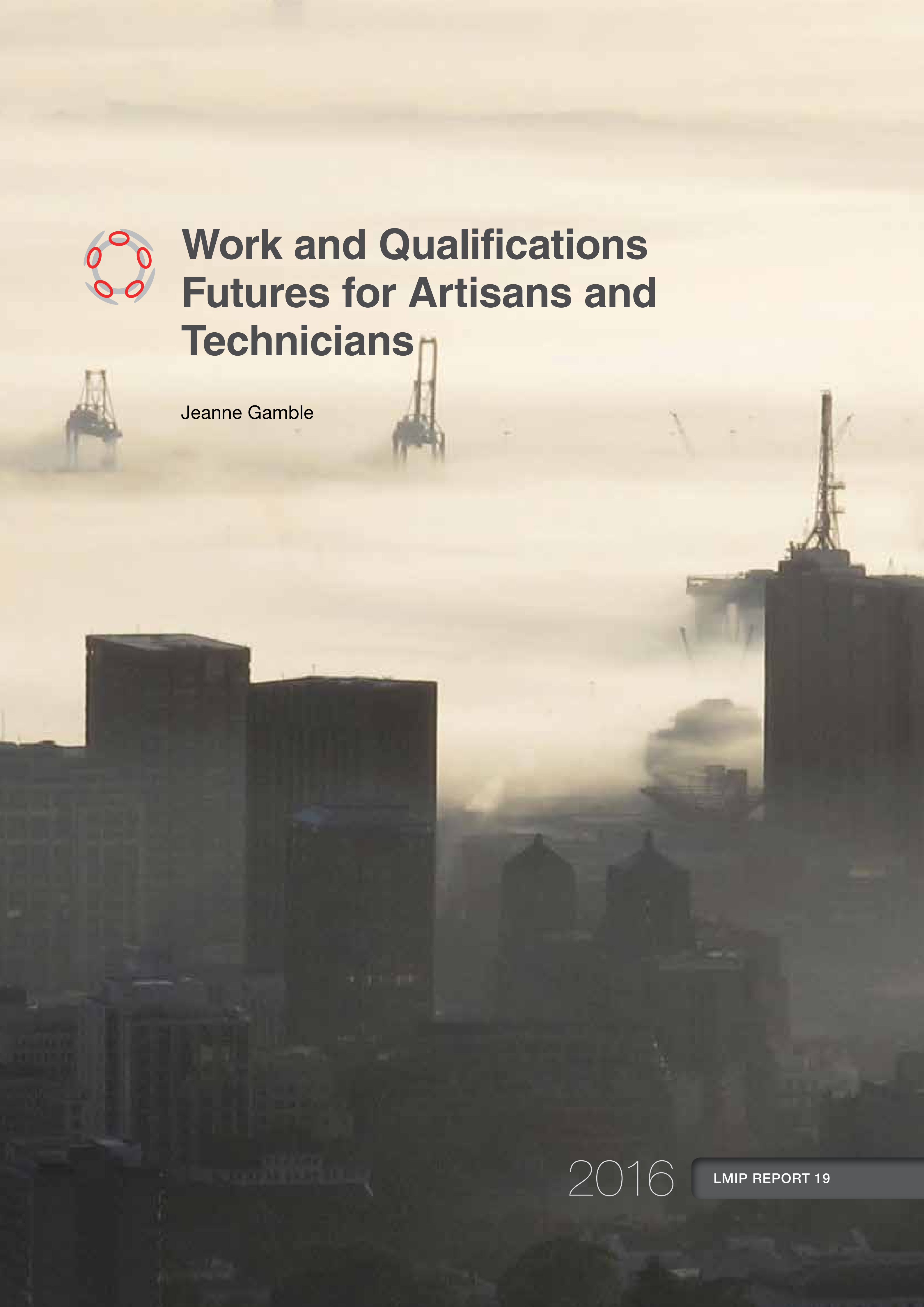

Work and Qualifications Futures for Artisans and Technicians

Jeanne Gamble

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LABOUR MARKET
INTELLIGENCE PARTNERSHIP

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ABBREVIATIONS AND ACRONYMS

CEO	chief executive officer
COTT	Central Organisation of Technical Training
DHET	Department of Higher Education and Training
DIT	digital imaging technician
DOP	director of photography
ETD	education, training and development
FET	further education and training
HSRC	Human Sciences Research Council
ICT	information and communications technology
ISO	International Organization for Standardization
LMIP	Labour Market Intelligence Partnership
NCV	National Certificate Vocational
NQF	National Qualifications Framework
NSC	National Senior Certificate
PLC	programmable logic controller
PSET	post-school education and training
SOP	standard operating procedure
TVET	technical and vocational education and training
VET	vocational education and training

ACKNOWLEDGEMENTS

This report offers a set of findings that synthesises the results of the four sector studies that make up the empirical component of the research study, *Work and Qualifications Futures for Artisans and Technicians,* under Theme 6 of the Labour Market Intelligence Partnership (LMIP). The four studies were:

- Boat Building (684907 Boat Builder and Repairer) (Researcher: Vanessa Davidson);
- Engineering (671203 Mechatronics Technician) (Researcher: Carel Garisch);
- Film Production (Camera Assistant) (Researcher: Jane Gallagher); and
- Tourism and Hospitality (681201 Confectionery Baker) (Researcher: Marianne Spies).

As a team, we thank the respondents for their support of the research project, their cooperation with the scheduling of interviews, arranging work-observation opportunities, their invaluable contributions to discussions, and providing the research team with relevant documentation whenever requested.

We also thank Dr Angelique Wildschut, the theme leader for Theme 6, for her encouragement, support and collegiality; Ms Tania Fraser for constant administrative guidance and support; Dr Glenda Kruss for offering us the opportunity to undertake the research and for her overall leadership; as well as all the other members of the Human Sciences Research Council (HSRC) and the Department of Higher Education and Training (DHET) who have worked tirelessly to make the LMIP a reality.

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As the author of this report, I take sole responsibility for the analysis and interpretation of the findings, while gratefully acknowledging the comments and suggestions received from two critical readers. As far as possible, these were incorporated in the final draft.

Jeanne Gamble

PREFACE

> "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" (White Paper for post-school education and training, DHET 2013).

Many would argue that artisanal occupations are in crisis in our country. There are widespread claims around the shortage of artisans and the ability of our technical and vocational education and training system to produce the required quantity and quality of artisans is under question. However, while all agree that increased artisan development is important, there is substantial disagreement on the scale and nature of demand for these skills. In other words, we know it is important to foster and grow the systems of artisan skills production (Kruss et al. 2012), but we lack clarity on the nature of the skills required. How many artisans exactly are needed, in which areas, at what levels and in which configurations within differentiated workplaces?

Our lack of certainty around the nature of demand is exacerbated by confusion around the nature of the supply of artisan skills. There appears to be confusion and inadequate knowledge in relation to the varied routes to artisanal skilling and the extent of the contributions made by the different routes, as well as poor understanding of the issues underlying quality and success in the production of qualified artisans. These factors contribute to widespread assertions that artisan and mid-level skilling continues to be a key gap in the post-school sector (Kraak 2012).

Within this context, the Department of Higher Education and Training (DHET) initiated the Labour Market Intelligence Partnership (LMIP), with the Human Sciences Research Council (HSRC) leading a research consortium to support the development of an institutional mechanism for skills planning in South Africa. The issue of artisans was identified as a key focus area. However, the playing field has changed and our responses to address artisanal skills production and retention challenges have to as well. Over the last three decades, there have been extensive changes to the nature of work, the increasing impact of technology, changes to work organisation, and new fields and forms of practice are emerging. In addition, our country has a complex history of vocational education and training (VET), characterised by gender, race and language inequalities. Not only do such aspects hold implications for our understanding of artisanal work, but how can and should we plan for artisanal skills in such shifting occupational contexts?

It is clear that improving our ability to plan for artisanal skills requires a better understanding of the contextual issues that impact on the extent, nature and location of demand and supply of artisanal skills. Critical questions to direct such an endeavour would thus be: how have historical patterns shaped the nature of artisanal training and work today? How can planning for artisanal skills respond to the changing nature of work and the division of labour in the workplace? How can planning be responsive to innovation and change?

To engage with these questions towards better understanding such a complex and multi-layered context (occupational milieu and identities), three projects were developed to investigate: the underpinning history (Mbatha et al 2015), changes to the nature of artisanal work and its organisation (Wildschut et al 2015), changing intermediate knowledge bases and the resulting implications for future artisanal work and preparation (Gamble et al, 2015). This theme of research is entitled: Understanding changing artisanal occupational milieus and identities, arguing that changes to the nature of work critically affect the nature and location of skills demand and supply and thus we need to focus more effort on understanding this dimension of our labour market.

This project report on *Work and Qualifications futures for artisans and technicians*, relates to the third aspect. In support of labour market planning, the main research question was: *What knowledge and skill does a 21st century artisan need?* To address this question, sector studies were designed as a series of four interlocking contexts to interrogate change to 1) sector and company futures, 2) workplace culture futures, 3) work futures for artisans/technicians and 4) artisanal qualification futures. The report draws on the evidence emerging from the sector studies (Boatbuilding, Engineering, Tourism and Hospitality, and Film Production) to argue that understanding labour process variations and their impact on diagnostic and problem-solving at the intermediate level provides a solid basis for supply-side planning.

The research findings show how such information constitutes an important resource for the interpretation of macro-labour market trends identified in quantitative model-based projections and/or employer surveys. It illustrates the important contribution qualitative sector studies can make to systems planning, especially as these take the actual work process as starting point, rather than an 'imaginary curriculum'.

