planning model that also addresses the capabilities of universities to shape their core education and training activities, and it places a stronger focus on organisational learning – through sensing change, coordinating, and integrating new mechanisms and structures within the university.
CHAPTER 7

A framework for understanding capabilities for skills development in sectoral systems of innovation

Glenda Kruss and Il-haam Petersen

A team of Labour Market Intelligence Partnership (LMIP) researchers proposed to adopt an innovation systems approach grounded in evolutionary economics, a conceptual framework that had not yet been used systematically or widely in South Africa to inform skills planning. For an innovation systems approach, at the heart of explanations of economic growth and development is a focus on the alignment between capabilities for knowledge, skills and learning in firms, and capabilities for knowledge, technology and innovation in the education and training subsystems.

Basically, the theory underlying innovation system analysis is about learning processes involving skilful but imperfect rational agents and organisations. It assumes that organisations and agents have a capability to enhance their competence through searching and learning and that they do so in interaction with other agents and that this is reflected in innovation processes and outcomes in the form of innovations and new competences. (Lundvall 2010: 331)

Innovation system analysis offers a systems approach, mapping the main actors in key systems and subsystems, and the linkages and networks between them. It traces change over time, and how previous historical trajectories and conditions shape what is possible. It focuses on interaction, mapping flows of knowledge and resources between actors for learning and innovation. With a focus on learning, capabilities and interaction, it enables us to identify weaknesses that may lie within organisations, related to their institutional arrangements and capabilities, or externally in the system itself, including misalignment between networks, missing organisations and critical blockages of flows of knowledge and resources.

The LMIP research team proposed that such an approach would enable analyses that highlight the capabilities of firms, post-school education and training (PSET) organisations and intermediary organisations that lead to effective skills development. An example of a good skills development network is a work-integrated learning office at a university of technology that has institutional status and sufficient resources to coordinate activities across departments and faculties, build long-term partnerships with firms, and mentor and support students in a way that is functionally integrated into the organisation’s teaching and learning activities and ensures that students are able to receive quality workplace learning to graduate.
Another example is industry advisory boards that have been an effective mechanism for interaction between firms and universities of technology in relation to specific occupations and disciplinary fields, and that may provide a model for enhancing flows of knowledge and resources more effectively in universities or technical and vocational education and training (TVET) colleges. Or, as another example, the key role played by private sector industry associations in linking firms and specific departments in universities or colleges may be replicated on a wider scale.

There are also existing practices that result in blockages and gaps. For example, firms may not be willing to host interns for work-integrated learning purposes, which blocks the flow of qualified graduates available. University academics may respond negatively to the demands made by firms, as they may view it as imposing a narrow instrumental orientation at odds with their mission to produce well-rounded citizens for a democratic future. Or a TVET college may not have the up-to-date technology infrastructure to train their students in the way firms require, which leads firms to set up alternative in-house or private training.

Such a lack of capabilities leads to misalignment between firms and public colleges and can contribute to shortages of employable graduates with the skills required for specific sectors or occupations at different levels. Systemic analysis allows us to identify specific ways in which to enhance capabilities for skills development and promote flexible and adaptive education and training organisations.

This conceptual approach led to methodological novelty as well. South African skills development and planning research tends to occur in a way that fragments the subsystems of the PSET system. There are experts who conduct research on the role, contribution and challenges of higher education, others on TVET, others on Adult Basic Education and Training (ABET), and so on. This research, in contrast, was designed as a set of comprehensive and conceptually integrated comparative case studies of a sectoral innovation system as it operated in its entirety in a specific spatial location. The case studies investigated skills development arrangements within and between all types of firms, PSET subsystems and intermediary organisations, in an integrated cross-cutting manner.

From the design phase, the plan was to analyse across these case studies once they were completed, to investigate critical issues comparatively. For example, if we compare how well each of the sectoral systems meet their skills needs, we may be able to identify organisational forms that work well in these specific cases, and that can be of wider relevance and application in other sectors and settings. If we synthesise across the cases to investigate what is common, we can identify institutional arrangements, capabilities, incentive mechanisms and interventions that may be significant. Abstracting from the analysis of empirical patterns, we may thus gain insight to inform policy debates to strengthen and inform new models of skills planning and development.

**Why focus on building networks and interactive capabilities?**

The framework was informed by previous work on the role of universities in the national system of innovation and development. A body of work was created on the interaction between universities and firms in developing countries that aimed to promote innovation and economic development. This was extended to analyse university interaction with a range of external social partners, including government, communities and civil society organisations (Kruss 2003; Kruss, Visser et al. 2012). The focus of this work was on understanding the institutional policies, structures and mechanisms that promote or constrain distinct forms of interaction, with their associated benefits for firms in a sector, and for universities. The research focused primarily on the role of universities in relation to knowledge generation and research and innovation. However, innovation and skills development are inherently interlocked and interdependent; hence, the role of universities in knowledge diffusion in teaching is closely intertwined with innovation.
So, although it was not a primary focus, previous innovation studies work highlighted dynamics relevant to the production of skilled graduates for high-skilled professions and occupations.

The LMIP research team decided to explore the new kinds of questions that would be raised and the new kinds of insights that would be possible if an innovation systems approach was applied more systematically to focus directly on skills development across the PSET system. There is growing precedent for this in the international literature. Lall’s work (1992, 2001) stresses the significance of skills development across all levels of the workforce, which highlights the significance of PSET organisations at all skills levels. More recently, Lundvall and Lorenz emphasised the significance of vocational education and training for ‘firm learning’ in developing economies, proposing that, rather than the typical sole focus on academic qualifications, attention should be also paid to ‘developing practical skills and experience based learning ... to the training of skilled workers, technicians and engineers’ (2012: 13). In this regard, the starting point is to determine the skills and capabilities that are important for firms, and to consider how firms build those capabilities to enhance productivity and facilitate technological upgrading and hence economic growth.

Focusing the unit of analysis and operationalising concepts for the design of the methodology and instruments for the case studies required a number of steps. First, innovation systems research typically places firms at the centre of analysis, and the literature is far stronger in terms of analysing firms. The literature was mined for concepts that could be used to illuminate research on universities and drew on concepts from the higher education literature to facilitate more in-depth analysis of PSET systems within the national system of innovation. Second, existing work had to be extended to investigate post-school organisations other than universities, such as TVET colleges, with their distinct knowledge focus, strategic purposes and forms of organisation. Third, the concepts needed to focus on and theorise the role of PSET systems in skills development more sharply. The research team proposed that the most appropriate conceptual distinctions could be drawn from Von Tunzelmann’s (2010) framework, which emphasises alignment, competences and interactive capabilities of actors in a network (Von Tunzelmann & Wang 2007).

This chapter outlines and defines the key concepts that informed the case studies, which will be elaborated on and refined in the following chapters in light of the empirical trends.

A network and interactive capabilities framework

Considering that industrial sectors differ significantly in terms of their knowledge bases, skills needs and institutional conditions, analysis is focused on sectoral systems of innovation (SSIs). Rather than simply emphasising a sector as an industrial concentration, a sector is defined as ‘a set of activities which are unified by some related product groups for a given or emerging demand and which share some basic knowledge’ (Malerba 2005: 65).

Figure 7.1 provides a generic representation of the actors and potential flows and interactive learning in an SSI in the South African context. It illustrates how the system could be mapped, as a basis for studying skills development networks, and the interactive capabilities of the main actors. We integrate Malerba’s (2005) SSI framework and Von Tunzelmann’s (2010) interactive capability and network alignment framework, and identify four main building blocks for analysing the nature and extent of alignment in skills demand and supply, namely

- common knowledge bases and similar technologies;
- actors and networks;
- institutions;
- interactive capabilities.
A focus on interactive capabilities for dealing with routine activities has the effect of directing empirical attention to the network alignment between the components of the system (Von Tunzelmann 2010; Von Tunzelmann & Wang 2007). For our purposes, the focus on interactive capabilities brings a critical focus on the (organisational) competences of actors in the system and the institutional environment. What is highlighted is the need to map the existing structure, agents, mechanisms/strategies and dynamics of skills development in specific sectors. The unit of analysis is the interaction between the main actors in the PSET organisations, firms and labour market intermediaries within an SSI, from which challenges and bottlenecks to inform policy interventions can be identified.

The approach requires data describing the key actors (firms, universities, colleges, government agencies) and the relationships between these actors, with a focus on the generation and movement of skills (Lorentzen et al. 2011). Figure 7.1 provides a framework for mapping the SSI as a basis for studying networks and interactions and the interactive capabilities of the main actors. We elaborate on the concepts underpinning the four building blocks in the next sections of this chapter.

**FIGURE 7.1 Capability-building processes at the sectoral level**
The four building blocks

Four key concepts provide the building blocks for the approach, and we describe each in turn below.

Knowledge bases and technologies

An SSI approach emphasises the role of knowledge and learning in the process of innovation. It is assumed that firms in a sector search around similar knowledge bases to inform their productive activities, face similar technologies (and challenges related to national and global technological development), undertake similar productive activities and are influenced by the same institutional environments (Malerba 2005). They would thus show similar patterns of learning and organisation. Firms in a sector are, however, likely to be heterogeneous, to some extent, in terms of their previous learning experiences, competences, organisational routines and culture, and opportunity conditions.

The knowledge base of a firm and the accessibility of appropriate technologies may act as constraints to innovation and learning. Similarly, the knowledge base in the sector around which firms search may pose constraints to or opportunities for technological upgrading and innovation. Interaction and dynamic interdependencies in the SSI can be a source of learning, organisational change and innovation – hence, the emphasis on networks.

Actors and networks

Innovation is an interactive or ‘networked’ activity shaped by the institutions in which the actors are embedded. The networks of actors include interaction between firms (for example producers, input suppliers) and ‘non-firm’ organisations (for example universities, government agencies) – also including subunits (for example R&D departments) or groups of organisations (for example industry associations) – and individuals (for example scientists, entrepreneurs) connected through market and non-market relations. Hence, the analysis of an SSI investigates the wide variety of actors involved in the generation and exchange of knowledge that is relevant to innovation and its commercialisation (Malerba 2005). The structure and nature of interaction and networks differ from sectoral system to sectoral system. Rather than placing the types of actors, usually the firm, at the centre of the analysis, the SSI ‘places dynamics, process and transformation at the centre’ (Malerba 2005: 64). Sectoral boundaries are thus not a given, and are not static, but dynamic.

Structural network analysis (SNA) was used to map the actors, structure and interaction of the networks, which enabled the identification of distinct forms of organisation, (actual) network intermediaries and missing organisations and linkages. SNA is, however, limited in that it provides static ‘pictures’ of networks. Additional data were required to illuminate the dynamics and benefits/disadvantages of the interactions and skills development strategies of organisations in the SSI.

Institutions

The institutional environment plays a key role in shaping the structure and nature of interaction among actors and networks of actors in the SSI. Institutions broadly refer to rules or guides for behaviour. Different types and levels of ‘guides for behaviour’ are recognised in the SSI approach: formal (for example institutional policy, national policy) and informal (for example organisational culture), binding (specific regulations) and created by interaction (for example contracts), national (for example patent system) and sectoral (for example sectoral labour markets). Here, institutional ‘subsystems’ (for example university sector, further education and training [FET] college sector), each with their own ‘guides for behaviour’, are also identified.

Hence, the main assumption of the SSI approach is that innovation and learning – with skills development lying at the heart of these processes – take place in networks shaped by their institutional environments, with actors transforming and being transformed by institutions.
Competences, interactive capabilities and dynamic interactive capabilities
What is most useful about Von Tunzelmann’s approach for our present purposes is that it highlights the importance of specific sets of capabilities required for effective interaction.

Competences stem from inputs to produce goods and services – that is, the pre-set attributes of individuals and firms, typically produced by organisations such as PSET organisations (Von Tunzelmann & Wang 2003). In our framework, competences take two forms, namely

• tacit knowledge embodied in the human resources of the organisation and organisational routines;
• codified knowledge present in organisational structures, technologies, formal policies or other physical resources.

An actor’s organisational processes or routines are shaped by its competences, and both its competences and routines as well as the strategic alternatives available to it are path dependent (Teece et al. 1997). Competences also include cognitive aspects, such as beliefs and attitudes, which influence learning. For instance, the recruitment of university graduates or artisans may be a necessary internal competence for firms that want to adopt new technologies (Audretch & Vivarealli 1994, in Lammarino et al. 2009). However, merely employing graduates or qualified artisans does not guarantee learning or the successful adoption of new technologies.

This requires ‘interactive capabilities’ – defined here as the capacity for learning and accumulation of new knowledge on the part of the organisation, and the integration of behavioural, social and economic factors into a specific set of outcomes (Von Tunzelmann and Wang 2003, 2007 in Lammarino et al. 2009). Interactive capabilities are the result of adaptive learning processes that in their collective dimension can be highly localised, giving rise to system capabilities. This means that, within a specific region or locale, a concentration of highly qualified human resources is not a capability per se, but a resource (competences possessed) that, through learning, may become technological capabilities for firms or academic capabilities for PSET organisations or the system as a whole. All variables related to human resources or cooperative linkages with external actors are to be considered as determinants of an organisation’s capabilities.

In the context of dynamic change – in terms of dynamic competition and institutional change – actors in an SSI require an additional set of capabilities – that is, the capability to effectively and efficiently respond to non-routine changes in circumstance. Changes in circumstance also often result in changes in the organisation’s capabilities. In the literature, this set of capabilities is often referred to as ‘dynamic capabilities’ in emphasising the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organisational skills, resources and functional competences to match the requirements of a changing environment (Teece et al. 1997: 515).

Drawing on Von Tunzelmann (2010) and Von Tunzelmann and Wang (2007), we refer to such capabilities as ‘dynamic interactive capabilities’ in order to distinguish the interactive capabilities necessary for routine activities and interactive capabilities requiring greater flexibility in responding to non-routine changes in circumstance. The four dynamic capabilities identified by Pavlou and El Sawy (2011) are useful for the purposes of our research: sensing, learning, integrating and coordinating (see Figures 7.2 and 7.3).

As depicted in Figure 7.1, the ability of an organisation – a firm or PSET organisation – to effectively and efficiently respond to changes in the business and institutional environments depends on the appropriate use of the organisation’s competences through its organisational processes or routines. Management thus needs to identify (or sense) changes in the environment that present opportunities, threats or constraints to the organisation, and identify the organisation’s competences and capabilities to respond through its organisational routines. An appropriate response requires the exploitation of
the organisation’s competences and capabilities, and often involves the acquisition of new knowledge and competences, which transform and are transformed by the firm or PSET organisation (through learning). The new knowledge and competences then need to be integrated into existing organisational structures and processes. Most importantly, the success of this process hinges on the effective coordination capability of management and leadership.

Here Malerba and Von Tunzelmann’s frameworks fall short. Neither provides the analytical tools needed to analyse the role of the skills of key individuals in searching for relevant knowledge and coordinating learning. The concept of ‘social skill’ identified by Fligstein (2001) and Fligstein and McAdam (2012) is apt for this purpose. The strategic management literature commonly refers to the crucial role of managerial or leadership skills without clear definitions. Essentially, social skill refers to ‘the ability to induce cooperation’ among actors in an organisation or any other field (Fligstein & McAdam 2012: 46). With the notion of social skill, we understand that those in managerial and leadership positions (for example unit managers, principal investigators of projects) have to possess effective skills for sensing changes in the external environment and be aware of the organisation’s competences. They should be able to sense which external changes are relevant and appropriate for the organisation to take on board and devise effective strategies for coordinating and integrating new knowledge into the organisation. These strategies may include the identification of appropriate actors with which to collaborate in order to best address those changes and improve the performance of the organisation. This process of coordination and integration involves the identification of matches and mismatches in competences and capabilities and finding effective ways of getting individuals and groups of individuals within the organisation on board for changes. Skilled strategic actors possess a repertoire of social skills (for example agenda-setting, presenting themselves as a neutral actor) which they use as appropriate.

In this framework, the importance of feedback between actors in interaction, and the co-evolution between actors and the wider institutional contexts in which they are embedded, is highlighted. Also highlighted is the relative compatibility of the capabilities of actors in the subsystem (for example firms or industry) or related subsystems (for example the university sector) representing the ‘pool’ or ‘networks’ from which actors can source essential knowledge and other resources. Hence, alignment in capabilities and goals between networks of actors in the subsystems that make up an innovation system plays a critical role. It is important to note that units within organisations can differ in terms of their interactive capabilities.

**Actors and networks critical for skills development**

The research focus is on the networks and alignment between the actors in PSET subsystems and firms in distinct sectors. Here we elaborate on each of the main actors and networks of the SSI essential for skills development: firms/farmers, PSET organisations and sectoral intermediaries (public and private).

**Firms/farmers**

Skills demand in an SSI is not simply ‘an aggregate set of similar buyers’ (Malerba 2005: 67). Rather, demand in the system consists of a heterogeneous group of firms – or farmers, as economic agents may take diverse forms, particularly in developing countries – each ‘characterised by knowledge, learning processes, competences and goals, and affected by social factors and institutions’ (Malerba 2005: 67).

Determining skills demand requires an understanding of employability, which depends on an understanding of firm learning and technological upgrading (Gamble 2003). An important elaboration on technological upgrading or technological capability building is found in the work of Lall (1992, 2001) on firm learning and technological capabilities. Technological capabilities can be defined as the specialised resources – skills, knowledge and experience, as well as the institutional structures
and linkages – that are needed to generate and manage technological change in a firm or sector (Bell & Pavitt 1995: 78; Costa et al. 2001). We refer to these specialised resources as competences and interactive capabilities.

Initially, developing countries obtain industrial technologies mainly from more advanced countries, although increasingly, they develop their own capacities. Therefore, the process of building capabilities starts with importing and using technology developed elsewhere (Sato & Fujita 2009). The main technological challenge is to master, adapt and improve on the imported knowledge and equipment in relation to local contexts. Lall (1992: 166) points out that gaining mastery of new technology requires skills and efforts by the receiving firm, and the extent of mastery achieved is uncertain. Once technology has been identified, its efficient use requires firms to undergo another costly, risky and lengthy process of developing new skills and knowledge to master its tacit elements (Lall 2001). This learning process is characterised by externalities and coordination problems, which might limit the process. Even though firms in a country may not innovate in the sense of creating new products at the technology frontier, they do need to invest in technological effort, requiring processes of firm learning and technological development (Bell & Pavitt 1995; Fransman & King 1984; Lall 1992). Technological capability building calls for purposive and incremental efforts to collect new information, try things out, create new skills and operational routines and strike new relationships (Lall and Pietrobelli 2002: 262). In South Africa, we have lead firms that do innovate at the technology frontier, but most innovative firms are mastering machinery and technologies acquired elsewhere.

The learning process is path-dependent and cumulative. Firms tend to move along particular trajectories in which past learning contributes to particular directions of technical change and experience derived from the past reinforces existing stocks of knowledge and expertise (Bell & Pavitt 1993: 168). The stock of the past capabilities and routines provide a base on which firms develop the capabilities to cope with new technology change. Thus, firms are distinguished according to the levels of technological capabilities – that is, basic, intermediate and advanced – they possess in key areas. As they possess different stocks of accumulated knowledge and expertise, structures and linkages, firms at different technological capability levels face different challenges and constraints. Some technologies are more difficult and costlier to master than others because the learning process is longer and more uncertain and involves more advanced skills, greater technological efforts, and more externalities and coordination problems.

The literature points to different kinds of strategic mechanisms for learning and accumulating technological capabilities, such as staff training, staff hiring, systems of performance feedback, interaction with external agents, agglomeration, networking and R&D activities (Costa et al. 2001). The skills base – the stock of people produced by the national PSET system with the right kinds of qualifications – is recognised as one critical factor in firm learning and technological capability building.

Hence, research on firms is focused on understanding how they acquire the qualified human resources required at all occupational levels, through interaction with national PSET subsystems.

A significant contribution made by Lall for this purpose is the emphasis on the development of technological capabilities at all levels of the firm. Technological upgrading does not involve only R&D or high-level skills but depends also on informal activities and learning at all levels of a firm.

Capability building involves efforts at all levels – shop floor, process or product engineering, quality management, maintenance, procurement, inventory control, outbound logistics, and relations with other firms and institutions. (Lall 2004: 12)
In sum, Lall’s approach to technology capability building provides key insights by pointing to the importance of specific embodied resources (tacit knowledge embodied in human resources and organisational routines) and disembodied resources (codified knowledge – appropriate structures, technology and other assets) for routine operational activities and developing competitive advantage. These resources can be acquired and developed:

- internally through workplace learning, formal training, feedback and R&D;
- through linkages with external actors, with the use of various strategies and mechanisms (for example knowledge transfer, training, hiring and financial investment).

These (generic) resources and capability-building processes are illustrated in Figure 7.2. One significant addition – the set of dynamic interactive capabilities – is made, to distinguish between sets of capabilities required for effective, efficient response to routine and non-routine changes in the environment.

**Education and training organisations**

Similar to demand, supply in an SSI is not provided by a homogeneous group of PSET organisations. PSET organisations’ activities are crucial to firms’ technological capability building, which is
necessary for innovation and economic development at a sectoral and national level. The concept of technological capabilities may be extended from firms to PSET organisations. Similar to firms, PSET organisations require specialised resources for producing employable diplomates and graduates and for effectively managing change within the organisation and in the educational environment and wider institutional context.

An analysis of how PSET organisations learn and the strategies they use to meet skills demand in sectoral systems of innovation is generally lacking in the literature. Liefner and Schiller (2008) introduced the term ‘academic capabilities’ in relation to universities, based on Lall’s framework of technological capabilities, an approach that we draw on and extend to other PSET organisations. As with firms, the competences of PSET organisations can be distinguished between internal embodied and disembodied resources, which PSET organisations need to exploit in meeting the needs of industry and society more broadly. They do so through the use of internal and external mechanisms and strategies (that is, internal and external interface structures). The strategies they use depend on their stock of knowledge and other resources (or internal competences) and the current routines or organisational processes they have in place – that is, their interactive capabilities. The strategies they use also depend on the opportunities available to them (environmental conditions and circumstance).

Liefner and Schiller (2008) classify universities according to three levels of capability – basic, intermediate and advanced – in relation to four functional competences (teaching, research, outreach and functional integration) and three organisational competences (budgeting, management and institutional building). The different levels of academic capability, in relation to the competency areas that result, are outlined in Table 7.1 for illustration.

These distinctions are useful to differentiate between universities according to level of capability, and at the same time allow for the assessment of the capability of the university sector as a whole for meeting the skills needs in an SSI. The aim was to develop such distinctions for other PSET organisations in relation to skills development in specific sectoral systems of innovation, based on the empirical findings of the research.

The functional integration capability is an important concept for our research on the dynamic interactive capabilities of PSET organisations, as it emphasises the need for networking and learning between departments and units, and integration of knowledge across functions within a university or college (for example integrating knowledge obtained via R&D university–industry linkages into teaching). We can use the concept of functional integration as an indicator for analysing dynamic interactive capabilities. Functional integration is, however, only one internal interface strategy that PSET organisations use as part of their organisational learning or capability-building processes. Other possible strategies and mechanisms that PSET organisations may use as part of their learning and capability-building processes are illustrated in Figure 7.3.

PSET organisations may develop new or sharpen existing competences and/or develop better ways of carrying out their routine activities through interaction with other organisations (for example firms, other PSET organisations) and in managing change in the education environment. For example, through research collaboration with firms, universities may develop the skills of their postgraduates, but staff may also learn new and current techniques to teach their students. They would, however, need to be open to learning these new techniques and integrating them into the curriculum, which also needs to be supported and promoted by the institutional culture and formal policy of the university. An analysis of the competences of the organisation is thus important.
### TABLE 7.1 Framework assessing academic capabilities according to level of capability and competence area

<table>
<thead>
<tr>
<th>Low capability and competence</th>
<th>Intermediate capability and competence</th>
<th>Advanced capability and competence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching</strong></td>
<td><strong>Teaching</strong></td>
<td><strong>Teaching</strong></td>
</tr>
<tr>
<td>Limited mix of programmes (e.g. undergraduate education only), outdated curricula, teaching mainly from textbooks, lack of quality and quantity of courses</td>
<td>Some mix of programmes, up-to-date curricula, research-oriented teaching, lack of quality</td>
<td>Mix of programmes (e.g. undergraduate, diploma, PhD), research-oriented teaching, demand-oriented curricula (from industry, community, etc.)</td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td><strong>Research</strong></td>
<td><strong>Research</strong></td>
</tr>
<tr>
<td>Adaptive assimilation of existing research results, internal grants, lack of equipment, no specific reputation</td>
<td>Appropriate application of excellent international research, competitive research grants, national reputation</td>
<td>Reputation for innovative research, competitive research grants</td>
</tr>
<tr>
<td><strong>Outreach</strong></td>
<td><strong>Outreach</strong></td>
<td><strong>Outreach</strong></td>
</tr>
<tr>
<td>Occasional ad-hoc linkages, consulting and laboratory services, direct hiring of professors, personal contacts</td>
<td>Regular linkages, contract research, training courses, graduate placement programmes, official contacts on behalf of university</td>
<td>Strategic linkages, alliances, collaboration, responsiveness to labour market and societal needs</td>
</tr>
<tr>
<td><strong>Functional integration</strong></td>
<td><strong>Functional integration</strong></td>
<td><strong>Functional integration</strong></td>
</tr>
<tr>
<td>Fragmentation of academic tasks, no cross-fertilisation between different activities</td>
<td>Occasional synergies between academic tasks, exploitation of academic capabilities through outreach activities</td>
<td>Cross-fertilisation, synergetic augmentation of academic tasks, teaching and research oriented towards labour market and societal needs</td>
</tr>
<tr>
<td><strong>Organisational</strong></td>
<td><strong>Organisational</strong></td>
<td><strong>Organisational</strong></td>
</tr>
<tr>
<td>Budgeting: Line-itemised public budgets, incremental changes, no own income besides tuition</td>
<td>Budgeting: Public block grants, performance-based funding, some own income sources</td>
<td>Budgeting: Diversified funding, performance and competitive funding</td>
</tr>
<tr>
<td>Management: Bureaucratic, dominated by government policy, teaching focus, no specialised units besides traditional faculties</td>
<td>Management: Partial academic autonomy, limited leadership of university administration, traditional academic focus, specialised research centres</td>
<td>Management: Administrative autonomy, strong leadership, enterprising</td>
</tr>
<tr>
<td>Institution building: Inefficient or non-existent evaluations, industrial outreach activities are not allowed</td>
<td>Institution building: Internal and external evaluations, incentives only for academic excellence, regulations for outreach activities still insufficient</td>
<td>Institution building: Performance appraisal, clear regulations and promotion of outreach</td>
</tr>
</tbody>
</table>

Source: Based on Liefner and Schiller (2008: 282)
Hence, the research focused on the capabilities and circumstances that may enhance or constrain a PSET organisation’s ability to interact with firms in a sector. The specific features of different types of PSET organisations were taken into account. VET organisations that operate primarily at the intermediate and basic skills levels play a very different role in the national system of innovation: knowledge diffusion, as opposed to universities' roles in knowledge generation and diffusion (Toner 2005, 2011; Toner et al. 2004). VET organisations have a more explicitly economic role, and a more direct link to meet the training needs of local firms. Their roles relate to diffusing practical and technical skills and knowledge of production processes, to ‘design, install, commission, adapt, operate and maintain new and existing technologies’ (Toner n.d: 10). Such analysis can inform the elaboration of a table akin to Table 7.1 in relation to VET organisations.

The framework highlights the need to explore how tacit and codified competences, and internal and external interface mechanisms, are manifest in TVET colleges (public and private) and Sector Education and Training Authority (SETA) skills development programmes, such as learnerships. What are the main forms of their competences, interactive capabilities and dynamic interactive capabilities?

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1 Toner (2005, 2011) has produced a useful body of work focusing on the role of organisations at the intermediate skills levels (Toner et al. 2004).
**Sectoral intermediary actors**

SSIs may be fragmented and weak, and characterised by system failures; hence, a key role is played by a set of intermediary actors. They may facilitate alignment between firms and other actors, address systemic problems or create conditions that promote networks and coordination to address failures in the SSI. They play a role in bridging the gap between user needs and the supply side, particularly in relation to knowledge flows through skills, human resources and R&D (Intarakumnerd & Chaoroenporn 2013b). Sectoral intermediary organisations may also be identified as part of the skills demand networks in an SSI. For example, an industry association may provide highly specialised training for graduates in order to meet specific skills needs of firms in the sector. They may also play a crucial role in coordinating skills development in a sector and in providing training in sector-specific skills in order to fill skills gaps. Hence, sectoral intermediary organisations are suitably placed to provide insight into knowledge and technological change in the sector and related skills needs, as well as into challenges, constraints, threats or facilitators to skills development and any bottlenecks, in order to provide recommendations for more targeted institutional mechanisms.

**FIGURE 7.4 Role of sectoral intermediary organisations: A generic framework**

- **Skills demand**
  - Smallholders
  - SMMEs
  - Large firms
  - Multinational companies
  - Other

- **Circumstance/Environmental turbulence**

- **Mechanism/strategies**
  - Public intermediaries:
    - Formulating policies
    - Training in critical skills
    - Providing testing facilities
    - Initiating R&D programmes in fields critical for upgrading in global value chain
    - Etc.

  - Private intermediaries:
    - Promoting trust among members
    - Diffusing technology know-how and information
    - Assisting members to upgrade technologies
    - Enhancing their international marketing capability and operations management
    - Linking the industry and the government
    - Etc.

- **Skills supply**
  - Universities
  - VET
  - Private education and training organisations
  - Other
The roles of public and private sectoral intermediaries are distinguished, as they differ in terms of their main functions (see Intarakumnerd & Chaoroenporn 2013b). Figure 7.4 illustrates the key dimensions investigated in relation to sectoral intermediaries, with possible features of each for illustrative purposes.

Public sectoral intermediary organisations include organisations that support technological upgrading of firms in a sector, by providing ‘public goods’ such as training or R&D that are costly for a single firm and by connecting key actors. Public sectoral intermediary organisations may include:

• government-funded sectoral authorities (such as the National Agricultural Marketing Council [NAMC]);
• government-funded sectoral programmes or master plan (such as the Automotive Industry Development Programme).

SETAs may play a key intermediary role in a sector (in addition to anchoring VET subsystems).

Private sectoral intermediary organisations support and inform these activities, and include:

• industrial and trade associations;
• professional associations;
• research and technology organisations;
• private foundations.

The coordination and alignment between public and private sector intermediaries is critical to their effective functioning in an SSI. For example, if a public intermediary does not have sufficient funds for its skills programmes, or if roles are not clearly defined, there may be competition with private intermediary actors, weakening the SSI.

This conceptual framework was used to inform the empirical research and data analysis for a set of case studies of sectoral systems of innovation, which are analysed in the following chapters.
High skills and labour market alignment: The case of the SKA

Michael Gastrow, Glenda Kruss and Il-haam Petersen

Accelerating global technological change and scientific progress present moving targets and great opportunities, raising the question: How does a highly unequal developing country like South Africa develop the skills and capabilities to compete at the global technological frontier?

On the one hand, knowledge-intensive and high-technology sectors are intrinsically oriented towards employees with a high skills level, and offer relatively few opportunities for labour-absorbing, low-skills employment, thus excluding marginalised groups from participation. On the other hand, failing to develop South Africa’s capabilities in knowledge-intensive sectors is likely to have negative consequences for our ambitions to grow a knowledge economy. The fundamental tension between the imperative for inclusion and the imperative for the development of high-technology sectors is complex to reconcile or resolve. This tension is felt globally, for example in the form of concerns about the impact of the Fourth Industrial Revolution, which could arguably benefit the highly skilled while resulting in job losses for the low-skilled.

South African policy-makers have recognised that alongside efforts to promote inclusive development, the growth of high-technology sectors must be pursued, and skills development is a critical part of this process. In South Africa’s unequal skills landscape there exist pockets of excellence where the resources, networks and capabilities of the small apex of the system are concentrated (Wolhuter et al. 2003). To build capabilities in knowledge-intensive sectors, an effective strategy is to connect these pockets of excellence in order to attain the capabilities and critical mass to compete at the global level, thus leveraging existing knowledge assets to the overall benefit of the country.

The Square Kilometre Array (SKA) is a large radio telescope that will ultimately consist of a network of 3 000 large radio receiver dishes and tens of thousands of smaller receivers constructed in aperture arrays. This giant radio telescope will become the largest science project ever undertaken in Africa, the world’s most powerful telescope, and one of the largest science installations of any type in the world. The SKA organisation, which includes Australia, Canada, China, Germany, India, Italy, the Netherlands, Poland, South Africa, Sweden and the UK, is headquartered at the Jodrell Bank observatory in the UK. In 2003 South Africa, together with its African partner countries in Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia, entered its first bid to host the site infrastructure, based on excellent natural conditions for astronomy and on its existing astronomy capabilities.