SUMMARY OF KEY FINDINGS

The Human Sciences Research Council (HSRC) has been commissioned by the Department of Higher Education and Training (DHET) to lead and co-ordinate research towards developing a credible institutional mechanism for skills planning that will better promote the national priority of a skilled and capable workforce to achieve an inclusive growth path. A consortium, known as the Labour Market Intelligence Partnership (LMIP), was established to drive the research agenda. This consortium includes the HSRC, the Development Policy Research Unit (at the University of Cape Town) and the Centre for Researching Education and Labour (at the University of the Witwatersrand).

The overall study is divided into six themes, of which one focuses on understanding the changing nature of knowledge and skill at artisan and technician level. While there is general agreement that artisan development is crucial to scarce-skills remediation in South Africa, there is little consensus about the scale and nature of the demand, or about the nature and quality of artisanal work preparation.

This project, which falls under Theme 6 of the LMIP, involved qualitative research in four industry sectors:

- Boat Building (684907 Boat Builder and Repairer);
- Engineering (671203 Mechatronics Technician);
- Film Production (Camera Assistant); and
- Tourism and Hospitality (681201 Confectionery Baker).

In support of labour market planning, the main research question was: *Which knowledge and skill does a 21st-century artisan need?* To address this question, sector studies were designed as a series of interlocking contexts (see diagram below), each driven by a sub-question.

Figure 1: Work and qualifications futures for artisans and technicians

Sector and company futures

Sub-question 1: What are some of the changes anticipated in companies or enterprises over the next one to two decades that may impact on the role and functions of artisans and technicians?

Finding 1: Business growth through diversified markets
With a few exceptions, the majority of sites, whether large or small, report positively on current and anticipated business growth. Growth is linked to a wide range of market strategies in terms of local and international market diversification across niche and mass markets. While structural factors influence industrial and commercial production in different ways, three factors are viewed as having the highest potential positive or negative impact on future growth: (1) the global economic climate; (2) regional and local political stability; and (3) market volatility.

Finding 2: Employment flexibility
All sectors anticipate that employment trends such as subcontracting, outsourcing, decentralisation, casualisation of work, temporary contracts and seasonal work fluctuation will affect future employment flows and staff movements.

Workplace-culture futures

Sub-question 2: What levels of technical and communicative competence will be required by company employees in general and will there be training and development opportunities?

Finding 3: Shift to 'low-risk' work culture with technical competence redefined
All sectors predict a 'low-risk' work culture in the future, which they ascribe to increasing routinisation and standardisation of work through mechanisation, automation and digitalisation. Although the technical complexity of work itself may or may not decrease, a sound technical vocabulary to talk about work, as well as the capacity for ongoing self-education and training in order to remain up to date, will contribute significantly to what counts as a technical-competence culture in the future.

Finding 4: An increased communication requirement
Medium to high levels of workplace literacies in terms of reading and writing in English, ICT (information and communications technology) expertise, and technical and social communication are viewed as important components of workplace-culture futures across all four sectors, although not to the same degree. The expectations of a younger generation of workers, easy access to print media, and more open and participative management-communication cultures are viewed as key prospective drivers of change towards an increased communication requirement.

Finding 5: Training and development both a reality and an aspiration
Training and development cultures are reported as uneven. High ratings refer to formal qualifications as an entry requirement for work, or indicate a strong in-house and/or on-job training culture. High ratings also express an identified need for ongoing training and development and a desire for more training opportunities. Low current and future ratings reflect perceptions that very little training is available for artisans and that 'down-skilling' will be the future trend.

Work futures for artisans/technicians

Sub-question 3: What kind of diagnostic and problem-solving knowledge and skills will flexible work futures require of artisans and technicians?

The study investigated the kind of knowledge on which artisans and technicians draw when they diagnose and solve problems.

Finding 6: Opposing, but simultaneous, work-change trends
The study found evidence of two opposing work-change trends: a shift 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 down-skilling.

Finding 7: Occupational diversification
The effect of patterns of upskilling and down-skilling is that no sector has only one version of the designated trade or specialist occupation studied. In each sector, at least two or more variants and/or sub-variants co-exist.

Finding 8: Differentiated knowledge and skill within and between sectors
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. Thus, there are differences in type, depth and breadth of knowledge. This has a significant impact on training and development pathways. Knowledge and skill bases of small and medium/large enterprises in the same sector also show degrees of difference.

Artisanal-qualifications futures

Sub-question 4: How will artisans and technicians become work-ready?

Finding 9: A range of NQF-registered qualifications, but limited delivery
Each sector has a range of formal qualifications registered on NQF (National Qualifications Framework) levels 2 to 6, but there is little systematic evidence of delivery and take-up.

Finding 10: On-job training and supplier training the dominant modes of provision
In all four sectors, on-job training and informal learning remain the dominant modes of education and training, with supplier-provided training in respect of specific items of equipment or technology identified as a fast-growing trend.

The report concludes with a discussion and interpretation of the trends noted in the above findings, followed by a set of exploratory recommendations towards answering the policy question about the re-establishment of a ‘good artisan-training system’ (DHET 2013: xvi).

1. THE RESEARCH STUDY IN CONTEXT

Introduction

The Human Sciences Research Council (HSRC) has been commissioned by the Department of Higher Education and Training (DHET) to lead and co-ordinate research towards developing a credible institutional mechanism for skills planning that will better promote the national priority of a skilled and capable workforce to achieve an inclusive growth path. A consortium consisting of the HSRC, the Development Policy Research Unit (at the University of Cape Town) and the Centre for Researching Education and Labour (at the University of the Witwatersrand), and known as the Labour Market Intelligence Partnership (LMIP), was established to drive the research agenda.

The overall study is divided into six themes, of which one focuses on understanding the changing nature of knowledge and skill at artisanal and technician level. While there is general agreement that artisan development is crucial to scarce-skills remediation in South Africa, there is little consensus about the scale and nature of the demand, or about the nature and quality of artisanal work preparation.

The research study on which we report here involved further investigation of some of the findings of an earlier study (Kruss et al, 2012) that probed the learnership and apprenticeship pathways followed by a cohort of employed and unemployed learners. One of the findings of the 2012 study was that there is a significant degree of mismatch between what workplaces require and the skills acquired by apprentices and learners. Various reasons were cited for this finding, mostly related to limitations of formal curricula and trade tests. A further concern was that qualifications are currently obtained mostly at lower and intermediate skill levels and not at intermediate and higher levels.

What makes the present study different is that, instead of tracking the learning pathways of individuals, or studying curricula and assessment, the study turns to work itself, to its organisation and to the diagnostics and problem-solving found in the work of artisans and technicians. It is a demand-focused study that takes the changing nature of work as its central theme and seeks to contribute to labour market intelligence by putting forward an evidence-based argument for how artisans and technicians of the future should be prepared to be work-ready.

In manufacturing, which is the traditional base of artisanal work, both mass production and flexible specialisation provide ongoing proof of the relation between technology and the organisation of work. While mechanisation and its effects dominated work-organisation debates in the years of early industrialisation, current debates focus almost exclusively on the effects of new types of flexible, electronics-based automation technologies. A distinction is drawn between what is called *the first industrial divide* of mass production, dominated by stable mass markets, large corporations and large-scale production, and *the second industrial divide* of flexible specialisation, dominated by market volatility, specialised niche markets and smaller firms. There are also indications of a return to artisanal production in 'high-tech' cottage industries that combine craft forms of production with computerised technology (Thompson 1989; Braham 1992; Castells 2001; Ouye 2011).

To attract young people to the trades, South Africa has declared the period 2014 to 2024 the Decade of the Artisan, under the slogan: 'It is cool to be a 21st century artisan'.[1] At the same time, the 2013 White Paper for Post-School Education and Training (PSET) acknowledges that, even though

> *in 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 2013: xvi)

What will a 'good artisan-training system' look like? This question can only be addressed once a prior question has been explored: Which knowledge and skill does a 21st-century artisan need? 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.

In order to start the process of enquiry, this project, which falls under Theme 6 of the LMIP, undertook qualitative-research studies in four industry sectors:[2]

- Boat Building (684907 Boat Builder and Repairer);
- Engineering (671203 Mechatronics Technician);
- Film Production (Camera Assistant); and
- Tourism and Hospitality (681201 Confectionery Baker).

For each study, a Sector Report was produced, which discusses the trends identified in relation to the work and qualifications of a particular trade. This Synthesis Report uses these sector studies as an empirical resource to draw out general trends that provide the basis for a series of recommendations. Key findings of the study point to shifts in the types of knowledge on which diagnostics and problem-solving draw at artisan and technician levels, and to a misalignment between available training and what is required. The labour market implications of these findings are significant.

How the study works

Research design

The relationship between education and training, on the one hand, and work, or the economy, on the other, has long been a contested issue. Policy-makers in most countries remain convinced of a positive link between investment in education and training, and economic performance. Technical and vocational education and training (TVET) and, more recently, general education are viewed as primary determinants of economic success in a globally competitive world. A second causal link often assumed is that economic success is made possible by technology and technological advances, and that the more a sector and/or country invests in technology, the more successful they will be in terms of economic performance. The counter-argument is that such causal chains are, in fact, the other way around: that it is the state of the economy that determines patterns of participation in education and training and the labour market, and that it is the way in which business is transacted in the short or longer term that makes technological development possible (Brown & Keep 1999; Collins 1992; Wolf 2002). Whichever way around one chooses to view these relationships, it is clear that they are far more complex and nuanced than simple causality.

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 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.