From 2003 to 2012, a South African SKA project office worked to develop local skills and technologies in support of this bid, in the process developing a prototype set of seven receiver dishes, the KAT-7,
and beginning construction of a 64-dish instrument, the MeerKAT. During this period, the SKA in South Africa also established formal and informal mechanisms to bolster the development of the required skills and to ensure alignment with other actors relevant to its innovation system, in order to bring together the pockets of excellence that could make it internationally competitive against a rival bid from Australia and New Zealand. A decision was taken to support students through learning pathways towards radio astronomy and the engineering skills required to design and build radio telescopes, with the overall objective of creating the required research capacity and support capacity for the MeerKAT and eventually for the SKA. This decision was supported by national government through increased levels of funding and legislative support.

In May 2012, the site allocation for the SKA infrastructure was announced: most of the project would be located in South Africa and its African partner countries, and the remainder in Australia and New Zealand. The project continues to proceed in the design and construction phases. The South African strategy to build local capabilities to leverage its geographic advantage was therefore successful. This makes the SKA a suitable case study of a successful sectoral skills planning exercise, one that proceeded by building systems and capabilities to improve alignment between the supply of competences produced by education and training systems and the skills demands of the labour market. We therefore focus on how dynamic interactive capabilities vested in universities, colleges, firms, intermediaries and the SKA itself have made it possible to connect pockets of excellence in the sectoral innovation system, and thus successfully develop technological pathfinders and precursor instruments, establish relevant skills development systems, bid for the SKA project against international competitors and continue with the ongoing progress towards construction and scientific utility.

The chapter offers a micro- and meso-level analysis of a national skills development programme in the astronomy sector, reflecting on a ten-year period of structured investment in the skills required to design, build and operate the SKA telescope. We ask how the main actors in this programme responded to changing demands in the science and engineering skills domains. Our primary focus is on the interactions between these actors, and the manner in which these have facilitated or constrained alignment between skills supply and skills demand. Conceptually, we draw on an innovation systems approach, coupled with the analysis of interactive capabilities in the context of skills development networks. In the context of dynamic change such as that in which the SKA has operated, actors require an additional set of capabilities that allow them to effectively and efficiently respond to non-routine changes in circumstance. Changes in circumstance and the environment also often result in changes in the organisations’ capabilities. Von Tunzelmann and Wang (2007) refer to ‘dynamic interactive capabilities’ in order to distinguish the interactive capabilities necessary for routine activities, and those interactive capabilities supporting greater flexibility in responding to dynamic changes in circumstance. Pavlou and El Sawy (2011) identify four dynamic capabilities: sensing, learning, integrating and coordinating. The ability of an organisation like the SKA to effectively and efficiently respond to changes in business and institutional environments depends on the appropriate use of its competences through its organisational processes and/or routines. Management thus needs to identify (or sense) changes in the environment that present opportunities, threats or constraints to the organisation, and identify the organisation’s competences and capabilities to respond through its organisational routines. An appropriate response requires the exploitation of the organisation’s competences and capabilities, and often involves the acquisition of new knowledge and competences, which transform and are transformed by the organisation through learning. The new knowledge and competences then need to be integrated into existing organisational structures and processes. We will use these concepts to inform our analysis. (See Chapter 7 for an elaboration of the framework and concepts that informed the research and analysis.)
Empirically, we draw on a set of in-depth interviews with key actors, as well as the modelling of the astronomy sectoral system of innovation (SSI), and the SKA’s innovation network. The conclusion reflects on how the dynamic interactive capabilities of each of the main actors in the SKA’s innovation network enabled labour market alignment. For policy-makers seeking to learn from this success, this raises the following questions: How were these technological capabilities built up, and how were existing pockets of excellence in the national education and training system aligned with the skills and technology requirements of the SKA to facilitate this success?

Methodology

The first step in the methodology was to undertake desktop research to develop a map of the key organisational actors in the SSI focused on the SKA telescope. Employers include the SKA itself, related science facilities (such as other telescopes) and firms. These form a value chain, with the SKA at its apex. Actors in the skills development arena primarily include South Africa’s large research-oriented universities, as well as one university of technology and one technical and vocational education and training (TVET) college. Another key set of actors are intermediaries, including both public sector and private sector actors. See Figure 8.1.

FIGURE 8.1 Capability-building processes in the astronomy SSI

Skills demand  Mechanisms/strategies  Skills supply

• SKA project
• Firms in the SKA engineering value chain
• National science facilities
  - SALT
  - HartRAO
  - Hermanus Magnetic Observatory
  - Etc.
• University astronomy facilities

Organisational linkages (knowledge and experience)

Resources (e.g. bursary programmes)

Skills movement (graduates, upskilling)

• South African universities: physics, engineering, ICT, mathematics, astronomy
• International universities
• SKA project: HCDP
• FET college – peripheral

Sector intermediaries (international)
• International Astronomical Union
• Office of Astronomy for Development
• African European Radio Astronomy Platform
• EU Space Agency

Sector intermediaries (South Africa)
• South African Astronomical Observatory
• National Astronomy and Space Science Programme
• Department of Science and Technology
• National Research Foundation

Policy

DST 10-year plan  Astronomy Geographic Advantage Act  DST Astronomy Desk  NRF Astronomy division

Interpreting and implementing policy

Interpreting and implementing policy
A total of 71 interviews were conducted from September 2013 to February 2014 with senior staff from the main actors involved in the astronomy sectoral innovation system, including senior management and scientists from the SKA, three firms in the SKA’s innovation network, seven universities, seven public sector intermediaries, one private sector intermediary, one science facility and one TVET college. Interviews with university academics and management focused on the competences, interactive capabilities and dynamic interactive capabilities within their education and training organisations, in relation to three dimensions of their activities, namely what they teach (the manner in which programmes are informed by skills needs in the sector), how they teach (the approach and mechanisms that shape work readiness of graduates) and how they facilitate labour market access (the approach and mechanisms that support labour market transitions in interaction with employers). Interviews with intermediaries aimed to understand their roles in linking demand and supply-side actors. Questions for employers, including the SKA and firms in its innovation network, centred on the drivers of innovation and technology change in the sector and the strategies that employers use to meet their skills needs, and skills constraints, across high, intermediate and basic skills levels (Gastrow 2015).

**The SKA and the astronomy SSI**

Astronomy is not, at least in the economics literature, commonly referred to as a ‘sector’. However, it enters the analysis of sectoral innovation systems as a clearly defined sector: a set of actors organised around the core productive activities of astronomy science and astronomy engineering, and within distinct geographical and institutional settings that apply to astronomy in South Africa. Astronomy, as an economic sector, is not strictly market-oriented at the micro-level. However, at the macro-level, there is a global aggregate demand for astronomy facilities (embodied in observational and processing capabilities) and astronomy research, and a global aggregate supply of facilities and research capabilities.

In this marketplace, the sector in South Africa is seeking to expand its supply (of facilities and researchers) and capture a greater share of global demand, since the establishment of the first observatory in Cape Town in 1820 (Paterson et al. 2005; Wild 2012), growth in the formal astronomy sector has been based on a strong comparative advantage in astronomy, which requires adequate infrastructure, clear skies and low levels of light, dust and radio frequency pollution. Moreover, the Milky Way has its plane across the Southern sky, making observational capacities in the South essential for observations of our own galaxy. South Africa is host to numerous telescopes, including the largest single-lens optical telescope in the southern hemisphere – the SALT. Historically inherited capabilities in the areas of telemetry and defence (Kahn 2006) provided a pool of specialised skills that found application in the growing area of astronomy.

The SALT, KAT-7, MeerKAT and nascent SKA have spurred expansion of the SSI as a whole, with new science facilities, increased skills demand, increased funding for studies and increasing numbers of graduates and postgraduates with relevant skills. For example, the number of astronomers with PhDs almost doubled between 2005 and 2010 (Bharuth-Ram 2011; Paterson et al. 2005). In the niche area of radio astronomy, this has been even more marked. At the time of the initial SKA bid, there were five or six practising radio astronomers in South Africa. At the scale that the SKA would reach, the number of astronomers and engineers required would need to increase by several orders of magnitude. The number of PhD-level radio astronomers would need to increase from six to 60 simply to make full use of the 64-dish MeerKAT (Bharuth-Ram 2011), let alone the 3 000-dish SKA.

Skills demand in the SSI is created by the national science facilities, such as the SKA, SALT, HartRAO and the SAAO, as well as the country’s leading research universities that include pockets of astronomy activity, since these also require astronomy skills for teaching and research. A major source of demand for engineering skills emanates from firms in the SKA’s supply chain and innovation network, as well
as the science facilities. In terms of skill supply, this emerges primarily from niche areas of astronomy-related activity, including both science and engineering, within South African leading research universities. However, a large proportion of astronomers in the SSI are foreign nationals, since the supply of astronomers has historically fallen far short of the aggregate demand in the country.

Interaction within the astronomy SSI is supported by an array of intermediary organisations operating at multiple levels and contexts (see Table 8.1). Key South African public sector intermediaries include the DST, and the NRF. International public sector intermediaries include the AERAP and the US-based NRAO. Private sector intermediaries include the IAU, with its associated OAD.

The SKA’s innovation network, while partially located within this SSI, also spans international boundaries, and can be conceived as a global innovation network (GIN). This is defined by Chaminade (2009) as a ‘globally organized network of interconnected and integrated functions and operations by firms and non-firm organisations engaged in the development or diffusion of innovations’. The SKA’s innovation network spans Europe, the Pacific region, China, India and Africa. Although African partner countries are primarily involved as infrastructure locations, capacity development and networking efforts are increasingly involving scientists, engineers and students from these countries in the SKA’s activities, linking these small niche areas of capability to the SKA’s broader innovation system.

The SKA is divided into a number of subprojects, research consortia and science projects. For example, the technology development for the SKA is parcelled into 10 consortia, each one of which operates as a global innovation network to develop the technology for a particular component of the telescope. Then, at a third level, localised innovation networks, which link to globalised innovation networks, evolve. The SKA, from a network point of view, is thus effectively a hub for numerous innovation networks, each of which is related to the others, and each of which is global in its reach. This complex structure requires advanced internal coordination capabilities in order to operate effectively, both among international partners and among South African actors in the system.

**Interactive capabilities of the SKA in South Africa**

The SKA organisation requires advanced skills in the domains of science, engineering, ICTs, and management, as well as artisanal and vocational skills required for site infrastructure. The science objectives of the SKA require specialists in astronomy, physics, mathematics and cosmology. Generic organisational skills also constitute an important area of skills demand, including office management, human resources (HR), supply chain management, project management and finance.

<table>
<thead>
<tr>
<th>Intermediary function</th>
<th>Public intermediaries</th>
<th>Private intermediaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding and resources</td>
<td>DST, NRF, AERAP</td>
<td></td>
</tr>
<tr>
<td>Strategic direction</td>
<td>DST</td>
<td></td>
</tr>
<tr>
<td>Skills planning</td>
<td>DHET</td>
<td></td>
</tr>
<tr>
<td>Network building</td>
<td>AERAP, DST</td>
<td>IAU/OAD</td>
</tr>
<tr>
<td>Knowledge transfer and diffusion</td>
<td>AERAP</td>
<td>IAU/OAD</td>
</tr>
</tbody>
</table>
These skills requirements are experienced in a context of rapid change. Rapid technological change presents challenges for capability-building mechanisms and necessitates strong dynamic interactive capabilities. Because ICTs in particular are constantly and rapidly advancing, the SKA needs to be able to forecast technological changes and build this into its technical and skills planning processes. To this end they interact with major firms such as Intel and IBM. Rapid organisational growth has presented challenges in terms of the dynamic interactive capabilities required to bring the required skills into the organisation at the right time – a ‘build the plane while you’re flying it’ scenario. This has been accomplished through a combination of tactics, including continued interaction among all the key players to determine future skills requirements, and ongoing assessments of future technological scenarios and what their impact might be on skills requirements. In addition, for the management of human resources within the organisation, rapid growth has necessitated the maintenance of holding patterns interspersed with internal assessments of skills requirements and actions to bring those skills in.

The SKA thus deploys a range of strategies and mechanisms for meeting its complex and rapidly changing skills needs. The most important of these mechanisms is the HCDP, which by 2017 had awarded over 900 bursaries, grants and fellowships, and established five research chairs as part of the South African Research Chairs Initiative. HCDP administrators closely monitor the bursary recipients and research positions supported by the programme and maintain control over the range of disciplines and skills that are covered. This includes the disbursement of grants to students from African partner countries, bolstering capabilities across the continent. The allocation of funding to skills domains and research topics occurs through intensive interaction with scientists and engineers, both within universities and within the SKA itself. This is facilitated by an administrator positioned at the top of the organisation with easy access to senior management. She is placed to consult widely and interact formally and informally with many different parties in order to coordinate the process and optimise the matching between the skills and knowledge needs of the SKA and the skills and knowledge production that is funded by the HCDP. The HCDP’s selection panel, which selects applicants for bursary and research funding, is a powerful mechanism for interaction. Academics from the main partner universities, as well as representatives of the NRF, serve on the selection committee, thus facilitating discussions about future skills requirements and what capabilities and skills are in the pipeline.

Beyond the HCDP, the SKA has fostered strong engagement with universities. Relationships are well established with senior university managers, for example with deputy vice-chancellors and vice chancellors, and also with academics at all levels. These are largely informal relationships that succeed on the basis of tacit interactive capabilities that enable rapid, responsive and informal communication between senior staff. Engagement with universities also takes place through an external interface mechanism: an informal, non-institutionalised Universities Working Group. This group meets on a regular basis to discuss the progress of the project, the scope of research projects and any other items of relevance to the interaction between universities and the SKA.

The SKA organisation has advanced interactive capabilities for engaging with firms and public sector actors. The SKA’s business development manager is responsible for establishing and managing connections with firms and for assessing their capabilities and alignment with the SKA’s skills and knowledge requirements. Interviews with senior management from the SKA, DST and NRF indicated that there are intensive formal and informal interactions involving all three organisations. Management meet regularly, both in their formal capacities and through personal relationships. These interactions help to align skills needs and possible skills supply by coordinating strategies, management and funding for capability building.
Firm strategies to address skills needs

Empirical research focused on three knowledge-intensive and technologically advanced firms that contributed to the design and manufacture of telescope components for the SKA. These firms exercise an array of tactics to effectively connect with niche areas within the higher education system, thereby meeting their skills and knowledge requirements. One firm, a well-connected small enterprise, perceived their strategy of personal contacts, academic networks and word of mouth to be sufficient for meeting their skills needs. A larger and more established firm reported that, as the firm grew, it relied less on personal networks and more on external recruitment agencies. It also engaged with universities through informal networks and individual interactions in order to learn about course content at universities and, significantly, to influence course content. Using this information, the firm draws on exiting graduates to enter their internship programme. The largest of the three firms reported a limited range of strategies for meeting skills needs. They reportedly do not interact directly with universities, preferring to rely on recruitment agencies. Thus, of the case study firms, the smaller firms rely more heavily on informal networks, while larger firms rely more heavily on formal mechanisms and market structures. Both of these, in the case of the SKA, have been effective in building interaction between firms and higher education organisations.

The roles of intermediaries

The main roles of intermediary organisations in the astronomy SSI are funding, strategy, planning, management oversight, network building and knowledge transfer (see Table 8.1). The DST is the central public sector intermediary in terms of policy and funding. Public expenditure on astronomy, and the SKA specifically, has risen sharply over recent years, and is expected to increase continually over the medium term (National Treasury 2013, 2017). The main form of legislative support has been through the Astronomy Geographic Advantage Act (No. 21 of 2007), which protects geographic areas suitable for astronomy by restricting industrial activity, construction or any development that emits electromagnetic interference.

Beyond the explicit legislation, the tacit political support for the SKA should not be underestimated. From the early stages of its conception, the SKA bid was seen as a flagship national project with enormous potential, not just for science, technology, skills and economic development, but also as a national symbol of world-class scientific and technological achievement (Gottschalk 2007). This political support, leading to policy and funding support, has been a key factor behind the SKA’s skills development efforts – and ultimately the success of the project as a whole.

The NRF is a key partner, performing an agency function on behalf of the DST and acting as a funding channel and the direct managing agency of the SKA in South Africa. Another public sector intermediary is the Department of Higher Education and Training (DHET), which, as part of the National Infrastructure Plan, conducts detailed quantitative skills planning for 18 priority Strategic Integrated Projects (SIPs). The SKA is one of these SIPs, and future skills planning has been undertaken in partnership with the SKA and the DST to inform funding and to assist the HCDP.