This study, which seeks to understand how artisans and technicians of the future need to be prepared for the labour market, makes no claims to direct causal relations with regard to either of the trajectories described above. The design was informed more generally by a review of the relevant literature on future work and preparation for work (Gamble 2012), which yielded the following set of general presuppositions:

- Artisans and technicians of the future will work in both large-scale and small-scale firms of varying technological capacity.
- Innovation through technological invention, adaptation, improvement and on-job improvisation will be a key requirement of work of the future.
- (Re)production and maintenance of goods and services to internationally accredited quality, safety and ecology standards will remain key components of work of the future.
- Entrepreneurial activity will be a strong component of all work, but especially when craft forms of design and production are combined with computerised technology.
- Different modes of 'risk' and 'certainty' will be found in future artisanal work, e.g. mechanised and proceduralised work practices that 'down-skill' the work of artisans and technicians alongside practices that rely extensively on innovative and specialist diagnostics and fault-finding that 'upskill' the work of artisans and technicians.
- The knowledge base of specialised work will consist of both situated and formal knowledge.
- Multiskilling refers to a combination of social, discursive, technical and technological capacities.

In order to capture as many of the above issues as possible, the study was designed as a series of interlocking contexts (see Figure 2).

Figure 2: Work and qualifications futures for artisans and technicians

The overall research question was: *Which knowledge and skill does a 21st-century artisan need?,* with sub-questions related to each context:

Company futures: What changes are anticipated in companies or enterprises over the next two decades, which may impact on the role and functions of artisans and technicians?

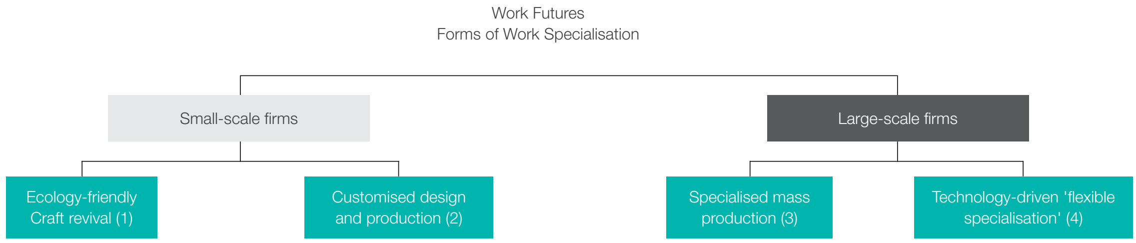
Workplace-culture futures: Which levels of technical and communicative competence will be required by company employees in general, and will there be training and development opportunities?

Work futures: What kind of diagnostic and problem-solving knowledge and skills will flexible work futures require of artisans and technicians?

Qualification futures: How will artisans and technicians become work-ready?

The study made a distinction between small and medium-large sites. Sites were purposively selected according to the descriptive criteria in Figure 3.

Figure 3: Criteria for site selection



Each study focused on at least two small sites and two medium-large sites. In some sectors, a small firm had one or two employees and, in another sector, a small firm consisted of 30 to 40 employees. Where sites were very small, a third small site was included in order to ensure adequate coverage.

In each site, we undertook the following activities:

- We interviewed the company owner, the chief executive officer (CEO) or a nominee about *sector and site contexts and anticipated changes* (one interview per site).
- We interviewed (1) the CEO or owner, (2) a supervisor or first line manager, and (3) two artisans or technicians *about the work, training and development of artisans and technicians at that site, with a particular focus on diagnostics and problem-solving* (four interviews per site).
- We conducted further individual interviews with all of the above people, as well as with an administrative staff member, *about current workplace culture and anticipated changes* (five interviews per site).
- We observed *an artisan or technician at work* for a full day or night shift.

The SPSS program was used to code and capture information. Even though the sample was limited, this enabled systematic findings at both a site and sector level.

In the second part of the investigation, we undertook desktop research to obtain information about the qualifications and training opportunities available for artisans and technicians in each sector. This enabled researchers to carry out a 'gap analysis' that shows the alignment or misalignment between what is required and what is available in each sector.

The Synthesis Report presents the overall findings, with detailed findings available in the Sector Reports.

Research vocabulary

It was important to find ways of describing work that could be used across the different sectors. Two ways of describing work were adapted from the literature and are set out below.

Work as a continuum of 'certainty' and 'risk'

The complexity of work is captured by two opposing concepts: *certainty* and *risk*. The difference lies in the degree of predetermination of the end result (Pye 1968). When the end result is continually at risk during the process of making or producing or maintaining, we talk about *work of risk*. All workplaces try to reduce risk and aim for *work of certainty* through the use of templates and jigs in handcraft, through automated work processes, or through strict adherence to standard operating procedures (SOPs) and health and safety procedures. Rather than viewing work as fitting in under one or the other of the two oppositional poles, it is more useful to see the two poles as the far ends of a *continuum* (see Figure 4).

The ideal description of most types of technical and artisanal work would probably be at the midpoint between complete predictability and complete unpredictability of results. In reality, though, it is likely that any one kind of work may tend to veer more to the one side or more to the other. For certain components of work, there may also be more certainty, while, for other components, there may be a greater degree of risk.

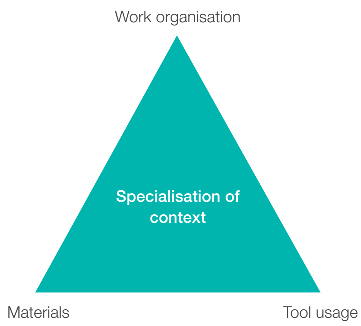
Figure 4: A depiction of work along a certainty–risk continuum

Work of certainty ◄-------------------►	**Work of risk**
• Routine work	• Mostly novel or unique situations
• Narrowly specified tasks	• Experimentation
• Predictable problem-solving	• Complex problem-solving
• Simple tasks/subject matter	• Complex tasks/subject matter
• Technique-focused	• Conceptually driven
• Supervised work	• Autonomous work
• Rule-following	• Independent judgement
• Simple interpersonal relations/teams	• Complex interpersonal relations/teams

Work as a 'labour process'

Work can also 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. (See the model in Figure 5.)

Figure 5: Work as labour process



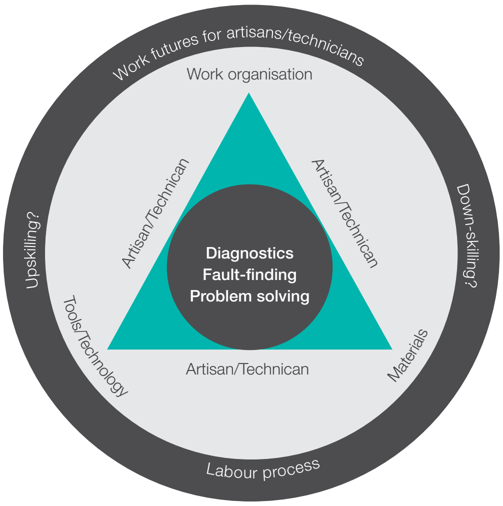
This three-way relation was the traditional way of separating one trade from another. Even though advances in technology and materials have broken down many of the original trade demarcations, the value of understanding work in this manner remains undisputed. The three-way relationship is the same in all labour processes, but each site of work has a particular configuration of work organisation, materials, and tools/technology that specialises the context and stipulates the work roles within that organisational context.

Studying 'problem-solving' as the core of artisanal and technical work

The above vocabulary helped the researchers to understand each site as a specialised context in terms of labour process, with a focus on the kind of problem-solving found in a particular labour process configuration: tending towards routine problems and predictable or standardised solutions; or tending towards complex problems requiring new and innovative solutions.

The diagram below shows how we combined the two ways of describing work to make an investigative lens for this study.

Figure 6: A problem-solving approach to work



The next challenge was to find a way of capturing the specialised nature of work contexts.

Diagnostics, fault-finding and problem-solving are generally regarded as skills – moreover, as *generic skills* – that are applicable across jobs and occupations in an occupational group (DHET 2014: 41). As a general category, 'skill', or even 'critical problem-solving skills', was not going to be of great help. So, we adopted a definition of skill proposed by the European Commission (as cited by Bohlinger 2007/2008: 99) that describes skills as the 'ability to apply knowledge and use know-how to complete tasks and solve problems'. 'Knowledge' as used here is 'the body of facts, principles, theories and practices that is related to a field of study or work'.

This definition is confirmed by numerous other descriptions that do not talk about skill without reference to the knowledge base on which skilled performance draws. In the British context, for instance, Fuller and Unwin refer to the link between 'a set of skills and related vocational knowledge that combine in the form of vocational practice to enable the individual to perform at a specific level in the workplace' (2011: 37). Putting forward the reverse side of the same coin from the Australian vocational education and training (VET) context, Wheelahan (2008) argues that 'competency-based vocational education and training qualifications in Australia deny students access to the theoretical knowledge that underpins vocational practice, and that this results in unitary and unproblematic conceptions of work'.

In order to find out about diagnostics, fault-finding and problem-solving in different trades and in different work contexts, this study takes up the issue of knowledge and how the knowledge bases required for problem-solving in particular trades may change in the future. Answers to these questions will be crucial for decisions about what the 21st-century artisan and technician need to know and do.

In the following three chapters, we present the overall findings of the study.

2. SECTOR AND COMPANY FUTURES

Introduction

This chapter is the first of four empirical chapters that present the main research findings. We follow the order of the interlocking contexts (described and shown as a diagram in the previous chapter), starting with a broad contextual picture of structural changes that will impact on enterprises, and then moving to anticipated shifts in workplace cultures.

To ensure anonymity, the term 'site' is used in this chapter to refer to businesses, companies, organisations, enterprises and corporations.

Sector and company futures

Sub-question 1: Which changes, if any, are anticipated in companies or enterprises over the next two decades, and how will this impact on the role and functions of artisans and technicians?