Private sector intermediary organisations play a small but important role in the sectoral innovation system and are primarily focused on network-building – bringing together research partners and possible funding opportunities, particularly in the international context. The IAU is an international coordination body for astronomy, with a membership body of professional astronomers. Intermediary activities include hosting international symposia and hosting discussions about large-scale facilities such as the SKA. AERAP is a stakeholder forum of industry, academia and the public sector, established to define and implement priorities for radio astronomy cooperation between Africa and Europe, including the SKA.
Competences and dynamic interactive capabilities of universities

The sample of seven universities in the case study reflects the overall orientation of the SKA towards research universities, with lower levels of interaction with the other types of university making up the 23 organisations in the higher education system. Only one university of technology, and no comprehensive universities, are present among the key partners. At the same time, the emphasis is also on historically advantaged universities, with only one previously disadvantaged university in the sample. Both outcomes are a result of generally higher levels of institutional competences available at previously advantaged research universities, as well as higher levels of competences and core expertise specifically relevant to radio astronomy and related engineering (see Table 8.2).

This again raises the question of inequality. SKA-related funding for teaching and research has substantially benefitted the capabilities and outputs of some historically disadvantaged universities (including the University of the Western Cape [UWC] and Durban University of Technology [DUT]). Support for TVET colleges offers another means to address inequalities, build local capabilities and increase access and success. Nevertheless, the competitive dynamics of partnership with the SKA more commonly lead to a replication of inequality within the higher education landscape overall.

Institutional-level competences act as enablers for the development of astronomy-specific competences, as well as the basic interactive capabilities that cultivate university engagement with other actors in the sectoral system. These basic institutional competences are most advanced in the previously advantaged research universities that make up the majority of the SKA’s university partners. They include the existence of strong institutional planning functions, well-developed professional support and development for university staff, and effective programmes for student transition into the workplace.
Astronomy competences available at universities have grown rapidly over recent years, with escalating staff and student numbers in the areas relevant to astronomy at all the universities in the sample. Wits, UKZN, RU, and UWC are currently establishing undergraduate programmes in astronomy. This has partially been a result of the influx of funding, as well as the attraction that the SKA offers to prospective students and academics. This is an indicator of the well-developed dynamic interactive capabilities of these universities. They were able to sense changes in their external environment by assessing that demand for skills in the area of radio astronomy will increase in the medium term, and adjusting institutional arrangements for teaching, learning and research accordingly.

Formalised interactive capabilities are largely vested within faculty or department structures, while individual academics emphasise tacit capabilities for interaction (see Table 8.3). The structure and characteristics of the interactive capabilities of academics and managers in engineering departments differ from those in science. A good example of one university with well-developed interactive capabilities relevant to the astronomy SSI is the faculty of engineering at SU. Teaching curricula and learning methods have been highly responsive to changes in the astronomy sector, particularly to changes in the demand for radio astronomy engineers for the SKA. In 2012, the faculty initiated a one-semester postgraduate course on radio astronomy targeted specifically at SKA bursary holders. The aim of the course is to bridge the gap between astronomy and engineering – primarily to position engineers to play a role in astronomy.

Interviews with academics and university management at SU, as well as all the other universities in the sample, highlighted lower levels of responsiveness at the undergraduate level compared to the postgraduate level. Appropriately, undergraduate course contents are seen as foundational and, hence,

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**Table 8.3 Overview of interactive capabilities at universities relevant to the astronomy SSI**

<table>
<thead>
<tr>
<th>Institutional level</th>
<th>Interactive capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central university functions</td>
<td>• Institutional planning&lt;br&gt;• Professional support and development&lt;br&gt;• Transference into the workplace</td>
</tr>
<tr>
<td>Faculty/department</td>
<td>Science and engineering departments:&lt;br&gt;• Highly responsive teaching and learning&lt;br&gt;• Highly responsive research and innovation&lt;br&gt;• Research and innovation networks&lt;br&gt;• Collaborative research projects with external actors&lt;br&gt;• Academic networks&lt;br&gt;Engineering faculties:&lt;br&gt;• Advisory boards&lt;br&gt;• Five-year review process&lt;br&gt;• Academic time allocations for working with industry&lt;br&gt;• Contract R&amp;D for industry&lt;br&gt;• Funding for equipment&lt;br&gt;• Close engagement with the engineering professional body&lt;br&gt;• Invited speakers from firms</td>
</tr>
<tr>
<td>Individual academics</td>
<td>Important role for personal relationships and networks, tacit interactive capabilities</td>
</tr>
<tr>
<td>Informal/tacit</td>
<td>Relationships and resource mobilisation underpinned by strong tacit interactive capabilities and informal mechanisms</td>
</tr>
</tbody>
</table>
relatively slow to change, while curriculum changes require lengthy approval procedures. In contrast, specialisation takes place at the postgraduate level, where academics are able to be more flexible and thus more dynamic.

However, when the pace of technological change is very rapid, as is the case with the ICT-driven technologies relevant to the SKA, a slow response at the undergraduate level can lead to the development of knowledge and skills that are no longer relevant for employers. In some cases, such as the computer sciences department at SU, the faculty administration has created space for more rapid change in the undergraduate curricula, and this has improved the relevance of the resulting competences to employers.

The engineering faculty utilises a number of formal interface structures and mechanisms to support its ability to sense and integrate changes in its turbulent external environment. These include an advisory board, which provides a critical interface between employers and academics, and a five-year review process, in which half of the review team must be drawn from potential employers. The faculty also has contract research partnerships with a wide range of employers, and these relationships are actively cultivated by leaders of research centres. A critical intermediary role is played by the Engineering Council of South Africa (ECSA), the statutory professional body. ECSA has a specification for the B.Eng. degree with generic outcomes that are approved by the council, which directly shapes the curriculum to align with changes in the profession, at all universities.

One of the most powerful interactive mechanisms is the allocation of time for external engagement. Academics are allocated 400 hours per year (approximately one day per week) to conduct work external to the faculty, largely as consultants in the private sector. There are many benefits to this mechanism. Academics benefit from additional income, and engagements with employers and centres of demand for knowledge provide a source of ideas for research directions that are up to date. This mechanism builds networks between academics and employers and aligns the research activities of academics and postgraduate students with the requirements of employers. The precedent set in institutional practices could be applied directly to the SKA network, with members of the engineering faculty consulting to firms in the SKA’s supply chain and innovation network and also forming their own start-ups that participate in these networks.

Informal modes of interaction are also important. The faculty regularly invites guest speakers from firms and potential employers to inform final-year students about what their needs are. The faculty engages through alumni functions and a graduate group through which it builds relationships with employers. Individual academics largely utilise informal mechanisms. For example, one key informant operates in a loose collaboration with academic colleagues who are working with firms on antennae and dish design and radio frequency interference mitigation. These relationships are based on the interactive capabilities of academics established over long periods of time, which strengthens their ability to use networks to connect the supply of and demand for skills and knowledge.

Tacit and informal interactive capabilities are important at all the universities. The astronomy department at UCT clearly hosts strong tacit interactive capabilities, having proven its capacity to mobilise resources and alliances, both internally within UCT and externally. At RU, there is informal internal collaboration between academics within the various fields relevant to astronomy, with a view towards coordination and alignment. RU is a small university, and the academics find it easy to operate through loose and informal networks. Informal interactive mechanisms are similarly important at the other research universities. For example, at Wits, academics in South African Research Chairs Initiative (SARCHI) engage with colleagues within the SKA and bring that information back into the university, where it is discussed internally and, where possible, used to inform teaching and research practice.
At DUT, participation in the SSI has largely been driven by a single individual with strong interactive capabilities, using informal and tacit mechanisms to engage with the SKA over several years, making a case for DUT’s role in the technical training required.

Universities also play intermediary roles that contribute to the strength and functioning of the sectoral network. A good example of this is the National Astrophysics and Space Science Programme (NASSP), a nationally coordinated postgraduate programme based at UCT. The NASSP, structurally, aims to make the most of South Africa’s uneven and fragmented competences and capabilities in the space science and astronomy domains. Bharuth-Ram (2011) reports a rapid increase in applications to the NASSP programme in the years leading up to 2011, in part attributed to the attraction that the SKA has had for prospective students and academics.

At the institutional level, this programme represents a high level of collaboration. It is funded by the NRF, managed through the SAAO, coordinated by UCT, and involves all the universities active in astronomy in South Africa. It thus represents a true confluence of actors collaborating in the area of skills development for astronomy and is made possible by UCT’s strong organisational and interactive capabilities. The NASSP established a pipeline of astronomy skills that proved crucial to the success of the bid for the SKA. It represents a crucial mechanism for articulating skills demand and supply through long-term planning and institution building.

The NASSP relies on the strong interactive capabilities of the actors in this ‘network within a network’ to support the process it follows to determine curricula. A key interactive mechanism is a curriculum workshop, at which all the main actors in the sectoral system meet to discuss and determine future needs. Key informants all reported that they participated in this workshop on the future skills and research requirements of the various employers in the astronomy SSI, including the SKA, over the short, medium and long term. The NASSP steering committee includes SKA representatives, academics and practising astronomers, providing another structured forum for these actors to exchange views and information. There are several student recipients of SKA HCDP bursaries that participate in the NASSP programme, and therefore communication between key actors in the two programmes has been vital.

Interactive capabilities and TVET colleges

Clearly, the SKA organisation has established and grown extensive links with South Africa’s universities, in many cases intertwined with skills networks already present for many years. The same cannot be said for links to TVET colleges, which have historically not featured in sectoral skills networks, and which do not have a foundation of prior informal relationships.

The scale of constructing the SKA will require a significant artisanal and technical skills pool, and the HCDP has an evolving relationship with the TVET sector aimed at supporting the development of these skills, using the same model it used with universities. The evidence shows that TVET colleges are only linked into the SKA network very weakly, and at the time of research, the skills development programme was not very successful, with few graduates. It is instructive to consider why this is so.

The HCDP programme assessed the South African TVET landscape and decided to initially focus on the Kimberley TVET college, since this was geographically the closest to the SKA core site. HCDP staff began an ongoing engagement with the leadership of the college. However, as in the TVET system in general, which has been challenged by multiple policy changes and weak overall capabilities, the college displayed relatively weak dynamic interactive capabilities. There was evidence of constrained communication with the SKA, and limited capacity to internalise planning and develop programmes to meet specific skills requirements.
The SKA responded by initiating longer-term and ongoing capability building in partnership with the college, allocating resources and taking measures to train TVET staff and to build basic competences that could provide a platform for improved relations and increased outputs of relevant skills. At the same time, the capabilities of the HCDP to interact with the college have grown through experience. Consequently, graduate throughput has improved, and the alignment of curricula with SKA requirements has advanced.

The relationship between the SKA and the TVET college presents a contrast to that of the universities: weak interactive capabilities within the TVET college acted as a constraint on labour market alignment. However, this example also shows how these interactive capabilities can be purposively developed in order to be more effective.

Skills and interactive capabilities in the SKA and the astronomy sector

This chapter focused on illuminating skills development networks at the micro- and meso-levels. At the meso-level, it analysed the structure and dynamics of a system of innovation that developed skills in a high-stakes, high-technology and knowledge-intensive sector. At the micro-level, it explored how key actors in these networks displayed the dynamic interactive capabilities that enabled their organisations to interact, align and coordinate effort to achieve shared sectoral skills development goals.

We found that the knowledge and technology structure of the astronomy SSI influenced the distinctive nature of organisational interaction and labour market alignment within the SKA’s innovation network. As a highly specialised niche area, skills in astronomy are rare and cannot successfully be treated as skills ‘commodities’, where large numbers of graduates with standardised qualifications enter a labour market consisting of a multitude of potential employers. On the contrary, in the case of astronomy, a handful of astronomers and highly specialised engineers enter a labour market consisting of only a few employers. Moreover, each employer requires such narrow skills bands that they are largely aware of which specific individuals within the system hold these skills or are developing them. Likewise, postgraduate students or employed astronomers and engineers largely have an awareness of which small group of actors requires their specific skills. This structure can be seen to be a function of operating within the small apex of a skills pyramid that has a large base.

A focus on learning, capabilities and interaction enables the identification of pockets of excellence and strengths in firms and PSET organisations, related to their dynamic interactive capabilities and the conditions in which they find themselves in the PSET or sectoral system. In the skills development network itself, key intermediary organisations and critical facilitators of flows of knowledge and resources align the skills and technology needs of the SKA with PSET providers in a dynamic process. The case study showed how the ability to connect skills, knowledge, technologies, networks, intermediaries and funding has been paramount in ensuring the success of universities in responding to current and future skills needs.

These empirical and theoretical insights have implications in the policy domain. If the SKA network model is to be replicated in other knowledge-intensive projects and sectors, what are the institutional arrangements and capabilities the principal actors, both public and private, are required to foster?

The success of skills planning in the SKA was the result of four critical enabling conditions. Firstly, there was a dense network structure, and strong coordination mechanisms that facilitated interaction at the sectoral level amongst the key actors and stakeholders. Secondly, these were driven and coordinated by the strong interactive capabilities within the SKA organisation itself, underpinned by formalised
mechanisms as well as informal and tacit, long-standing personal relationships. Thirdly, public and private intermediaries played a key role in linking the actors in the network. Significantly, public intermediaries were backed by substantial high-level political support and financial resources. Fourthly, there was a high level of competences and dynamic interactive capabilities within niche disciplinary fields at South Africa’s leading research universities. University managers and academics had the will, competence and capability to sense what the SKA needed, and to change their teaching and research in response, without compromising the academic project.

A key implication for skills planning and development is the need to target and support network mechanisms rather than market mechanisms. The structures, mechanisms and incentives that facilitate interaction and skills networks in the SKA can inform strategies in other niche sectors that rely on high-level skills. However, the tension between the imperative for inclusion and the imperative for high-technology development remains. The growth of the SKA, driven in part by strong interactive capabilities, led to increased funding, research and teaching at some historically disadvantaged universities, and offered support for some TVET colleges – thereby addressing issues of access and success in the PSET sector. On balance, the benefits of participation in the SKA’s innovation networks largely accrued to historically advantaged research universities. This appears to be a function of the fundamental competitive drivers of participation in high-technology sectors, and active policy intervention may be required to shift the outcomes towards more equitable goals. In particular, context-specific support to strengthen the dynamic interactive capabilities of previously disadvantaged universities, and greater institutional support for TVET colleges, may serve to offset some of their disadvantages in terms of network access and financial resources.
Skills development is increasingly described as a ‘collaborative project’ involving private and public sector actors, including government, firms, universities and colleges, and intermediary organisations (DHET 2013a: 9). This implies that the particular interests served by skills development is strongly determined by which actors are included and who takes the lead. Bridging the gap between public and private interests is thus critical if skills are to make a significant contribution to the national development goals of reducing poverty, inequality and unemployment. How can we bring about the ‘right’ kinds of linkages and effective coordination to bridge the gap between public and private sector objectives towards achieving national development goals?

In South Africa, the skills literature has highlighted the important role of intermediaries (Kraak 2008a; Kraak et al. 2006) and in policy (DHET 2013b). Recent research has shown that whether public or private sector intermediaries are best suited to take the lead is influenced by sectoral and spatial differences in the types of actors and networks involved, the specific technology and knowledge challenges and the related skills needs, and institutional contexts (Intarakumnerd & Chaoroenporn 2013b; Petersen et al. 2016). This points to the need for contextualised and systemic approaches that take into account occupational, spatial and sectoral dynamics. ‘One-size-fits-all’ approaches are not appropriate.

This chapter therefore argues for the need to better understand the networks of actors that drive skills development on the ground, specifically the roles of public and private sector intermediaries in facilitating linkages and information flows, coordination and decision-making processes. Our empirical focus is the sugar sector, which is a capital- and labour-intensive sector that contributes significantly to the economy and employment in impoverished rural areas. The focus of the analysis is on the sugarcane growing and milling segments of the value chain, which are concentrated in the KwaZulu-Natal region. This is an interesting case to study because of its direct importance for inclusive development, and because the sector experiences changing skills needs at the full range of basic, intermediate and high skills levels to the extent that it requires alignment with all levels of the post-school system.