This section presents an overview of trends discussed in each Sector Report. In order to obtain views on macro-contextual conditions, the most senior person at each site was interviewed.

Macro-factors anticipated as having an impact on future business growth

One of the first questions asked of interviewees was for them to consider the categories set out below and then to choose three factors that might impact on future development of the site's type of business. While it is often assumed that work is most affected by technological advances, all four sectors selected *'global economic' climate*,[3] *'political stability'* and *'market volatility'* as the top three factors perceived as impacting on future growth. This trend is indicative of how vulnerable industrial and commercial production sites perceive themselves to be to factors largely beyond their direct control. Significant, also, is that e-commerce marketing opportunities are not yet perceived as a significant impact factor.

3 Film Production was the exception, as this sector selected 'technological advances that change the way work is organised' as the category that would have the strongest impact on the future development of the sector.

Figure 7: Overall views on factors impacting site growth

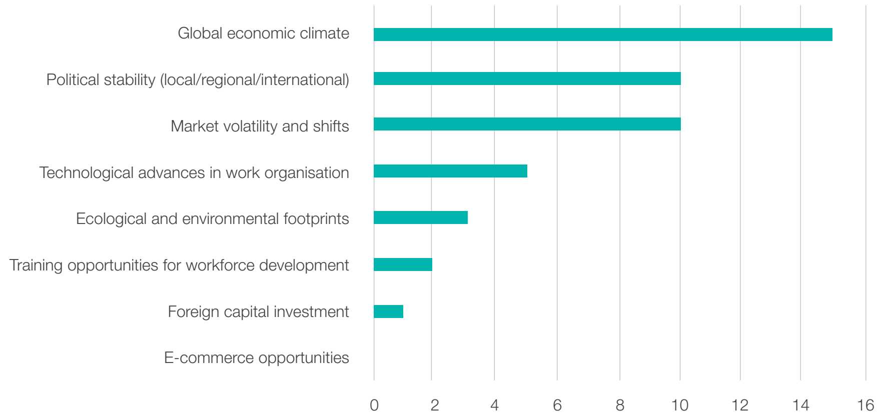


Table 1 presents a comparative view of the categories selected by each sector.

Table 1: Sectoral comparison of factors impacting on business growth

Impact factors	Industry sectors				Total
	Engineering	Boat Building	Baking	Film Production	
Global economic climate	4	4	4	3	15
Political stability	1	2	5	2	10
Market volatility and shifts	2	3	3	2	10
Technological advances in work organisation	0	1	0	4	5
Ecological and environmental footprints	1	1	1	0	3
Training opportunities for workforce development	1	0	0	1	2
Skilled foreign labour supply	0	0	1	0	1
E-commerce opportunities	0	0	0	0	0

Against this background, we turn to sectoral views about current and projected business and market growth or decline.

Anticipated changes in core business, market share and growth

All sectors reported on both stability and change in core business, presently and in the future.

Table 2: Trends in business and market growth

	Will this sector's core business change significantly in future?		Has your core business changed over the last 10 years? (in the future)		Has your business's market share changed over the last 10 years? (in the future)		Has the business grown in the last 10 years? (in the future)			At which markets are your products or services mainly directed? (in the future)			
	Yes	No	Yes	No	Yes	No	'Yes, has become bigger'	'No, became smaller'	'Stayed much the same'	Local mass markets	Local niche markets	International mass markets	International niche markets
Baking	2	3	2 (3)	2 (3)	5 (2)	0 (2)	5 (4)	0 (1)	0 (0)	2 (0)	3 (3)	0 (0)	0 (0)
Boat Building	2	2	1 (1)	3 (3)	1 (4)	3 (0)	3 (3)	0 (0)	1 (1)	0 (0)	0 (1)	0 (0)	4 (3)
Film Production	1	2	2 (2)	2 (2)	4 (3)	0 (1)	4 (3)	0 (0)	0 (1)	1 (1)	2 (1)	0 (1)	2 (0)
Engineering	2	2	2 (1)	2 (3)	1 (0)	2 (3)	3 (2)	1 (0)	0 (2)	1 (0)	1 (0)	1 (0)	1 (1)

Business growth is reported as the strongest cross-sectoral trend. Where no growth is reported or predicted, this is attributed to niche market consolidation rather than to an anticipated downturn in business. There is no direct relation between growth trends and types of market. Growth is linked to local niche and mass market diversification, to international niche market specialisation, as well as to local and international market diversification across niche and mass markets.

Work organisation and innovation

In this section, we present short extracts from the Sector Reports to indicate whether changes in work organisation are anticipated and whether there are differences between large and small sites.[4]

BAKING

> 'Large mass market sites indicate that work is driven by a production line and most jobs are semi-skilled. Small niche sites indicate that they have specialised and skilled workers performing one operation from start to completion … Most of the sites indicate that the way in which work is organised has not changed over the last ten years.
>
> All sites indicate the importance of product and process innovation in their businesses. Although their products have remained reasonably stable, the majority of sites are constantly innovating in terms of finding ways to work smarter.
>
> All sites are in agreement in their prediction that design and innovation will become extremely important in the future. One big mass production site is of the opinion that, as a result of increasing competition, innovation will make a difference to the success of their type of business. Small sites indicate that, as artisanal baking is a growing trend, there will have to be a greater variety of breads in future as competition from other businesses increases.' (Sector Report: Baking 2015: 6–7)

BOAT BUILDING

> 'Smaller sites place a premium on multi-skilled teams working together from start to finish and they cite a low volume 'semi-custom built' environment as requiring a multi-skill team-based philosophy. Larger sites, however, rely on a mix of specialised and semi-skilled artisans performing single operations and teams completing operations. The production line requirements of higher volumes require a mix of single operation and multi-skilled teams and the mix varies depending on the methods of construction, materials used and the stage of construction … The way work has been organised has not changed over the last ten years; however, the sector anticipates change in future.
>
> The sector is constantly innovating both at a small and a large business level. The type of innovation varies with smaller sites finding ways to work smarter and larger sites being more able to bring in design capabilities reflective of the larger resource base they have to work from. There is a strong trend, both currently and in future, for design and innovation to influence work organisation.' (Sector Report: Boat Building 2015: 4–5)

ENGINEERING (MECHATRONICS)

> 'Significant variation is evident regarding the way operations are organised across the four sites. A common denominator, however, is the significant influence of increasing automation and computerised control of production processes. Linked to this is the emerging trend of increased level and breadth of knowledge and skill requirements required for technical and maintenance support at artisan level.

---

4 Differences in materials and tools or technology employed are detailed in the individual Sector Reports.

> In terms of changes in the way work has been organised over the last ten years, all sites are broadly in agreement that the single-most important shift in recent years pertains to more functions driven by ICT [information and communications technology] platforms which are predicted to 'become increasingly clever' in the future. Accordingly the way work is being done '… has become more complex and sophisticated, with particular reference to automation technology or elements thereof'.
>
> At all sites, innovation is valued and is a key focus with regard to product, equipment, and process and systems improvement.' (Sector Report: Engineering (Mechatronics) 2015: 4–5)

FILM PRODUCTION

> 'Multi-skilled production or service teams work together from start to completion … A minority view states that the work done is organised around fully automated or digitalised processes.
>
> Management and artisans presented film making as 'craft'. This contradicts work observations on the large film sets where technology and equipment are the heartbeat of the production. In small-scale sites (which generally lack the technology and equipment), the notion of craft and individual creativity is more visible.
>
> Both management and the workforce agree that product innovation is at the heart of the site in both small and large companies. Both concur that at the centre of the sector is a dynamic and vibrant approach to product and process. Stability is not a strong feature. Design and innovation are seen as a core feature of the workplace in the future.' (Sector Report: Film Production 2015: 14)

Particularly noticeable in all four of the above depictions of work organisation is the simultaneous emphasis on stability and innovation or change. Although there are no reports of dramatic changes in work organisation, there is a definite emphasis on finding ways of 'working smarter'.

The Film Production sector describes creative expression in terms of teams working from start to completion. The researcher explains this as the continuing presence of the 'ideology' or value framework of craft and not necessarily its practice. In practice, the sector has changed, and is changing, rapidly from analogue format to digital format, with a resultant change in work organisation and in the technical positions that make up a film crew.

The Baking sector reports on large-site mass-production practices where most jobs are semi-skilled, but also on small niche sites where specialised and skilled workers perform one operation from start to completion. In this sector, the distinction is very clear.

In boat-building, both large and small sites utilise multiskilled teams, but the term has different meanings. At small sites, every person in the team has multiple skills, while 'multiskilled' at large sites refers to what the team as a whole possesses, with some workers being termed 'semi-skilled' and others highly specialised in particular technical operations.

Mechatronics in Engineering differs from the other three sectors in that the artisanal and technical work described does not refer to automated production, but to the maintenance and process modification of the mechatronic systems of automation. Even though the four sites included in this sector study differ markedly in terms of what they produce or deliver, the influence of automation and computerised control of production processes emerges as a common denominator that has a significant impact on the level and breadth of knowledge and skill requirements necessary.

Anticipated staff movements

Which staffing requirements are anticipated for the future? Anticipated impact of future growth and innovation on staffing and staff movement differs between small and large sites. Some sectors are also viewed as being more affected by staff movements than others. (See Figures 8 and 9 below.)