Given the limited view of intermediaries in the skills literature, we draw on the innovation studies literature, where the notion of intermediaries is most developed, for insight into intermediary roles in skills development. The innovation studies literature proposes a systemic perspective on the role of intermediaries, understood through an innovation systems lens that emphasises learning and interaction and the interplay between the macro-, meso- and micro-levels. The approach thus goes beyond analyses at the macro-level and interaction between the state and market, which tends to be the focus of the dominant political economy of skills approach to skills development in South Africa (Brown et al. 2001).
In this chapter, first we draw on the innovation studies literature to discuss the types and roles of intermediaries, distinguishing between public and private sector intermediaries. Second, we describe the skills challenges, key institutions, and actors and networks responsible for skills development in the sugar sector. Third, we present a historical account of how skills development has evolved over time in South Africa, in response to a changing political terrain and changing skills needs. The analysis shows the importance of alignment between the goals of the different actors involved and their strategies for addressing changing skills needs, and how these are shaped by the wider institutional context. Also, dynamic interactive capabilities – that is, the capability to learn through interaction, and sense and respond to change – were found to be an important determinant of effective coordination and alignment. With the support of strong private and public sector intermediaries, the sugar sector has developed a well-coordinated ‘self-sufficient’ skills development system that addresses routine skills needs. New skills challenges have prompted the search for new strategies and collaborative arrangements. We conclude the chapter with a discussion on implications for skills planning and policy.

The role of intermediaries in skills development

Drawing on the literature on innovation intermediaries, we define sectoral intermediaries as organisations that connect, translate and facilitate information flows (Van Lente et al. 2003: 248) as well as offer services that are essential but not easily available in the system.

Sectoral intermediaries (hereinafter referred to as intermediaries) may engage in one-to-one or one-to-many relations, not only to broker relations or mediate between actors, but also to promote learning and create dynamism. Services provided to support skills development and planning may include training, advisory services, quality control, funding and so on. We follow Dalziell (2010), to focus on the organisational purpose of intermediaries rather than their activities, as this recognises that intermediaries may have diverse functions in innovation besides linking different types of actors and mediating transactions.

Intarakumnerd and Chaoroenporn (2013a, 2013b) introduce a further distinction that is useful for our purposes: public intermediaries, which are publicly funded organisations that focus on mainly public good objectives, especially those related to policy; and private intermediaries, which are privately funded and focus more on industry or firm-specific issues. This classification is useful because it considers the institutional structure and main objectives of an intermediary, which influence the organisation’s form of management and performance assessment, and its functions (Intarakumnerd & Chaoroenporn 2013a, 2013b; Klerkx & Leeuwis 2008; Smits & Kuhlmann 2004).

As Klerkx and Leeuwis (2008) indicate, organisations with a hybrid institutional structure (that is, public–private) may also emerge as intermediaries. They show that these intermediaries typically engage in liaison activities at the interface between public and private sector actors and are responsible for interface management within the system.  

Intarakumnerd and Chaoroenporn (2013a, 2013b) compare the traditional roles of public and private intermediaries in different sectoral systems of innovation (SSIs), drawing on a widely used set of distinctions, namely:

- consultant – provides information and advice on the recognition, acquisition and utilisation of relevant intellectual property or knowledge and technology capability;
- broker – ‘brokering a transaction between two or more parties’ (Intarakumnerd & Chaoroenporn (2013b: 109);

1 Parts of this section of Chapter 9 have been taken from Petersen et al. 2016, © Development Bank of Southern Africa, reprinted by permission of Taylor & Francis Ltd, www.tandfonline.com on behalf of Development Bank of Southern Africa.
• mediator – an independent third party who assists two organisations to form a mutually beneficial collaboration;
• resource provider – an agent who secures access to funding as well as other material support for the innovation outcomes of such collaborations (Howard Partners, 2007: 13, cited in Intarakumnerd & Chaoroenporn 2013b: 109).

Petersen et al. (2016) identified a fifth role for intermediaries in skills development networks in South Africa: coordinator. Since no single organisation can fill all the gaps, a range of organisations may perform different intermediary roles within a system. It is thus crucial that the efforts of these organisations are coordinated to some extent, because a lack of effective coordination may lead to tension and misalignment, which in turn may weaken the system (Intarakumnerd & Chaoroenporn 2013a, 2013b). For example, if a public intermediary does not have sufficient funds for its skills programmes, or if the division of labour between public and private sector intermediaries is not clear, the result may be competition with private sector intermediaries, weakening the system.

According to Intarakumnerd and Chaoroenporn (2013a, 2013b), while medium-technology sectors tend to be strongly disciplined by transnational corporations (TNCs), agro-processing sectors generally consist of a small group of large firms and a large group of small (mainly local) firms. Intermediaries in agro-processing sectors are thus needed, to broker relations among actors in the sector to assist in developing capabilities and ensure that their products and services meet sector-specific standards. Dutrénit et al. (2012) and Klerkx and Leeuwis (2008) add that the articulation of demand is particularly important, as farmers often find it difficult to express their needs. In medium-technology sectors, on the other hand, intermediaries are needed to negotiate with TNCs to provide assistance to local firms to develop capabilities. Similarly, in high-technology sectors, an important task of intermediaries is to keep up with technological change and broker relations between local actors and TNCs.

Government agencies and industry associations tend to play a key role as resource providers and brokers (in agro-processing sectors) or as mediators (in medium-technology sectors). In high-technology sectors, public research institutes and international industrial associations tend to emerge as the main intermediaries.

It is imperative for intermediaries to be knowledgeable about the actors and networks operating in the sector and the main challenges they face, in order to address systemic blockages, gaps and problems. A ‘one-size-fits-all’ approach to policy intervention or the crowding out of private sector intermediaries by government may be detrimental (Dutrénit et al. 2012; Intarakumnerd & Chaoroenporn 2013b; Klerkx & Leeuwis 2008). This highlights the importance of systemic thinking, which is especially important in systems in transition, where change is rapid and dramatic (Smits & Kuhlmann 2004; Van Lente et al. 2003). Smits and Kuhlmann (2004: 18) point out the need for policy instruments that promote systemic functioning and refer to these as ‘systemic instruments’. Systemic functions include the management of interfaces, which is not limited to bilateral relations; building and organising systems; creating conditions for learning and experimenting; providing an infrastructure for strategic intelligence; and stimulating demand articulation, strategy and vision development (Smits & Kuhlmann 2004, in Van Lente et al. 2003: 254–255).

While the focus in the literature has been on the traditional roles of intermediaries (see Howells 2006), Van Lente et al. (2003: 256) suggest the emergence of a new type: a ‘systemic intermediary’. Typically, these aim to satisfy the need for the articulation of options and demand, the alignment of actors and possibilities, and support for learning processes by enhancing feedback mechanisms and stimulating learning.
In the South African context, we have argued that public sector intermediaries, in particular the sector education and training authorities (SETAs), are well suited to carry out these functions (see Petersen et al. 2016). In this way, they could strengthen their role in skills development.

Through the different functions described above, intermediaries contribute to network alignment in the system, which involves enhancing the consistency between multiple and heterogeneous networks, in terms of their ability to contribute towards the attainment of the developmental goals defined for a system. According to Von Tunzelmann and Wang (2003, 2007), network failures – or misalignment – relate to constraints on the flow of knowledge about technology and production at the system level. They elaborate on three potential ways in which misalignment occurs. It may be that the network required to facilitate flows of knowledge about technology and production may not exist. Or, the network may exist, but it may have a goal that does not promote development for the system. Finally, the network may exist and have a developmental goal, but it may function in such a way that it fails to achieve these developmental goals. Network misalignment is an instance of the failure of a system, rather than an individual organisation or network.

A related concept is ‘interactive capabilities’ (Von Tunzelmann & Wang 2003, 2007), which refers to the capacity to form linkages and use organisational competences and mechanisms to learn through interaction. This is a useful attribute, not only for intermediaries but also for universities, colleges and firms. To address changing skills, ‘dynamic interactive capabilities’ are required to continually sense changes in the business, education and policy environment, adapt to the demand for new skills and coordinate change across the organisation.

For this chapter, we use the concepts described here to focus the empirical analysis on an in-depth case study of the role and interactive capabilities of public and private sector intermediaries in the skills development network of the sugarcane growing and milling subsector in KwaZulu-Natal. The boundaries of the case study were thus defined by sector and geographical location. The research was conducted as part of a larger study aimed at exploring alignment between skills supply and demand in South Africa, through case studies. Full details of the methodology, sample and data analysis are available in a set of reports (Kruss et al. 2014; Petersen 2015) accessible via the project’s website (www.lmip.org.za).

**Sugarcane growing and milling in South Africa**

Sugar production involves two distinct activities: the production and milling of sugarcane, which also produces downstream by-products, including molasses and electricity. Due to the bulky, perishable nature of sugarcane, sugar mills must be located close to a supply of sugarcane and vice versa. The result is that growers and millers of sugarcane have a mutually dependent relationship, strong shared goals and a shared knowledge base.

As a capital- and labour-intensive sector, the sugar sector contributes significantly to social and economic development. Importantly, the sector creates jobs in rural areas that are generally poverty-stricken and characterised by high rates of unemployment. Not surprisingly, unemployment in sugar

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2 The case study design included a desktop process to map the actors in the system. Social network analysis was conducted to map the patterns and strength of interaction. A total of 67 semi-structured in-depth interviews were conducted with senior managers and heads of knowledge fields at the milling companies, public and private intermediaries, private training providers, public universities and technical and vocational education and training (TVET) colleges. The interview data was supplemented by desktop research on their goals, policies, structures and interactive mechanisms.

3 This section and the final section of this chapter are largely taken from Kruss and Petersen (2016a), © HSRC, reprinted by permission of HSRC Press.
The role of intermediaries | 125

milling towns and sugar farming areas is much lower than in other small towns and rural areas in South Africa (NAMC 2013). Most of the job opportunities in the sector are unskilled and semi-skilled (4,941 skilled jobs, 63,412 semi-skilled jobs and 25,638 unskilled jobs) (NAMC 2013).

Figure 9.1 maps the actors involved in the sectoral system of innovation (SSI) in KwaZulu-Natal. The region accounts for approximately 85 per cent of the sugar produced nationally (NAMC 2013). On the skills demand side, the milling segment is concentrated in a small number of large local companies. Sugarcane production is likewise dominated by a small number of large-scale growers. However, in recent years a large number of small-scale growers have emerged, encouraged by land reform policy, given that sugarcane does not entail complex farming practices.

FIGURE 9.1 Map of actors in the sugarcane growing and milling SSI, KwaZulu-Natal

Skills demand

- Cane growers
  1. 25,200 small-scale farmers
  2. 1,570 large-scale growers (83.2% of crop)
  3. Sugarcane growing companies

- Millers in KZN
  1. Illovo Sugar (4)
  2. Tongaat Hulett (4)
  3. Tsb (1 in KZN, 2 in Mpumalanga)
  4. Gledhow Sugar Company (1)
  5. Union Cooperative Limited (1)
  6. Umfolozi (1)

Mechanisms/strategies

- Organisational linkages (knowledge and experience)
- Resources (e.g. bursary programmes)
- Skills movement (graduates, upskilling)

Skills supply

- Universities
  1. UKZN
  2. MUT
  3. Wits (Tongaat)
  4. Pretoria
  5. Stellenbosch

- TVET colleges
  1. Coastal
  2. Elangeni
  3. Esayidi
  4. Majuba
  5. Mnhambithi
  6. Mthashana
  7. Thekwini
  8. Umfolozi
  9. Umgungundlovu
  10. Saasveld
  11. Lawveld

- Private providers
  1. STC
  2. AGB Mathe

- Agricultural colleges
  1. Cedara College of Agriculture
  2. Owen Sithole College of Agriculture
  3. SA Cane Growers Association
  4. SA Sugar Millers’ Association
  5. SMRI

Notes:
The organisations in italics were interviewed. The rest were not included in the interviews, because they were located outside of KwaZulu-Natal or were not available for an interview.
AgriSETA = Agricultural Sector Education and Training; DAEA = Department of Agriculture and Environmental Affairs; DAFF = Department of Agriculture, Forestry and Fisheries; DHET = Department of Higher Education; DUT = Durban University of Technology; IPAP = Industrial Policy Action Plan; merSETA = Manufacturing, Engineering and Related Services Sector Education and Training Authority; MUT = Mangosutho University of Technology; NDP = National Development Plan; NSF = National Skills Development Strategy; Sasa = South African Sugar Association; Sasri = South African Sugar Research Institute; SMRI = Sugar Milling Research Institute; STC = Shukela Training Centre; UKZN = University of KwaZulu-Natal
Private sector intermediaries play a critical role in ensuring network alignment (Intarakumnerd and Chaoroenporn 2013b) and this is evident in the symbiotic relationship between millers and growers. These intermediaries were established as far back as the 1920s to coordinate activity in the sector and to ensure that its interests were represented. Early on, the industry created its own knowledge generation capacity, in the form of two research institutes that have grown global reputations.

Public sector intermediary actors include the AgriSETA in relation to sugarcane production, as well as the DHET, which has oversight over all public provision, including approval of the funding for the programme and qualification mix for higher education and setting the national curriculum for TVET colleges.

On the skills supply side, a range of public education and training providers in KwaZulu-Natal offer full qualifications and skills programmes in agriculture and engineering, which are the most important fields for the sector: four universities, nine TVET colleges, two agricultural colleges and two private training providers.

**Strong interaction and network alignment between private sector actors**

There are shared goals between firms, farmers and private intermediaries, but how well aligned are all the actors within this sectoral network? Who is more likely to interact around skills development, in practice? Figure 9.2 reflects the results of a social network analysis of the scale and intensity of interaction, reflecting that there is a dense core network with strong ties between actors, highlighted in the area inside the circle.

The core network includes the private sector intermediaries, a few public intermediaries (notably, the Department of Agriculture) and a few public education and training organisations located in the region, particularly agricultural colleges and a few universities, but not universities of technology.

**FIGURE 9.2 Network map illustrating the skills development networks in the sugarcane growing and milling SSI**

Source: Project data

Notes: The thickness of the lines corresponds with the scale of interaction, such that the thicker the line, the greater the scale of interaction (scale: 1 = ‘Not at all’; 2 = ‘Isolated instances’; 3 = ‘Moderate scale’; 4 = ‘On a wide scale’).
Most of the public TVET colleges fall outside the core network, as do some local universities and universities in other provinces or globally. Analysis of the interviews shows that in general, the public universities, universities of technology and agricultural colleges tend to provide foundational education and training qualifications in agriculture and engineering, to prepare employable graduates who have the mobility to enter a range of sectors. Sugar-specific education and training is provided by the private sector intermediaries, mainly through their own accredited private college/training centre, and practical training is provided by firms and farmers at the workplace, as attested by the mill managers interviewed:

Yes, and that’s where they do their theoretical training. And they come do practice here ... All the apprentices must go to training at Shukela Training Centre ... (Human resources [HR] manager at milling company U)

We also have the whole learning academy where we have in-house training facilitators, especially on the engineering side and on the process side, but then on premises at each mill we also have trainers in process and in engineering. (HR manager at milling company T)

Figure 9.3 provides a more detailed breakdown of the scale of interaction between the private sector intermediaries and each of the other types of actor, confirming their core role in network alignment. Strong interaction with firms is evident. The interaction with public universities and agricultural colleges and public sector intermediaries is present but not very strong, and there are very low levels of interaction with TVET colleges and other private providers. The skills goals of the sectoral system thus appear to be set by the private sector actors, and it seems that public sector actors are included in networks to the extent that they can offer expertise or complementary knowledge. Collaboration
Skills for the future may focus simply on ensuring a supply of skilled workers with specific types of scarce qualifications, or it may involve collaboration around the nature of training itself to address sectoral needs:

... boilermakers, it’s a very scarce skill ... I had to advertise three times because people who were applying were not even meeting our criteria ... we were looking for N4 at best ... we went specifically to technical colleges because they are the ones who train N courses ... (HR manager at milling company LSZ)

AgriSETA has provided some funding for the mentorship and government support, for us to try and test some of these training programmes, because the AgriSETA did learn that it’s not just about the training and certification of individuals ... (Manager L at Sasa)

How did the network evolve in this manner, in which private sector actors do not interact strongly with public sector actors, those legislatively responsible for skills development? Such misalignment clearly does not constrain private sector goals, as the system has been in place for almost a century, but is it desirable for achieving national developmental goals? Does it address the interests of all those involved in the sector, such as emerging small-scale farmers? In the following sections of this chapter, we examine the long history of the sector and the origins of its structures, showing how network alignment evolved in a self-sufficient manner amongst private sector actors, without strong linkages to the public sector and government actors. It will become evident that the private sector decides what it needs, and finds ways to circumvent government skills policy when this constrains and ways to draw public sector actors into the core network when national policy facilitates the achievement of sectoral goals.