Figure 8: Impact on future staff movement (small sites)

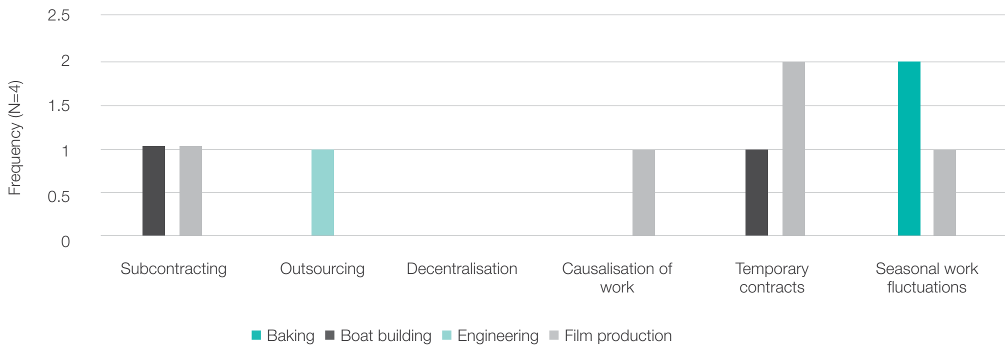
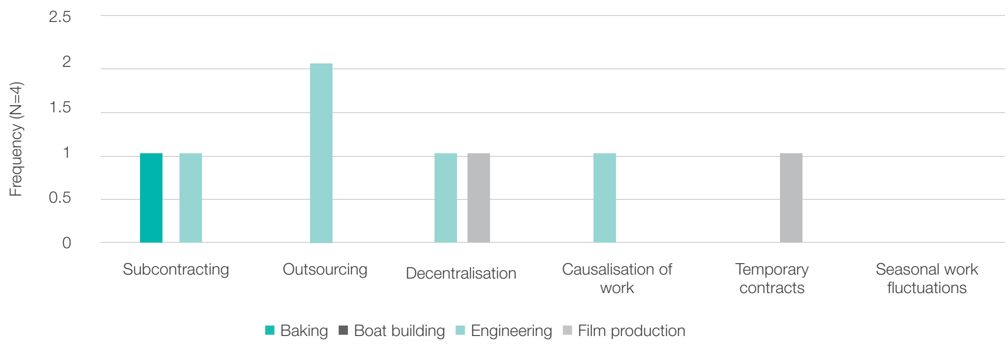


Figure 9: Impact on future staff movement (medium/large sites)



These trends do not necessarily mean that sectors will lose jobs, although certain sectors confirm this explicitly. For the purposes of this report, it is important to note the relation between staff movement and staff development through education and training. This is a theme that recurs in different sections of the report.

Summary of key findings: Sector and company futures

Sub-question 1: Which changes, if any, are anticipated in companies or enterprises over the next two decades, and how will this impact on the role and functions of artisans and technicians?

Finding 1: Business growth through diversified markets
With a few exceptions, the majority of sites, whether large or small, report positively on current and anticipated business growth. Growth is linked to a wide range of market strategies: local and international market diversification across niche and mass markets. While structural factors influence industrial and commercial production in different ways, three factors are viewed as having the highest potential positive or negative impact on future growth: (1) the global economic climate, (2) regional and local political stability, and (3) market volatility.

Finding 2: Employment flexibility
All sectors anticipate that employment trends such as subcontracting, outsourcing, decentralisation, casualisation of work, temporary contracts and seasonal work fluctuation will affect future employment flows and staff movements.

3. WORKPLACE CULTURE FUTURES

Introduction

Having examined structural factors that will have an impact on work in the future, the study now turns to the workplace as a site of cultural values and practices. It is often stated that work is not simply a technical exercise; it is performed at a site or in a context, and that site has a history, familiar rituals, work habits, patterns of communication, and training and development pathways. It is essential to understand what the broader cultural workplace patterns are to which the work of artisans and technicians relates.

Sub-question 2: What levels of technical and communicative competence will be required by company employees in general, and will there be training and development opportunities?

We investigated three dimensions of workplace culture:

- Work culture;
- Workplace communication culture; and
- Training and development culture.

Each person interviewed was asked to use the descriptive terms provided to rate seven dimensions of workplace culture on a Likert-type scale from 1 to 10. Once they had done so, they were asked to repeat the rating, but now to think into the future. Ratings were grouped into larger categories of low, medium and high. In the Sector Reports, the results are presented in terms of the broader categories, with a distinction drawn between the responses given by management and the responses given by workers (artisans, technicians and administrative staff).

For purposes of comparison between the sectors, this Synthesis Report only presents the aggregates of responses about the future, as the purpose here is to indicate broad trends. It needs to be noted that the discussion that follows cannot do justice to the patterns that emerge when the perceptions of managers and workers are presented separately, for both present and future.

Workplace culture futures

Work futures

Culture of risk

Certainty ◄------------------------►	**Risk**
Routine work situations	Novel and challenging situations
Work mostly procedural	Complex problem-solving
Work always supervised	Autonomous or self-directed work

For this dimension, the discussion focused mostly on risk mitigation and the extent to which technical work has become routinised, proceduralised and manualised. In some sectors, teamwork is viewed as a way of reducing risk and liability so that decision-making does not rest solely on individuals.

Culture of technical competence

The second dimension asked about the value placed on technical competence and whether there is a special technical vocabulary that staff members are required to use.

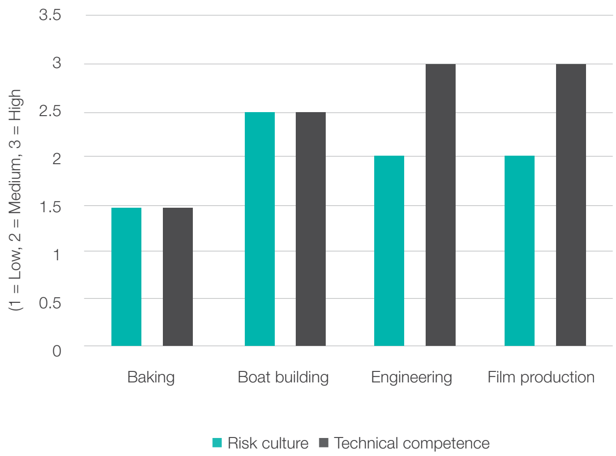
Low ◄------------------------------------►	**High**
High technical competence not necessary. Work mostly routinised and proceduralised to semi-skilled level	Technical competence highly valued and rewarded. All staff expected to remain up to date in their areas of expertise thrwough own research and subscription to trade journals
Little common communication in technical language. Only used among staff with formal qualifications	Technical vocabularies related to business commonly and correctly used at all workplace levels

For artisans and technicians, technical competence is crucial, as this is what is distinctive about their work. This includes the importance of having a technical vocabulary, acquired formally or informally when working under someone who is technically competent.

Some of the views expressed are clearly aspirational in terms of a desire to have work valued and to have access to technical information outside the immediate workplace. In this regard, a generational 'gap' is discernible in the views expressed.

Figure 10 shows a composite picture of how work culture is perceived. A rating of 2 or above shows respondents selecting descriptive terms on the medium to high side of the continuum in order to describe their workplace's culture. A rating below 2 moves the response to the low side of the continuum.

Figure 10: Work culture (future)



Standardisation, in line with national and international classifications, rests strongly on the mechanisation, automation and digitalisation of work. This was cited as the main reason why a low-risk environment, currently and in the future, best describes the cultural climate of work practice. Significantly, though, two sectors equate risk and technical competence, and two sectors see technical competence at a higher level than risk. The necessity for ongoing self-training (in film production) and the increasing requirement for technical vocabularies that benchmark workplace activities against international standards (mechatronics in engineering) are viewed as indicators of a future need for high levels of technical competence.

Workplace communication cultures

Workplace communication culture has four dimensions:

- The first focuses on the general culture of *literacy*, that is, the extent to which reading and writing are an everyday practice in the workplace and the extent to which *multilingualism* is encouraged and understood.
- The second focuses on the extent to which different kinds of *information and communication technology (ICT)* are used in workplace communication.
- The third focuses on the *management communication culture* of the workplace. Does management communication mostly happen in terms of direct supervision, or is there a visible and public communication culture in which staff members are expected to participate?
- The fourth focuses on general *socia relations* culture in terms of the workplace as interpersonal environment.

We briefly describe each dimension, followed by a chart that shows the four communication culture futures for each sector.

Culture of literacy and multilingualism

Low ◄-------------------►	High
Weak culture of reading and writing through memos, notices, and minutes of meetings	Strong culture of reading and writing through memos, notices, and minutes of meetings
Multilingualism not a standard feature of in-company communication and customer service	Multilingualism a standard feature of in-company communication and customer service

Many respondents linked this dimension to levels of school education and to the ability to communicate well in English, as an industry standard. Multilingualism was rarely mentioned as a requirement, even though it was reported that a number of different languages are regularly used.

As long as standard operating procedures (SOPs) are still printed in manual form, fluency in written English is considered important. Another issue, mentioned frequently, is that reading and writing in English are crucial for being able to make use of opportunities for training and development.

An opposing view predicted that the 'digital generation' would soon no longer read printed text.

Information and communications technology (ICT) culture

Low ◄-------------------►	High
Only some staff (usually younger staff members) use the Internet and Google to find information and problem-solve	All staff expected to be ICT-competent and to use the Internet and Google to find information and problem-solve
Staff and management seldom correspond via email and/or other ICT avenues	Staff and management always correspond via email and/or other ICT avenues
Electronic diaries seldom used to synchronise meeting times and other events	Electronic diaries always used to synchronise meeting times and other events
Virtual storage platforms not really used	Virtual platforms a standard feature of information storage and retrieval
Cell phones and related technology not a standard feature of workplace communication	Cell phones and related technology a standard feature of workplace communication

ICT already offers an indispensable means of communication for management and administrative staff, as well as for a younger generation of technical staff. Cell phones are seldom permitted on the shop floor, but access to the intranet for designs and drawings is becoming a more common occurrence.