The development of a self-sufficient skills development system up to 1994

Historically, the sugar sector has operated relatively independently, regulated by legislation that grants statutory powers of self-governance.

Origins in the 1920s

Industry insiders typically point to a ‘strong collective structure’ that has grown around the symbiotic relationship between growers and millers since the 1920s (NAMC 2013). The milling companies are described as ‘major corporations’ equipped with the interactive capabilities to assess and address their own skills development needs (Manager 1 at Sasa), while small grower development is a concern for the sector as a whole.

The sugar industry has been proactive in ensuring that it has effective mechanisms in place for training in ‘core industry or strategically important industry skills’ (Manager 1 at Sasa) – that is, ‘sector-specific’ skills. In the late 1920s and 1930s, in line with national trends (Wedekind 2013b), the sector relied on importing skilled artisanal labour from other countries, such as Mauritius, which was not a sustainable strategy (Report of the Committee on Training of Sugar House Apprentices 1930). The need to develop strategies for cultivating skills locally was identified, and the core private intermediary organisation, Sasa, was identified as the appropriate body to lead the process, a bridging role which it fulfills to the present day.

Under the leadership of Sasa, the intermediary actors chose to collaborate with the then relatively young public universities and agricultural colleges to develop the qualifications needed by millers and growers. Typically, partnerships were instituted whereby teaching expertise was provided by
the intermediary organisations and the public universities and colleges provided the physical facilities and accreditation. The system evolved during the apartheid period in response to shifting skills needs in the sector, changes in the political terrain, and policy governing the public education and training sector.

Developments in the 1950s to 1980s

In the 1950s, Sasa began developing an in-house agricultural training programme. It was recognised that sugarcane growers required the skills to interpret and use the research and technical knowledge produced by the Sasri, leading to the development of formal and informal training programmes at the low to intermediate occupational levels (Cleasby 1963). The training was not accredited but was well subscribed because of Sasri's reputation for facilitating knowledge transfer and diffusion, providing training and consultant services to farmers and articulating skills needs through its extension specialists.

From the 1970s, the racialised public system was increasingly found to be unresponsive to demand. Consequently, the private sector developed their own training centres for producing the 'sugar-specific' skills necessary for technological development.

Given apartheid job and training restrictions, the sector was challenged by a shortage of affordable, qualified artisans at the intermediate skills levels to work in sugar mills, particularly those located in rural areas. In 1974, Sasa opened a private training centre to provide sugar-specific artisanal training, which was open to all, including individuals classified as black, despite apartheid regulations. The milling sector introduced another mechanism—study bursaries offered to those residing in the sugarcane-growing provinces—in order to address the problem of lack of skills in the rural areas.

Initially, there was a close alignment between the sugar sector and technical colleges. During the early 1980s, the sugar technology qualifications offered by technical training colleges were stopped, due to an oversupply of sugar technologists and student complaints that the courses were too specialised, restricting their mobility (Oosthuizen & Dunsmore 1998). Moreover, managers at the sugar mills valued university degrees over diploma and certificate qualifications. Henceforth, it was decided that the training would be provided by the private sector SMRI, which created a short course taught by staff at the milling companies.

Networks were built as the need arose. For example, during the late 1970s, the SMRI collaborated with a local university to provide sugar-specific training to meet demand for skills in chemical process technology. The SMRI provided teaching staff for the modules, which were included in the general applied chemistry programme. The modules were stopped during the period of political change (Oosthuizen & Dunsmore 1998).

The analysis highlights the strong interaction and alignment of goals between milling firms, farmers and private sector intermediaries that evolved in the region historically. It also reflects the ways in which selected public providers of education and training were recruited into the skills network, as and when needed. The strong industry association was the main driver of all training decisions on behalf of its members. A public university and selected colleges provided foundational and occupational programmes, but also sector-specific skills and training, in close collaboration with firms and intermediaries. Thus, from the 1920s, the foundation was laid for a self-sufficient sectoral network that could manage its own skills needs, despite the constraints imposed by apartheid skills and training policy at the national level.
Post-1994: A system of private provision

Figure 9.2 showed that, in the present, there are weak linkages to public post-school education and training (PSET) organisations, particularly at the intermediate skills level. Our evidence suggests that new skills development legislation and increasing government regulation have been identified as blockages to skills development by private sector actors. Compliance with new DHET requirements for registration as private training providers and regulation of the work-based training provided at firms are viewed as too onerous and costly, as are frequent changes to the role and funding available from SETAs and uncertainty and poor governance in the TVET college system. In this context, Sasa took a strategic decision to address the routine skills needs of growers and millers through strengthening private in-house capabilities rather than through collaborative linkages with public sector organisations. In the following section of this chapter we explore in detail how these skills decisions are made in the present.

Foundational qualifications offered by public education and training organisations

Foundational qualifications in engineering and agriculture are offered by the public universities. Sugar industry actors are only indirectly involved, and mainly with one university, to ensure that there is a large enough pipeline of suitable graduates. The private sector then controls its own internship programmes to impart sugar-specific skills. Bursaries are offered to postgraduate students conducting relevant research, to address a critical shortage of agricultural and biological scientists. The milling companies offer bursaries to engineering students as part of an engineers-in-training programme, a strategy to groom students for jobs at the level of middle management.

The evident lack of network alignment with the public TVET colleges can be related to their lack of capabilities. Most of the TVET colleges located on the sugar belt reported the ‘enduring’ gaps and limitations challenging the system as a whole. The new national location of colleges and DHET interventions that were intended to grow, stabilise and steer the TVET system in a more responsive manner are clearly still an unfolding process, which has not taken root in individual colleges. Challenges reported include funding constraints, inflexible programmes, curriculum uncertainty and turbulence, lack of marketing, heavy staff workloads and bureaucratic demands. The limited engagement with the sugar industry was reported as being due to staff workload, rigidity of national curricula, lack of historical connections and lack of intermediaries to facilitate linkages.

In contrast, interaction is relatively strong between the private sector intermediaries and public agricultural colleges, currently under the control of the national and provincial departments of agriculture (Figure 9.3). One example will suffice to illustrate why. A young, historically black college that was set up in 1968 was tasked from 1996, after a period of institutional turbulence, to build its reputation and linkages as an agricultural college. The college decided to develop a Centre of Excellence for Sugar, since it is located in the region with the largest number of small-scale cane growers, nationally. It uses the strategy of relying on formal collaborative arrangements and a culture of teamwork and consultation with external actors to ensure that the programmes it delivers are responsive to the local context. It collaborates with private sector intermediaries and milling companies to develop and deliver modules for sugar-specific training. Innovative leadership and teamwork reflect strong dynamic interactive capabilities, which were not evident in the public TVET colleges. Agricultural colleges thus share goals with the sugar sector, have the competence to contribute missing expertise and have developed dynamic interactive capabilities to become inserted into their networks.
Sugar-specific skills: Private intermediary-based training

When it comes to industry-specific training and development to meet routine skills needs, Sasa operates as a ‘one-stop shop’:

Sasa is not responsible for managing the relationship between other employers in the industry and those 3rd parties… they will source their providers as they wish. We have no say over that. However, we are a one-stop shop of training and development needs in respect of core industry or strategically important industry skills … (Manager 1 at Sasa)

Specific industry actors offer training programmes aimed at management levels or at the operator and artisanal levels. In a policy context of frequent changes to the public TVET college and skills development subsystems, sector intermediaries decided to develop an accredited private training centre for all training. It would be the only division tasked with keeping up with frequent changes in legislation and the regulatory environment. The decision was taken to continue to offer private sector agricultural courses, through Sasri, without government accreditation, because of the high opportunity cost of regulation. Farmers’ associations and local grower councils in each area feed local development needs back to the private training providers, to inform the programmes.

The private training centre has both formal and informal mechanisms for interacting with firms and farmers and keeping up to date with skills needs, such as trade working groups that meet regularly with industry representatives. It acts as a bridge between industry members and government agencies like AgriSETA, keeping both informed of relevant changes. This practice facilitates the implementation of changes to training to align with changes in the policy environment, and to ensure that programmes are kept up to date with current standards. AgriSETA’s organisational structure includes a ‘sugar subsector’ committee with representatives from the private intermediaries, milling companies and private training centre.

There is thus strong network alignment between public and private intermediary actors, facilitated by strong interactive capabilities. Through mechanisms such as the sugar subsector committee, AgriSETA manages to keep abreast of changing skills needs and gain feedback on their mechanisms and approaches. A key aspect of interactive capabilities is learning through interaction:

AgriSETA has provided some funding for the mentorship and government support, for us to try and test some of these training programmes, because the AgriSETA did learn that it’s not just about the training and certification of individuals … in the past AgriSETA funded pure training and we have convinced them to say, you know ‘beyond the training what happens?’ You can’t just leave communities, you know, it’s a much more longer-term support programme … (Manager L at Sasa)

The milling companies tend to have a standard approach, offering long-term training informed by learning pathways developed by the firm. Emphasis is placed on training in-house, in order to ensure that the company has control over the training and trainees are groomed well for the job. Milling companies also offer in-service training to students from universities of technology as part of their work-integrated learning programme. Finally, apprenticeship training is a long-standing tradition in the sector, aimed at ensuring a pipeline of artisans.

Sasa and its component organisations thus display evidence of strong interactive capabilities to support interaction between firms, farmers and private training providers.
Changing skills needs: Driving new alignment with the public sector?

Human resource (HR) and skills development managers reported that they generally have a steady skills pipeline for meeting their routine skills needs, but that their approach is not as effective for keeping up with changing needs:

So we continually have to train our own … We run our apprentice programme … You see, even in engineering, even though they are scarce skills, but these programmes they help out, in the sense that we’ve got it running, that each year at least two people must come out of the programme. That way we know for sure that those people will be able to get trained fully, and act in a certain position … (HR manager at milling company L)

You know, with the new land reform … the quantity of entrants coming in, and the lack of knowledge of just any farming, let alone sugarcane farming, has caused a huge pressure, because there is a huge skills gap there … And we had a huge challenge of how to address that skills gap … we’ve battled to try and improve that … (Sasa manager S)

This may drive a shift to link with public sector actors to a greater extent. Here we briefly consider an example to illustrate how networks shift and realign as goals shift. There has been a rapid increase in new farmers and cooperatives, largely due to the national policy emphasis on land reform and inclusive development. New farmers tend to have little or no knowledge of how to manage a sugarcane farm, and do not have the capacity in-house to do their own training or to collaborate with public education and training organisations. They rely mainly on the services of the milling companies and private sector intermediaries, but they present a new demand that the sector is not equipped to provide internally – that is, for soft skills and business management. These gaps and bottlenecks in their skills development network have driven firms and private sector intermediaries to draw on public sector intermediaries to a larger extent, mainly for funding to support training activities, but also to offer expertise and training to cooperatives and to build a ‘sugar industry development pathway’ (Sasa 2014, per.com., 4 February).4

Implications for skills planning and policy

We have analysed the sugar skills development network to illustrate the critical role of public and private sector intermediaries in linking and aligning networks to address routine and changing skills needs. We show how networks shift and realign as goals shift, and how inclusion (and exclusion) of actors relates to their interactive capabilities. What are the implications for building stronger alignment of goals between government, the private sector and education actors at different levels?

In a well-coordinated skills development system, like the sugar skills system, private and public sector intermediaries play distinct but complementary roles. Private sector intermediaries respond effectively to address industry-specific goals. In contrast, public sector intermediaries work to achieve national policy goals for post-school education and skills development, in the broader interest of the ‘public good’, in ways that private sector intermediaries do not.

Private sector intermediaries may drive, fund and coordinate a self-sufficient skills development network, within and alongside the public system. In the sugar sector, private sector intermediaries played the leading role in governing skills development and taking decisions on behalf and to

4 Towards a sugar industry education and training development programme. Unpublished memo. Personal communication, 4 February 2014
the benefit of the sugarcane growers and millers they represent. They did so with little input from public sector actors, and with mechanisms to avoid the high opportunity cost of compliance with government skills development regulations, both in the past and the present. These private sector organisations have the necessary expertise and interactive capabilities for providing and supporting skills development and planning, by linking firms, public sector intermediaries and public education and training providers as the needs of the sector require.

There is much that public sector actors can learn from their approach to skills development, their sectoral interactive structures, the flows of knowledge and resources, and their skills development mechanisms. The role of private sector intermediaries is, however, given little attention in skills policy.

Public sector intermediaries that have strong dynamic interactive capabilities can play a role as bridging actors, linking public and private sector actors and objectives. One important way in which public sector intermediaries, particularly the SETAs and the DHET, can contribute is to intervene by addressing blockages in the system. One important blockage relates to the national accreditation system, specifically the onerous requirements for accreditation of courses offered by private sector actors. The analysis illustrates how private sector actors carefully consider opportunity cost when selecting or developing mechanisms to meet their skills needs. An implication is that private sector actors may opt to offer key training programmes, such as the renowned sugar-specific training programmes offered by Sasri, without accreditation. If the DHET wants to promote accreditation and compliance by private training providers, it needs to review the current accreditation process and take into account the practical reality of how these processes are understood and implemented at the sector and industry level. Mechanisms that may support this include the SETA subsector committees that promote network alignment through facilitating interaction and knowledge flows between government, industry and education and training providers.

Effective coordination and alignment between public and private sector objectives are essential for striking a balance between promoting foundational training versus sector-specific training. Through experimentation, constant reflection and a flexible approach, the private sector intermediaries worked closely with firms, universities and agricultural colleges to develop private sector-specific training programmes that complement a sound foundational base developed in the public sector. The historic analysis highlights the implications of different strategies and models. Sector-specific training programmes that were too specialised led to an oversupply of graduates and hindered mobility. For public universities and colleges to play a role, they have to build a reputation as providers of good quality foundational education and training that is relevant to the sector. The analysis of network alignment and interactive capabilities draws attention to the importance of engagement with private sector actors to understand the necessary skills and training needs. Public sector intermediaries are well placed to provide the necessary support.

Although potentially risky, it will be worth exploring whether forms of public–private partnerships may be a missing mechanism that could facilitate network alignment. Reflection on their use in public health (Widdus 2001) and social development (Hubbard & Paquet 2006), for example, and a growing research base on their efficacy (Osborne 2005; Wettenhall 2003) can inform careful design of interventions. It is worth exploring the constraints and benefits of potential models for such public–private social partnerships in greater depth, to consider what could work in the skills development domain. Mechanisms need to be designed so that public and private sector intermediary actors could play a strategic complementary role in driving change, to address changing skills needs or critical shortages more effectively.

In conclusion, we propose that in the process of devising national plans to implement skills development policies, greater attention should be paid to the role of private and public sector intermediaries.
that drive skills development and planning at the sectoral and regional levels. In a context of scarce resources, the interests of all would be better served if objectives were coordinated and aligned. Intermediaries play a critical role in coordinating and bridging public and private sector objectives, thereby addressing misalignment that may weaken the skills development system.
CHAPTER 10

Higher education and economic development: The importance of building technological capabilities

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In this chapter we offer an alternative account of how higher education contributes to skills and economic development. While we acknowledge that there is more to the developmental impact of higher education than economic development alone (see Walker 2015, for instance), we will restrict our argument to the economic sphere. This alternative account is developed by drawing on the national innovation systems approach (Freeman 2002; Lundvall 2011; Nelson & Winter 1982), which offers distinct benefits in conceptualising higher education’s developmental role, due to its stress on the importance of education, skills, work, innovation and production for economic development. Moreover, the focus on the level of the organisation (typically the firm, but the university by analogy) and network offers a new scalar level and methodological purchase on the higher education–economic development relationship. Together, these theoretical and methodological lenses offer very different policy implications and possibilities when compared to more conventional neoclassical approaches. Such alternatives may be of value for consideration alongside or in competition with orthodox policy options.

Our focus is on the explanatory potential of mid-level theories of technological capabilities (Lall 1992, 2001), sectoral systems of innovation (SSIs) (Malerba 1999, 2002, 2005) and interactive capabilities (Von Tunzelmann 2010; Von Tunzelmann & Wang 2007). Using these concepts, we examine the complex ways in which South African higher education is positioned to contribute to economic development. We do so through a comparison of two case studies: the high-skills case of the astronomy sector – particularly the Square Kilometre Array (SKA) project – and the automotive sector – specifically the ’Tier 1’ component supplier subsector in the Eastern Cape.

We proceed to a brief consideration of key concepts before reporting on the methodological approach taken. We will then examine two sectoral case studies separately through the lenses of our conceptual framework before drawing them together in a conclusion that considers the theoretical, practical and policy significance of such an approach to thinking about higher education and economic development.

1 This chapter is adapted from Kruss et al. (2015).
Technology, capabilities and innovation systems

Following the perceived failure of efforts to understand variations in country development and growth patterns through conventional neoclassical approaches, a series of alternative approaches emerged, emphasising the role of innovation in economic development, underpinned by evolutionary economics (Freeman 1995; Lundvall 1992; Nelson 1993). Nelson and Winter (1982) pioneered the argument that productive transformation is central to economic development. Contrary to linear models of technological development that privilege the knowledge frontier as the locus of economic growth, these scholars argued that innovation is a non-linear and non-sequential process. Moreover, drawing on the institutional tradition, they stressed that technical change and growth depend as much on social as on technical innovations. That is, it requires multiple processes occurring simultaneously in production, which in turn require not just research and development capacity but a variety of skills at all levels of the firm, and processes and systems for harnessing these in order to ensure effective diffusion and adoption of technology (Dosi 1988; Freeman 1995; Lundvall et al. 2002).

Technological capabilities

Within development economics, this approach was taken up most prominently by Lall (1992, 2001). He stressed that technology cannot simply be imported without investing in the technological effort to master, acquire, adapt and improve upon existing technologies (Lall & Kramer-Mbula 2005). This is crucial, for it goes against core assumptions of the neoclassical theory of trade by highlighting the difficulties that developing countries actually face in making technological and industrial progress. Lall’s work stresses that it is through building capabilities to learn that a country grows its ability to develop. Capability building involves effort at all levels of a firm, as well as new skills and knowledge that are required to master tacit elements of new technology. Lall’s ‘capabilities’ approach not only proposes that learning requires organisational capabilities, but also highlights the national level, stressing that countries also need to learn to be technologically capable, an important contribution to the notion of the developmental state.

This implies an important role for networks as the means of bridging the gap between the firm and national economy levels. Thus, the approach focuses on linkage capabilities between actors in the national system. Science and technology links and knowledge exchange with universities, research organisations and other organisations are critical for technological capability building, but equally so are linkages to those organisations or actors that build the skills required at all occupational levels of the firm. More recently, Salazar-Xirinachs et al. argue in this tradition that productive capabilities determine the realistic options for economic diversification and the competences to take advantage of potential opportunities: ‘Learning builds up dynamic capabilities which are key drivers of catching up and economic development’ (2014: 2). Thus, according to this account, a core role of an aspirant developmental state is to support learning processes to develop dynamic technological capabilities at all levels.

Bringing an education perspective to bear

The evolutionary economics and innovation systems literature has been applied to firms almost entirely, and, while stressing the centrality of learning, has had minimal engagement with literatures on education and skills development. While higher education is a focus, it is primarily researched in relation to its value as a source for firm learning. Thus, part of the contribution of our research is to build a bridge between these accounts and aspects of educational theory. We take the innovation systems literature into the educational space by looking at how interactive capabilities are developed and nurtured within the higher education sector at organisational level, the role that
sectoral skills development intermediaries play in this process, and how this engages with the higher education policy arena. While the key concepts have, to date, been applied to firms, it is evident that they are highly transferable to analyse the capabilities of other, non-market actors, such as higher education organisations, in relation to their capacity for learning to attain strategic national or organisational goals.

Figure 10.1 provides a schematic view of how capability building in a higher education institution might be conceptualised.

**Research design**

We designed a methodology to investigate the structure, agents, strategies and mechanisms that organisations use to build dynamic interactive capabilities and skills in diverse economic sectors with specific technological challenges. The unit of analysis was the interaction between the main actors in the education and training organisations, firms and sectoral intermediaries within the SSI, from which challenges and bottlenecks to inform policy interventions can be identified. The approach requires data describing the key actors (firms, universities, colleges, government agencies) and the relationships between these actors, with a focus on the generation and movement of skills (Lorentzen et al. 2011).
The design centred on a large-scale, multilevel case study methodology. Three broad subsectors were selected, one each in the primary, secondary and tertiary sectors. The first task was to define the bounds of an SSI as unit of analysis, so that it could be empirically researched. This was achieved through background studies of each sector that mapped key value chains, technological change and employment patterns in terms of regional concentrations of productive activity. A study of the policy frameworks and mechanisms that shape national economic growth and in each sector was included in this process.

The next step was to map all the actors involved in the sectoral system in the region, and to focus in on key locations of intense economic activity. Interviews were conducted with all the actors in the SSI, including with a purposive selection of firms representing national and multinational firms of different sizes, to determine their skills needs and strategies used to address these. All sectoral intermediaries were interviewed, to understand their roles and linkage mechanisms.

For universities, we interviewed all those located in the region, plus significant universities outside the region, to understand how they are organised to respond to the sector’s skills needs in general, such as curriculum structures or career placement services, and in terms of mechanisms specific to that sector (such as a technology hub or training programme). Interviews were conducted with senior organisational managers and with deans or heads of key faculties and departments. A similar process was conducted for the other post-school education and training (PSET) organisations, such as technical and vocational education and training (TVET) colleges, private providers, agricultural colleges or apprenticeship programmes.

A set of templates was developed for use in the interviews and a team of interviewers with experience in each economic sector or PSET subsystem was trained to work with a lead synthesis author for each case study. All respondents also took part in a social network analysis that provided an assessment of the reach and strength of interaction between actors (who was working with whom, how intensely and in what ways). In total, 153 interviews took place across the two cases reported in this chapter: 72 for the SKA and 81 for the automotive case study. The fieldwork evidence base was supported by additional desktop research, including materials provided by universities and other actors.

Evidence from two case studies: Higher education in the SKA and automotive SSIs

In recent decades there has been major growth in tertiary economic sectors and in high-skills occupations, accompanied by growing unemployment, poverty and inequality (Bhorat et al. 2013). The response has been to propose a developmental state model that is driven by stronger planning and monitoring of government outcomes. Since 1994, a deliberate set of science and technology policy instruments has promoted the development of a national system of innovation, prioritising big science, technology transfer and the growth of niche competences and capabilities. The Department of Higher Education and Training (DHET), formed in 2009, has promoted the creation of a single PSET sector, with a stronger message about employability and responsiveness than in the past.

Higher education interaction with industry in the forms of collaborative research and development and innovation has been incentivised by the Department of Science and Technology (DST). The national system of innovation remains characterised by ‘islands of innovation’, of cutting-edge activity at the technology frontier in selected niche areas, while firms in most sectors struggle to raise their levels of productivity and technological capabilities to compete more effectively in regional and global markets (DST 2012; OECD 2007).

2 In this chapter, we do not include analysis of the sugar growing and milling sector, the primary sector case study, as it is less concerned with higher education.
Our two cases in some ways reflect this tension and highlight the uneven role of the higher education system in distinct SSIs, in an increasingly globalised economy. Thus, the South African automotive sector is at a disadvantage globally, as it does not have access to large domestic markets as in China or India, or even Brazil, where there is access to large regional markets in Latin America (Gastrow & Lorentzen 2013). Moreover, our case study of Tier 1 suppliers is located in a province that is one of the poorest in South Africa, the Eastern Cape, with high levels of unemployment, poor infrastructure and low levels of educational achievement. The SKA case, in contrast, is premised on South Africa’s geographic advantage to host radio astronomy telescopes, and is strongly inserted into global innovation networks.

Meeting routine skills needs in the Tier 1 automotive component sector in the Eastern Cape

In countries like China and India, the automotive sector has succeeded in technological capability building to the extent that local firms have become part of global innovation networks and, in turn, have created national industries that are globally competitive (Gastrow & Lorentzen 2013). The automotive sector in South Africa, however, remains strongly disciplined by global production chains, and research and innovation are conducted primarily at multinational headquarters. All the large original equipment manufacturers (OEMs) and many of the Tier 1 component firms in the study are multinational corporations, and the decision to stay and invest in their South African operations is subject to frequent reappraisal. Government has prioritised the sector in its industrial policy strategies, and the sector is well organised into industry associations, with strong trade union presence. In the Eastern Cape, the sector is placed high in provincial and metropolitan economic development priorities and structures, and there is proactive interaction from two large industrial development zone initiatives. This has resulted in a rich set of public and private intermediaries that reflect both the sector’s own internal organisation and the priority placed on it by national and provincial governments. There is, thus, a complex network of relationships and activities, with significant additional resourcing for skills development. Through and beyond these, actors from industry, government and skills providers meet regularly and have some sense of a shared understanding of and commitment to the automotive sectoral system. There is some evidence of capabilities regarding strengthening innovation, quality systems and human resources (HR) management in a range of firms, but these include only a few components manufacturers.

Nationally, a sectoral prioritisation and development programme initiated by the Department of Trade and Industry (DTI) has been successful, in that its incentives have kept the South African sector alive; however, it does not provide a model for productive transformation. The DTI programme did not include specific mechanisms to promote skills development, and its benefits have been dominated by the small group of OEMs. The main actors in the automotive component firms and the sectoral intermediaries do not have coordinated strategies to promote research excellence or sector-specific skills. Industrial policy has recently prioritised technological capability building in the national components sector, and this is stimulating new initiatives around supporting sector-specific skills.

Equally, the capabilities of the provincial PSET system to interact within the sector are directed primarily at OEMs, such as Mercedes-Benz, Volkswagen and General Motors. Firms interviewed did not identify skills shortages as a constraint on their operations, but there is strong concern for process-level efficiency to reduce costs. This leads to a drive toward higher levels of skills, but fewer staff. As much as 70 per cent of employment is at basic operative levels, with relatively little current demand for intermediate-skill workers or high-level engineers. Firms have developed effective strategies to address their routine skills needs, and many do have the capacity to deliver in-house training or source courses from private training providers. The sourcing and upgrading of engineers are typically managed through interaction with universities, through bursary programmes, student placements and internships or leadership training.
In short, firms have the capacity to meet their routine skills needs and interact with universities in traditional ways to meet their high-level skills needs. The majority of HR managers interviewed acknowledged the existence of valuable relationships with public providers. However, our analysis suggests that the component sector is constrained by weak dynamic interactive capabilities. It has not concentrated sufficiently on sectoral coordination and networking directly aimed at building capabilities for technological upgrading, in order for it to be inserted more favourably into global production chains and innovation networks. As a result, interactions with higher education appear fragmented and limited.

Figure 10.2 draws on the social network analysis and reflects the thin networks of Tier 1 firms and, in particular, the limited scale and intensity of interaction with the four universities in the province, as reported by the 21 firms interviewed. Firms were most likely to interact with intermediary industry organisations, other suppliers and OEMs.

Further inspection revealed that on average, each Tier 1 firm had one interaction with a PSET organisation. Approximately half of these were with public universities. Only a quarter could be described as relatively intense and wide-ranging. In the higher education sector, almost all these thick relationships were concentrated in only one of the four public universities in the province. Such interactions included participation in an innovative Formula Student project, which produces a racing car to compete internationally; collaboration on course design; and the payment of generous stipends and bursaries to learners. The capacity to work with the automotive sector has been built through interaction in the form of international partnerships; income generation from short courses and training contracts; and infrastructural, materials and staff development, much of which is supported financially and brokered by intermediary organisations. However, it was evident that firms treated such relationships largely in an ad hoc way, and in order to address specific short-term problems.

**FIGURE 10.2** Network interactions of Tier 1 firms in the automotive components sector, Eastern Cape

Note: The numbers represent the mean weight, for that category of network actor, of relationships, calculated as the product of the number of partnerships and their relative strengths, as reported in the network survey.
The question is the extent to which this network misalignment may be attributed to the interactive capabilities of the four universities. Our analysis suggests that, while all the universities do have some interactive capabilities, as reflected above, one university has the strongest concentration, reflecting in part its location near main OEMs and its long history of producing engineering graduates. A key issue in relation to the competences of the universities is that three are still in the process of building new institutional identities following the national process of higher education merger that took place around 2004, with very uneven progress to date. One university has been under administration, and clearly has weak tacit and codified competences and interactive capabilities in relation to interacting with the automotive sector. Two universities are located in small towns, away from the core of the industry, and predominantly offer humanities programmes, with less than a quarter of their students registered in science, engineering and technology (SET) fields. These three universities provide graduates who may work in management or on the business side of component firms located in their region. There are a few linkages around management training programmes in these universities, but there are no structured SET-oriented programmes.

The comprehensive university in which most of the interaction is concentrated is the result of a merger between a former technikon (polytechnic) and a former university. The former technikon had a strong practice of industry interaction, which provides strong institutional culture, leadership and disciplinary competences with which to interact. The merged university has a clear employability-driven view of graduate attributes and a legacy of work-integrated learning that links students and academics to industry. The university’s interactive capabilities are reflected in external interface structures, such as sectorally funded research chairs (Volkswagen, General Motors and the Manufacturing, Engineering and Related Services Sector Education and Training Authority [merSETA] – the statutory sectoral training authority) and research units, and a technology station. The latter is funded by a national innovation agency that focuses on technology transfer to small enterprises in the automotive component industry, by supplying design and prototyping services. Another critical external interface structure is the programme advisory boards inherited from the technikon tradition. In terms of dynamic interactive capabilities, the university has a strong institutional planning structure that informs strategic planning, quality enhancement, and monitoring and evaluation of progress, which reflects its sensing and integrating capabilities.

We have described these examples in some detail here to illustrate how the framework can be used to differentiate between the universities within an SSI in terms of their interactive capabilities. This helps us make the larger point that this methodology offers important new insights for those thinking about higher educational planning at institutional and national levels, and about science, technology and industry policies. In this sectoral system, clearly there are gaps in the interactive capabilities of some universities, but the capabilities of the comprehensive university are sufficient to meet the routine skills needs of firms in the sector.

However, if South African Tier 1 firms are to be more competitive locally and internationally, then there is clearly a role for skills development. More universities in the region need to develop the dynamic interactive capabilities to network with component firms, to be able to address changing skills needs. In terms of technological capability building for economic development, the universities in the region could support local firms in Tiers 1 and 2 more effectively, whether through their graduates, research, technology transfer or training. As the main knowledge producers in the network, universities can contribute to enhance firm learning, if firms are to become more proactively inserted in global production networks. There are no guarantees that a more innovative automotive components cluster can be achieved, given the global constraints and disciplines under which it operates. Nonetheless, there is a pressing need to support the sector to continue as an important contributor of employment, exports and skills, and a potential need to support it further through enhanced national policies and improved local higher education organisations.
The SKA as a success story of skills and technological capability building

This case stands in stark contrast to that of the SKA, which, as Gastrow et al. analyse in Chapter 8, is a success story of skills and technological capability building in higher education. Its success depends on the ability to connect skills, knowledge, technologies, networks, intermediaries and funding, in order to deliver the world’s largest science project in a developing country. The mapping and social network analysis (Figure 10.3) revealed a complex and densely connected network with a number of large nodes and strong degrees of interaction that included universities, science facilities (such as large national telescopes), research institutes, firms (largely engineering firms), local and international intermediaries (both public and private), and government agencies at the national level. Rapid technological changes in the sector and uncertainty as to future technological pathways meant that the dynamic interactive capabilities of all actors are critical. A strong degree of network alignment is evident in the explicit shared emphasis on the goal of increased technological capabilities, in terms of the high demand for astronomy and engineering skills.

Figure 10.4 illustrates the strength and density of networks of firms with the SKA, universities, other firms and intermediaries. Firms interact most strongly with the SKA (mean weight of 59), then with universities (mean weight of 29), followed by other firms (mean weight of 10) and science facilities (mean weight of 7). Notably, firms interact with 11 universities, going beyond the six core university actors. The network thus has both greater depth and breadth than the network at the heart of the automotive SSI.

Interactive capabilities at the organisational level play an indirect role in driving the interaction, but a direct role in enabling it. The overall efficacy of functions such as institutional planning, teaching and learning, internal capability building and student support all impact on the overall quality and quantity of graduates emerging from a university, and on the university’s research capabilities and reputation. Research offices, contract offices, technology transfer units and departmental level structures are strong internal and external interface mechanisms that support the network directly.

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**FIGURE 10.3** Network map illustrating the skills development networks in the astronomy sector for the SKA
At the micro-level of faculties, interactive capabilities in the domains of teaching and learning, and research and innovation, emerge as the primary means of articulation with the astronomy sector. The interactive capabilities vested in individual academics, particularly premised on tacit competences for interaction that facilitate the maintenance of informal networks over time, have played a central and catalytic role. The rewards and benefits for academics and their universities are considerable, creating an impetus for further collaboration.

In contrast to the automotive case, the SKA case thus illustrates how networks can be strategically leveraged to attain global competitiveness in niche areas, but this requires risk-taking, funding, coordination, strong dynamic interactive capabilities and strategic skills planning.