Across sectors, an increase in ICT utilisation is predicted.

Management communication culture

Low ◄------►	High
Direct supervision in regulated work environment	Leadership in open-ended environment
Staff seldom attend management information sessions	Staff regularly invited to attend management sessions
No noticeboards and company newsletters	Company information public displayed and freely available
Little or no regular performance appraisal and work discussion	Regular performance appraisals and work discussion are standard practice

Management communication cultures range from very informal to formal, professionally oriented communication. Managers tend to rate this dimension higher than staff do.

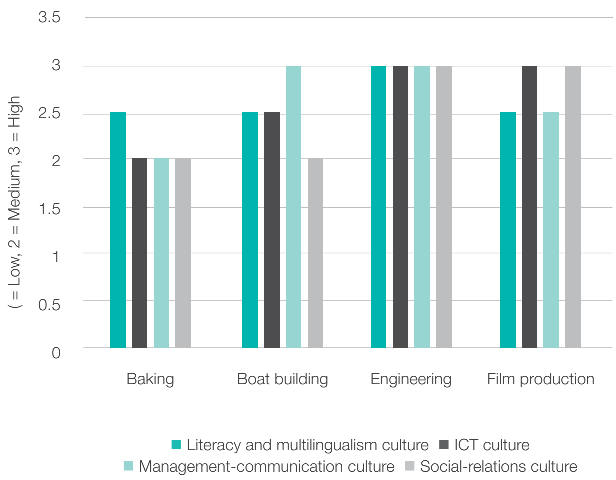
Social relations culture

Low ◄------►	High
Simple interpersonal environment	Complex interpersonal environment
Mostly individual work and problem-solving	Mostly teamwork and joint problem-solving
Specialist customer contact	All staff expected to interact with customers
Little joint planning and discussion	Frequent joint planning and discussion sessions
Staff relations limited to formal meetings	All staff members expected to attend internal and external functions and events regularly

Regular team meetings and group processes are viewed as evidence of an upward movement in the social relations of workplaces. On the other hand, the view was expressed that 'workers are workers; structures won't change' to show that artisanal cultures tend to be solitary and internally focused, even within a team environment.

Figure 11 shows a composite picture of workplace communication cultures (future).

Figure 11: Workplace Communication Culture (Future)



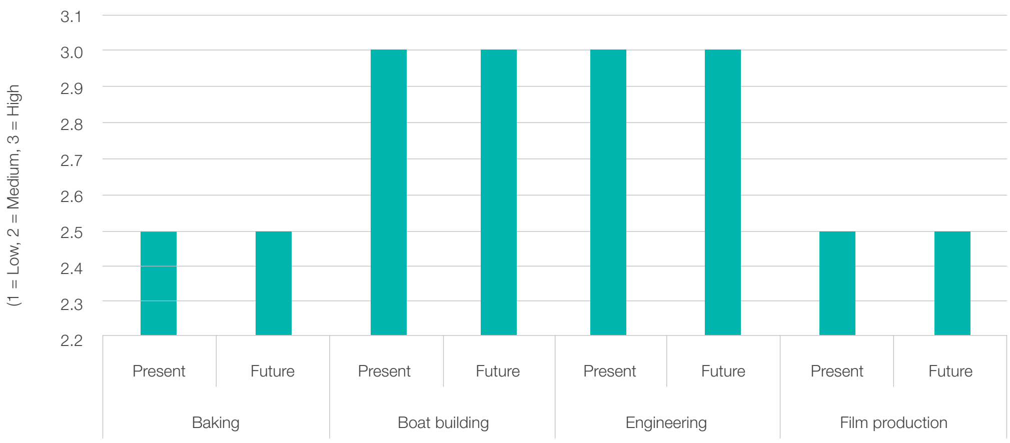
In all sectors, the future requirements of workplace-communication cultures are anticipated at medium to high levels. While there is definitely an aspirational gloss on some of the ratings, especially in terms of ICT usage, there is *a noticeable emphasis on literacy requirements* by both managers and artisans.

Training and development culture

Low ◄------►	High
Low knowledge and skill standards the norm	Excellent knowledge and skills the norm
Little induction into new job	Formal induction into new job standard practice
Weak culture of in-house training	Strong culture of in-house training
Low staff expectation of upskilling and retraining	Upskilling and retraining standard practice at all levels
Staff seldom attend external training	Staff often attend external training

Training and development focuses on knowledge and skill development, through internal as well as external training. In Figure 12, it is significant that, in the two sectors that most report ‘down-skilling’ through mechanisation and digitalisation, present and anticipated future training and development activities are viewed as low. In the two sectors where there are strong in-house and on-job training practices, training and development cultures are rated positively.

Figure 12: Training and development culture (present and future)



Summary of key findings: Workplace-culture futures

Sub-question 2: Which levels of technical and communicative competence will be required by company employees in general, and will there be training and development opportunities?

Finding 3: Shift to ‘low-risk’ work culture but with technical competence redefined
All sectors predict a ‘low-risk’ work culture in the future, which they ascribe to increasing routinisation and standardisation of work through mechanisation, automation and digitalisation. Although the technical complexity of work itself may or may not decrease, a sound technical vocabulary to talk about work, and the capacity for ongoing self-education and training to remain up to date, will contribute significantly to what counts as a technical-competence culture in the future.

Finding 4: An increased communication requirement
Medium to high levels of workplace literacies in terms of reading and writing in English, ICT expertise, and technical and social communication are viewed as important components of workplace-culture futures across all four sectors, although not to the same degree. The expectations of a younger generation of workers, easy access to print media, and more open and participative management-communication cultures are viewed as key prospective drivers of change towards an increased communication requirement.

Finding 5: Training and development both a reality and an aspiration
Training and development cultures are reported as uneven. High ratings refer to formal qualifications as an entry requirement for work, or indicate a strong in-house and/or on-job training culture. High ratings also express an identified need for ongoing training and development and a desire for more training opportunities. Low current and future ratings reflect perceptions that very little training is available for artisans and that ‘down-skilling’ will be the future trend.

4. WORK FUTURES FOR ARTISANS AND TECHNICIANS RESEARCH FINDINGS

Introduction

This chapter is at the heart of the study as a whole and provides the basis for the discussion and recommendations that follow in the concluding chapter. Against the background of anticipated changes in the structure and culture of work, we turn to the particular work performed by artisans and technicians.

Sub-question 3: Which kind of diagnostic and problem-solving knowledge and skills will flexible work futures require of artisans and technicians?

Led by the definition of skills and knowledge discussed in Chapter 2, the first part of this chapter sketches a way of talking about knowledge. Four types of knowledge are identified. A set of sector-specific graphs shows how each type of knowledge is viewed, currently and in the future.

The second part of the chapter sets up a composite knowledge base for each sector and links them to the types of artisanal work found in each sector.

A focus on knowledge

The knowledge on which artisans and technicians draw and what this means for apprenticeship have been contentious issues 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 on 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 (1998) notes the influence of both types of approaches on the South African apprenticeship system.

This study breaks knowledge down into different kinds. *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. Formal knowledge has to be learnt 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. *Procedures* follow a sequential or step-by-step logic that relates to a specific work context. We call this *'how-to' knowledge*. Procedures can also operate at a more general level that applies across contexts as we find, for instance, in a business's standard operating procedure (SOP) and in International Organization for Standardisation (ISO) standards that may apply to work processes in different parts of the world. We call this *'systems knowledge'*.

Principles establish 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). We call this *'craft knowledge'*. A principle can also establish relations between abstract concepts at a general or universal level, and then it is expressed in symbols or words. We call this *'scientific knowledge'*.

Figure 13 shows the four types of knowledge, labelled K1 to K4 for ease of reference.

Figure 13: Types of knowledge

	Situated knowledge (Specific)	Formal knowledge (General)
Procedures	**'How-to' knowledge** Work procedures or routines learnt through everyday experience (not written down) **K1**	**Systems knowledge** Formally codified knowledge of work rules and procedures (written down) **K2**
Principles	**Craft knowledge** Principle visualised through drawings and sketches **K3**	**Scientific knowledge** Principles understood in terms of symbols and words **K4**

It is easy to see how these different kinds of knowledge relate to *certainty* and *risk*: the greater the need for certainty of 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 components of 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 13 provides the basis for the investigation carried out in this study. In our interviews with artisans, technicians and their supervisors, we did not ask directly about knowledge, or qualifications or curriculum. We enquired about how artisans set about diagnosing and solving problems in their work settings, presently and in the future. Their supervisors were asked the same type of questions. Table 3 shows the kind of questions we asked.

Table 3: A framework for investigating diagnostics and problem-solving

Which of the following kinds of diagnostics and problem-solving do you do in your job? *Please use the rating scale below to allocate a rating to each item.* **Rating scale: 5 = 'very often' | 4 = 'often' | 3 = 'fairly often' | 2 = 'not often' | 1 = 'not at all'**	
I know most of the problems, so I work step by step according to a set routine.	
I use a manual or diagnostic tool and follow directions.	
When it is a new problem, I work things out as I go.	
When it is a new problem, I adapt ideas I saw somewhere else.	
I make drawings or sketches before tackling new problems practically.	
When tackling a new problem, I work out the solution in my head before I start.	
I use the knowledge I learnt at school/college/university.	
I research on the Internet.	
We solve problems as a team.	
Other (describe):	

All responses were inputted into SPSS and used to compute aggregate data. (See Annexures A to D.)

In the next section, we present the findings for each type of knowledge. K1 and K2 knowledge are represented as knowledge types that aim for certainty of end result. K3 and K4 knowledge are represented as knowledge types required for *innovation and unpredictability of end result.*

A cross-sectoral view of knowledge types

The graphs presented in this section show current and projected future use of K1, K2, K3 and K4 at *each site* in a particular sector, with variations between small and medium/large sites.

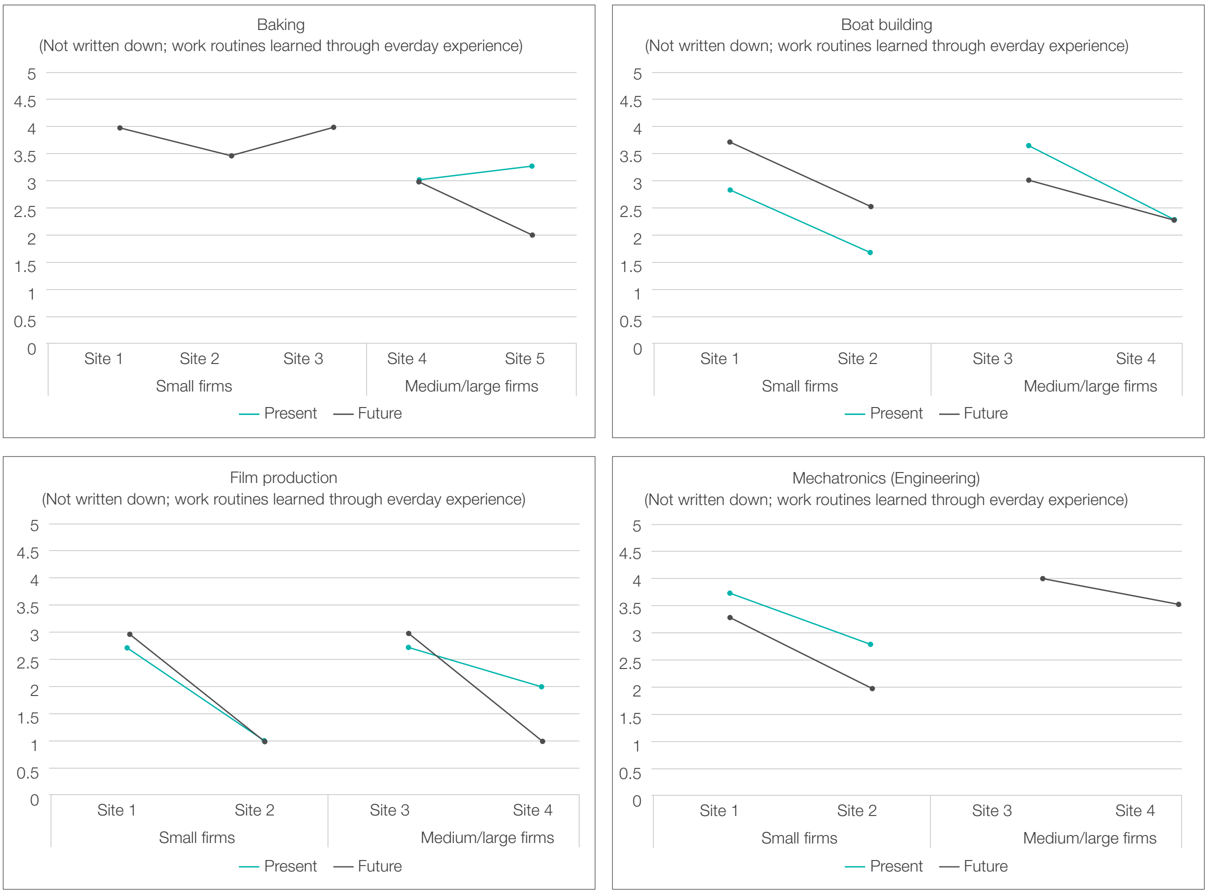
Towards work of certainty

K1 – 'How-to' knowledge

K1 is knowledge that is acquired through routine work. Workers with a strong K1 base know 'how to' do something in a particular work context. Regular work patterns provide the basis for this type of knowledge, with on-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, as well as client and workplace interaction (Mansfield & Mathews 1985, cited in Stewart & Sambrook 1995: 96).

Figure 14 K1 – 'How-to' knowledge



Note: Where the future trend line (grey) falls on top of the present trend line (blue), only the grey line will show. The vertical axis depicts frequency of use on a scale of 1 to 5: 5 = 'very often' | 4 = 'often' | 3 = 'fairly often' | 2 = 'not often' | 1 = 'not at all'.

K2 – Systems knowledge

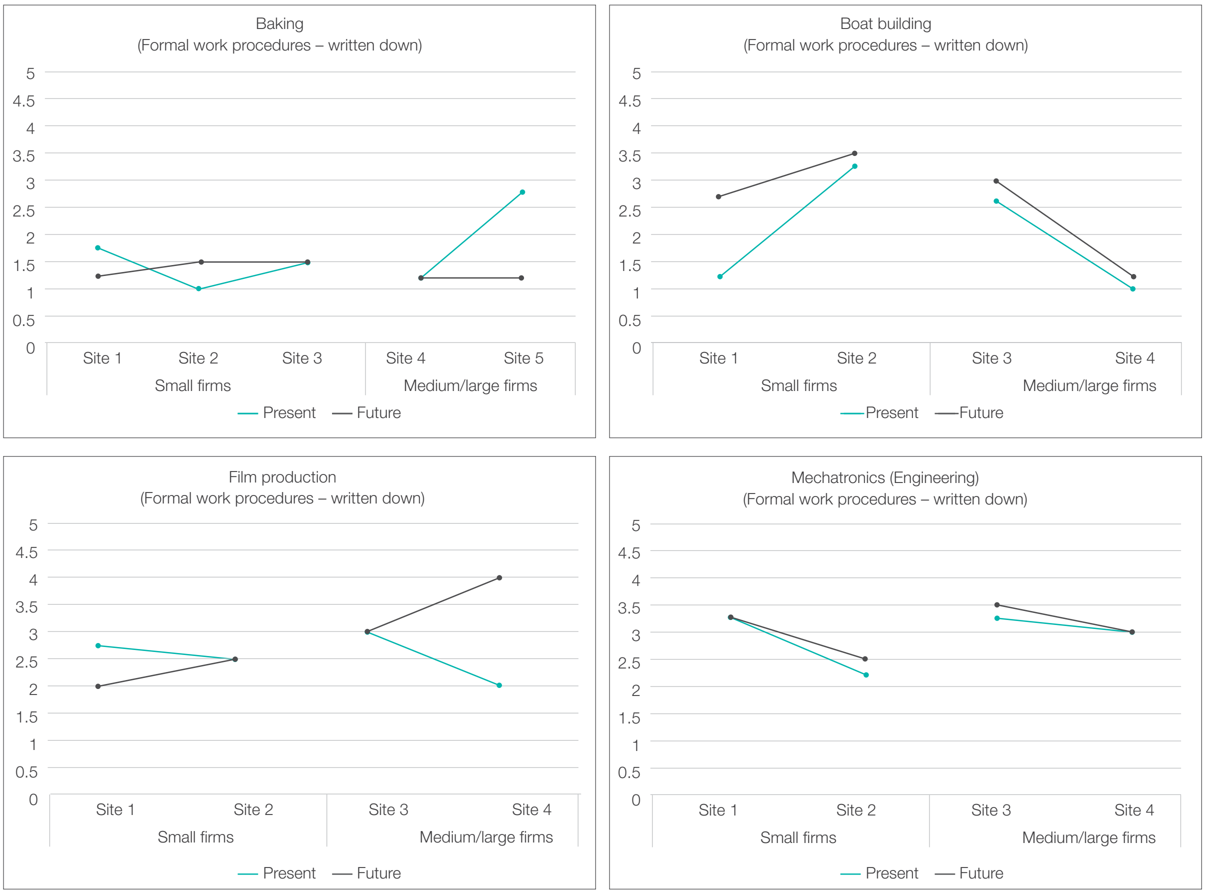
K2 is not simply a written-down version of K1. Whereas K1 applies to specific tasks or work performances, K2 operates at a general level. It may take the form of general work procedures documented as SOPs that a business or enterprise puts in place to ensure that services and/or products are delivered consistently every time. SOPs may apply to occupational areas, to departments, to organisations, or to sectors as a whole. At an international level, technical committees of the 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. It may also refer to complex systems requiring a scientific understanding of disciplinary and applied theoretical knowledge (K4).

Systems knowledge often comes in manualised form and may be learnt in the workplace or in formal, external education and training settings.

The graphs in Figure 15 show present and projected future K2 employment at *each site* in a sector.

Figure 15: K2 – Systems knowledge



Note: Where the future trend line (grey) falls on top of the present trend line (blue), only the grey line will show. The vertical axis depicts frequency of use on a scale of 1 to 5: 5 = 'very often' | 4 = 'often' | 3 = 'fairly often' | 2 = 'not often' | 1 = 'not at all'.

Towards work of risk

K3 – Craft knowledge

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. As a result, the risk has almost become invisible. Yet, the 'principle' of uncertainty of end result remains the 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 that 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* [it] *already existed ideally.* (Marx 1976: 283–284; also cited in Sohn-Rethel 1978: 84–85)

Practice-driven innovation means that new 'parts-to-whole' relationships are established through practical experimentation, as shown in the following example:

> *At one aircraft company, they engaged a team of four mathematicians, all of PhD level, to attempt to define in a programme a method of drawing the afterburner of a large jet engine. This was an extremely complex shape, which they attempted to define by using Coon's Patch Surface Definitions. They spent some two years dealing with this problem and could not find a satisfactory solution. When, however, they went to the experimental workshop of the aircraft factory, they found that a skilled sheet metal worker, together with a draughtsman, had actually succeeded in drawing and making one of these …* (Cooley, cited in Dowling 1998: 4).