A new approach to thinking about higher education and skills planning?
The chapter offers an important alternative to the current way of thinking about higher education’s contribution to skills planning and development.

Theoretical significance
Significantly, our analysis of the two cases stresses the importance of the intersection between the global, national, sectoral and spatial dimensions when thinking about the connection between education, skills and economic development. It shows how these vary considerably and how dynamics at multiple scalar levels work in complex ways to shape possibilities for skills and economic development.
In highlighting the role of actors and their interaction in networks – firms, higher education providers, intermediary organisations – the approach allows us to move away from the currently dominant accounts that focus simply on the responsibility of higher education to become more responsive to the skills needs of firms. Indeed, the approach balances the focus on actors with a stress both on policies and sectoral, and wider, institutional dynamics. The focus on interactive capabilities deepens the analysis of agency, exploring how academics and their organisations have the will, capacity and skills to interact with firms, with the possibility of mutual benefit. The approach also points to important methodological possibilities for researching higher education and skills development, in particular to map and understand the dynamics of skills development networks in SSIs.

**Policy significance**

The technological capability approach offers a radically new way of thinking and acting in relation to the role of PSET institutions in supporting national development goals. A focus on technological capabilities emphasises how innovation and improvement come about through learning and communicating. It shifts attention toward economic sectors and how the PSET system supports them. Rather than a focus on central planning mechanisms and structures, it highlights the need to build capabilities within organisations, networks and systems to be able to learn and innovate. This implies a need to have an enhanced understanding of the capabilities of PSET organisations to shape their core education and training activities. However, the automotive case serves as a cautionary tale about the need for a view of the realistic possibilities for development. This is in contrast to many national development policies’ statements of intent to become knowledge economies, and the tendency for these policies to prioritise the same few target sectors without any sense of national capacity to make this a reality within the global capitalist system.

We are not making an argument for the state to ‘build’ sectoral innovation systems. Rather, the creation of a distributed process of capacity development and network enhancement is a task in which the state must work particularly strategically with private and public intermediary organisations, as well as education and training organisations themselves.

The approach emphasises the crucial importance of building domestic firms’ capabilities, which suggests the need for more targeted industrial policy than has hitherto been the case. An innovation system is multi-scalar in nature and this requires policy approaches that can ensure that decisions are made at the appropriate scalar level.

A focus on learning, capabilities and interaction enables the identification of weaknesses that may lie within organisations, related to their capabilities, or externally within the system itself, including misalignment between networks, missing organisations and critical blockages of flows of knowledge and resources.

**Strategic significance**

Universities need an enhanced understanding of how they can respond to the changing technological capabilities and skills needs of firms, particularly in relation to their professional and occupational programmes. The emphasis on interactive capabilities assigns greater agency to universities as actors. Universities need to focus more on what their own capabilities are; how they capture their own tacit knowledge more effectively; and how they develop their capabilities more strategically, in relation to priority sectors that match their expertise, whether in their immediate contexts or nationally. This requires a stronger focus on organisational learning, through sensing change and coordinating and integrating new mechanisms and structures within the university. It requires a
clearer strategy, structures and mechanism for communicating with firms, sectoral intermediaries, government and other knowledge producers.

Conventional approaches to institutional responsiveness focus solely on what education providers should do better, couched largely in deficit terms. In contrast, this approach focuses more on the positive aspects of learning and on becoming more capable. There are equally strategic implications for firms, which are encouraged to enhance their understanding of dynamic demand and of the network of PSET organisations with whom they can work and the ways in which they can align their interests more effectively.
CHAPTER 11

Skills planning and development for the future in South Africa

Glenda Kruss, Angelique Wildschut and Il-haam Petersen

Trying to anticipate where the comparative advantage of human labour will lie fifteen years from now, let alone in fifty years, is a hazardous exercise. But we must try to detect the trends and project the consequences for changes in the structure of economies, the nature of labour markets, and the distribution of income and wealth. We will need policies that anticipate these changes and ease the dislocations resulting from them. In particular, we will need policies to modify the distributional consequences of the operation of these powerful technological drivers as they are translated into market outcomes. (Tyson & Spence 2017: )

This book contributes to the debate on the role of skills broadly, and the practice of skills planning more precisely, in engendering more equal growth and development outcomes. The debate has greater urgency in our contemporary world, where previously unimagined technologies are changing the nature of work in radically disruptive ways. The evidence aligns with and adds to critiques of the dominant models for understanding and acting on the role of skills in the economy and society, in South Africa and elsewhere. There is a shared assumption across all the chapters that narrow skills planning models based on neoclassical economics are not appropriate to address South African developmental challenges. Indeed, Chapter 1 demonstrates how inequality and poverty may actually be exacerbated by the current South African skills regime, and how the limited and mechanistic ways we typically conduct skills planning exercises add further constraints to effecting change. The chapters together provide new insights that challenge conventional conceptualisations of the relationship between education, work and development and the role that skills planning can play.

These assumptions are not completely novel. Scholars from a range of disciplinary backgrounds are criticising persistent and intensifying levels of inequality in access to education and training and labour market outcomes, and questioning how such skewed patterns translate to highly unequal access to material and social advantage. A shared alternative educational vision proposes that the prime skills policy concerns should move away from merely the production of efficient workers or potential workers, to the development of productive, flourishing citizens; that the definition of skills content should move away from notions of generic skills and specific competences, towards the identification of a limited number of common underlying capabilities; and that the prime institutional priority should move away from the design, registration and quality assurance
of qualifications towards improved coordination, nurturing relevant communities of trust and identifying and supporting the best educators in the system. The content of the book takes the reader beyond a human capabilities approach, which tends to focus on how education and training systems, curriculum and pedagogy on the supply side need to change. Our analysis aims to take into account firms’ resources and technological capabilities, organisational cultures and occupational milieus, or sectoral systems on the demand side.

Informed by interaction at the research–policy nexus, our research thus aimed to go beyond the level of a critique of dominant models, and beyond a focus on the supply side. Each chapter is based on fresh in-depth empirical investigations, explicitly framed by the intent to inform skills planning and development approaches. The challenge is how we are to practise and create more appropriate forms of skills planning and skills development systems that prepare us for an uncertain future and enable mobility and progression in ways that shift past inequalities.

The authors are intensely aware of the limits of the transformation that can be brought about through changes to the systems of education and training, in the context of the deeply rooted and intractable structural economic and political inequalities in South Africa. We acknowledge the scepticism highlighted decades ago by Bowles (1980): that in poor capitalist countries it is highly unlikely that educational changes alone can promote economic growth and achieve a more just distribution of economic rewards. Planning more effectively to grow the scale and nature of skills required for economic growth in isolation is thus not likely to be sufficient, and may reproduce inequalities in new ways.

We take this position, as our research underscores in a powerful manner the critical role education, training and skills policies can play, because we need skills planning now more than ever. Equitable access to education and skills opportunities remains one of the key policy areas that can impact on shifting inequality and poverty, particularly in the context of digitalisation, automation and the changing nature of work, jobs and occupations. Given our contemporary challenges, there is sufficient evidence to show that simplistic linear skills planning driven by supply-side dynamics cannot take us forward in any meaningful way.

Tyson and Spence (2017: 203) express the policy challenge well, emphasising that we need to consider what policy-makers and society more broadly can do to pursue the level of equality we desire, using a variety of policy levers to foster a more equal distribution of benefits than the distribution produced by market forces alone. The chapters each provide pointers and new directions to policy levers.

**Policy insights and leveraging change**

Ultimately, whether the benefits of technological change are distributed broadly, or accrue to only a small percentage of the world’s population, will depend not on the design of smart machines but on the design of smart policies appropriate for the new machine age. (Tyson & Spence 2018: 208)

We have shown how much of the research literature in South Africa focuses analysis on the macro-level, on education and training systems and the role of the state. Much of the policy advice is thus oriented to government departments, to propose what should be done differently and how government should intervene. Government is seen as the main policy actor and driver, which tends to hide from view the agency of other key skills actors. Firms, employees, universities, colleges or students are all acting and taking decisions that shape responsiveness, the design of curricula or occupational scopes of practice. The potential unintended consequence is that skills policy occludes their roles in shaping skills demand and practice.
Our analytical focus on the meso- and micro-levels shows how a wider range of actors plan for and develop the skills needed for specific sectors, occupations or professions and, hence, how they may act more effectively to leverage change.

In Chapter 5, our research on the changing nature of work at the meso-level tracks the simultaneous processes of de-skilling and re-skilling that may occur within a single industrial sector. The analysis leads to new policy insights—that we need to design differentiated apprenticeships and artisanal training programmes at distinct skills levels, which can in turn broaden opportunity. Individuals without mathematical prerequisites, for example, can enter a foundational apprenticeship, which ensures baseline requirements and opens up a progression pathway for a larger group of young school leavers. Or, since some artisanal trades in new fields such as mechatronics cannot be pegged at the intermediate level on the National Qualifications Framework (NQF), these can be facilitated by a different system to open up more options.

Our skills system currently places a lot of importance and allocates resources to standardisation and competences, but Volker Wedekind’s research in Chapter 6 shows that setting formal policy and regulatory frameworks is but a first step. He illustrates the complexity of the processes to create wider normative and cognitive-cultural understandings and acceptance of the system. Firms’ understandings and perceptions shape their notions of employability and, therefore, whether graduates actually get jobs in a particular industry. Angelique Wildschut agrees with Wedekind, providing evidence of continued employer belief in the value of all-round expertise, which makes it feasible to return to apprenticeship as the main mode of delivery of artisanal qualifications. The sugar case provides further illustration of this trend, in that the industry associations have developed their own training system that is not recognised on the NQF but is widely legitimised by industry actors.

Skills planning needs to foreground what is happening in the workplace. Using an occupational lens at the micro-level illuminates the real impact of work change on the scope of practice of a particular occupation. Due to the limited capacity of firms to uptake technologies, the demand for artisanal skills can remain largely unchanged or be affected by new forms of organisation of work to such an extent that even within one trade, the demand can vary by department within firms. This has implications for how we develop plans to address shortages of skilled artisans. The planning exercise needs to take into account that the demand for skills will be affected just as much by social choices and employer decisions about how to organise work, as it is expected to be affected by work change.

Occupational milieus and identities are contested at the micro-level of the workplace, which highlights spaces for individuals and managers to bring about change on the ‘shop floor’, or to reproduce inequalities and create barriers to access. Wildschut and Tamlynne Meyer’s research in Chapter 4 develops our understanding of the ways in which organisational and occupational cultures play distinctive roles in shaping the skills required from particular occupational groups. Social differences based on race, gender, language and age continue to inform the construction of occupational boundaries in the workplace, reinforcing inequalities. This highlights a new problem: an individual who has the qualifications or skills required for a job may be prevented from enacting them. Policy emphasises that to build capabilities, we need people to have transferable skills, as John Buchanan highlights in Chapter 2. However, unless these workplace dynamics are addressed, we will not succeed in transformation. Colleges and skills planners need to contribute to the goals of creating more artisans in a manner that is more likely to translate into increased opportunity and improved workplace relationships.

Wedekind proposes the need for a conversation among government, industry and educators to institutionalise new programmes, curricula and pedagogy. The question is how this is to be done, and the research by Glenda Kruss, Il-haam Petersen and Michael Gastrow (chapters 7–10 in this book)
provides a framework to map how actors on the supply and demand side are positioned, currently work together and can work together more effectively in future. Indeed, all the chapters demonstrate how critical it is to understand the sectoral, organisational and spatial context.

At the meso-level, sectoral dynamics need to be elaborated. Skills planning in a sector like the automotive sector that is strongly globally disciplined, is very different from one that is locally driven, such as sugar. Nevertheless, there is a degree of agency at the micro-level of the firm, to take decisions on how they will use skills to ensure their competitiveness and survival. This is determined by the firms’ resources and technological capabilities. Understanding these provides important levers for regional and local developmental interventions.

In the process of analysing dynamic interactive capabilities at the micro-level of the education and training organisation or firm, we can gain critical insights into how skills policies are translated and implemented in practice. The research on skills development networks at the meso-level by Wedekind (Chapter 6), Kruss and Petersen (Chapter 7), and Gastrow et al. (Chapter 8) highlights the important role of actors other than government in skills planning. Government cannot work alone to bring about change; it needs to be constantly engaged in skills networks with actors in firms, unions, skills providers, private intermediaries and so on. Identifying key actors that have legitimacy in a sector historically is important, but equally, some actors may need to be given stronger policy support to catalyse change and achieve shared skills goals. Spaces are needed to facilitate conversations about changing skills needs and capabilities and to inform more appropriate interventions at multiple levels, in a coherent manner. For example, the Square Kilometre Array (SKA) association had strong brokerage skills to ensure that multiple actors in the private and public sectors worked together, building on historical relationships and capabilities at the high-skills level. Success at the technical and vocational education and training (TVET) level was more elusive.

Universities, colleges, workplace training providers and private providers are exercising agency, but not always in ways that are coordinated with policy goals. To enter the skills conversation more proactively, they need to focus more on what their own capabilities are, and how they develop their interactive capabilities more strategically, in relation to priority sectors that match their expertise, whether in their immediate contexts or nationally. To avoid simply reacting to needs articulated by government or firms, they need to develop a clear strategy, structures and mechanisms for communicating and partnering.

The focus on learning, capabilities and interaction enables the identification of weaknesses that may lie within, related to their capabilities, or externally in the skills system itself, including misalignment between networks, missing organisations and critical blockages of flows of knowledge and resources.

A long way to go

Policy-makers are challenged to create a new skills settlement informed by an understanding of the political-economic and social situation of specific skills contexts, the objectives of priority interests for skills planning, the actors that should be involved, and the capacity of institutional arrangements available to implement policies. How does a skills regime balance the needs of private sector firms and opportunities for young people not in education, employment or training, for example? This requires very different skills policy analysis capabilities on the part of government, strategists in firms and institutional planners. This book is but a small step, and there remains a long way to go.
References


Ashman S & Pons-Vignon N (2015) NUMSA, the working class and socialist politics in South Africa. Socialist Register 2015: 93–113


Bhorat H & Kimani M (2017) *The role of post-school education and training institutions in predicting labour market outcomes*. Pretoria: Labour Market Intelligence Partnership (LMIP)

Bhorat H, Lilenstein A, Lilenstein K & Oosthuizen M (2017) *South transition from higher education to the labour market*. Pretoria: LMIP


DHET (2012) Guidelines: Organising framework for occupations (OFO) 2012. Developed with the assistance of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and IT Aware

DHET (2013a) Guidelines on the implementation of SETA grant regulations. South Africa: DHET

DHET (2013b) Media briefing on the official launch of ‘2013: The year of the Artisan’ by the Minister of Higher Education and Training, Dr BE Nzimande. 4 February


DHET (2014) Media statement by Deputy Minister of Higher Education and Training at the launch of the Decade of the Artisan. September


Fuller A & Unwin L (2001) Skill formation in a changing society: Questioning the viability of apprenticeship across traditional and non-traditional sectors. Centre for Labour Market Studies: University of Leicester


Garisch C & Meyer T (2015a) A study of the shifting boundaries between professions and occupations and how this impacts artisanal work and training. Case study report for the LMIP Theme 6: Understanding changing occupational milieus, labour markets and identities. Cape Town


Griffiths D & Lambert P (2011) Dimensions and boundaries: Comparative analysis of occupational structures using social network and social interaction distance analysis. Paper presented to the Spring meeting of the ISA Research Committee on Social Stratification and Mobility. University of Essex (13–16 April)


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Kraak A (2004a) Training policies under late apartheid: The historical imprint of a low skills regime. In S McGrath, A Badroodien, A Kraak & L Unwin (Eds) Shifting understandings of skills in South Africa: Overcoming the historical imprint of a low skills regime. Cape Town: HSRC Press


Malerba F (1999) Sectoral systems of innovation and production. DRUID conference on National Innovation Systems Industrial Dynamics and Innovation Policy, Rebild (June)


Marx K (1976) *Capital: A critique of political economy.* Moscow: Progress


Mbathe N, Wildschut A, Mcnwango B, Ngazimbi X & Twalo T (2014) Towards understanding the distinctive nature of artisan training: Implications for skills planning in South Africa. LMIP Client Report, April


Office of the Presidency (2010) Joint initiative on priority skills acquisition (JIPSA), final report, March


Wild S (2012) *Searching African skies: The Square Kilometre Array and South Africa’s quest to hear the songs of the stars*. Cape Town: Jacana Media


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