In many trades, increasing mechanisation has diluted, or partially destroyed, the parts-to-whole nature of craft work. Two examples from South African history illustrate this trend.

As early as 1908, evidence was presented to the Transvaal Indigency Commission of 1908 that 'the apprentice is not taught the whole theory and practice of the trade, because there is no one in the workshop who does more than a fractional part of the process of manufacture' (Lewis 1984: 26).

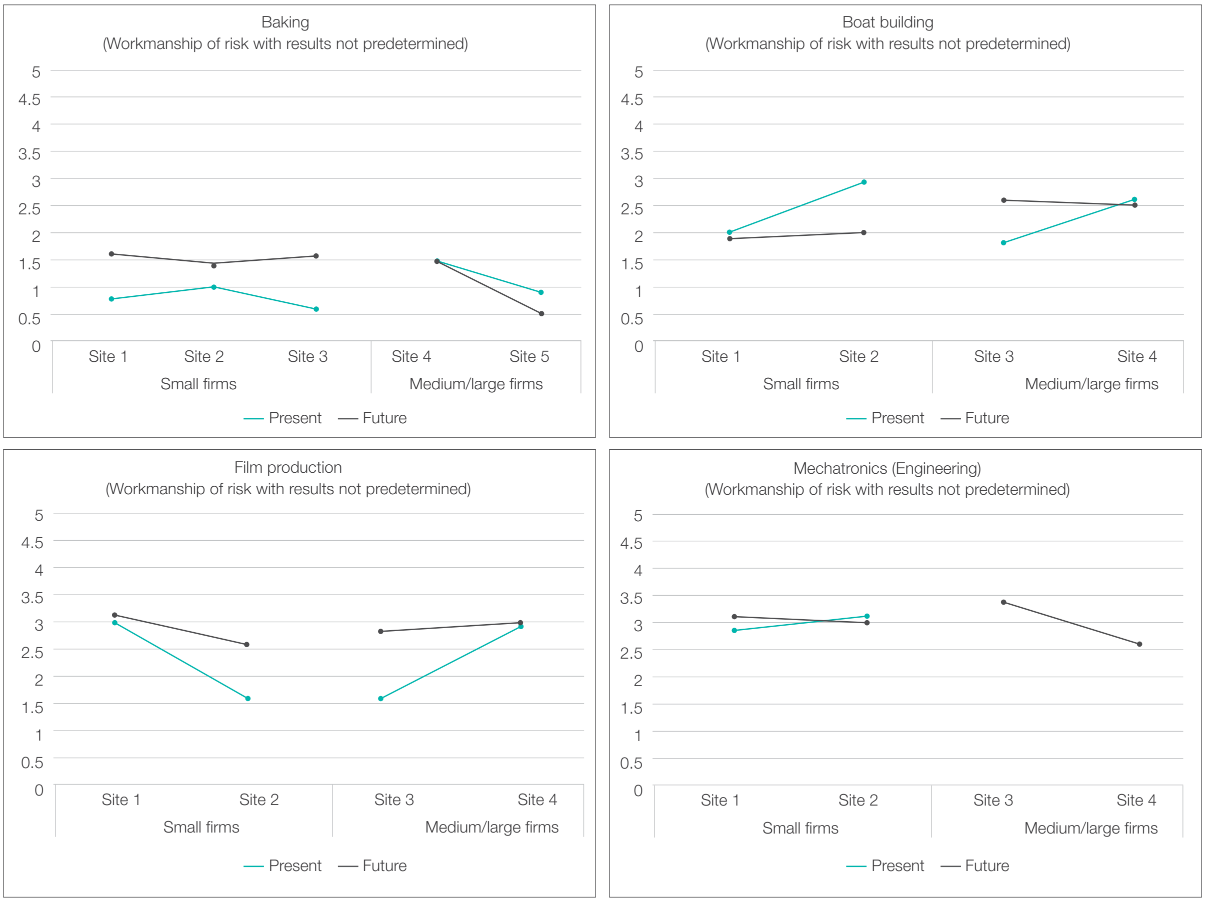
When mechanisation brought about mass production in the years prior to and during the Second World War, the significance of the apprenticeship system was reduced to such an extent that the De Villiers Commission of 1948 recommended a restructuring of the system. Referring to the training provided by the Central Organisation of Technical Training (COTT), which was established at the Pretoria Technical Institute in 1940 under the auspices of the Director General of War Supplies to organise training for the thousands of skilled workers required for work in munitions and civil defence and in support of the armed forces fighting in the Second World War, the commission's report describes the training as follows:

> *The system of training was based on mass production methods, and while it provided experience in various machine shop operations – backswing, chipping, filing, scraping and machine drilling – when the complete job was assembled no trainee could point out that it had been made entirely by himself, although he had made similar constituent parts.* (Para 1081 of the Report of the Committee on Technical and Vocational Education, UG 45, 1948; also known as the De Villiers Report, as cited in Webster 1985: 63)

This does not mean 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*.

The graphs in Figure 16 show current and projected future K3 use at *each site* in the four sectors investigated.

Figure 16: K3 – Craft knowledge



Note: Where the future trend line (grey) falls on top of the present trend line (blue), only the grey line will show. The vertical axis depicts frequency of use on a scale of 1 to 5: 5 = 'very often' | 4 = 'often' | 3 = 'fairly often' | 2 = 'not often' | 1 = 'not at all'.

K4 – Formal scientific knowledge

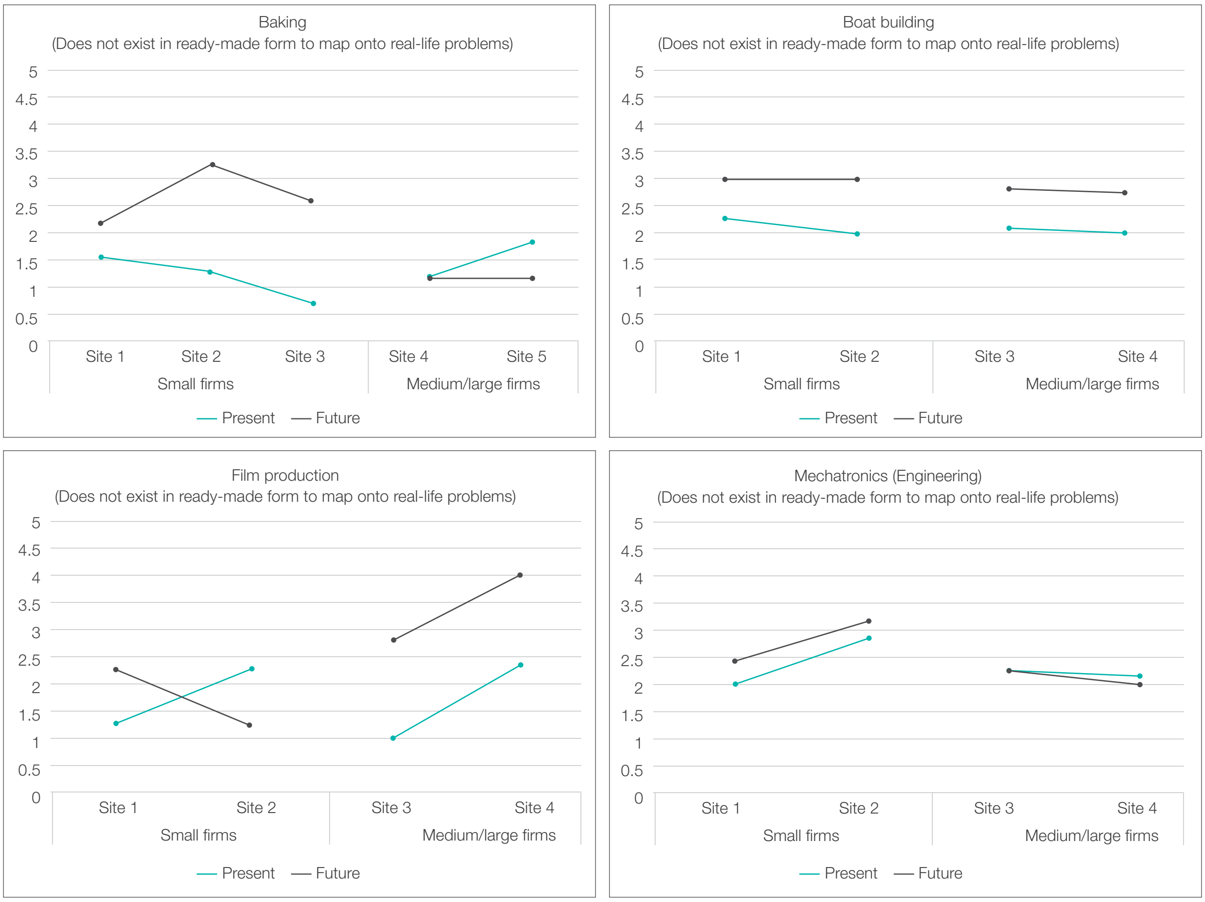
Scientific knowledge can be described in two ways – as *pure science* and as *applied science*:

> *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)

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

Perhaps not surprisingly, the graphs (in Figure 17) show that formal scientific knowledge is currently employed to a limited degree, if at all. However, in all sectors, there is an expectation of formal knowledge becoming a necessary ingredient of technical complexity and a resource of the future. In certain instances, though, trends are aspirational rather than actual. This can be ascribed to a fear of work dilution through standardisation, which tends to lead to exaggerated conceptions of the required formal knowledge base of work, as a counter-measure.

Figure 17: K4 – Formal scientific knowledge



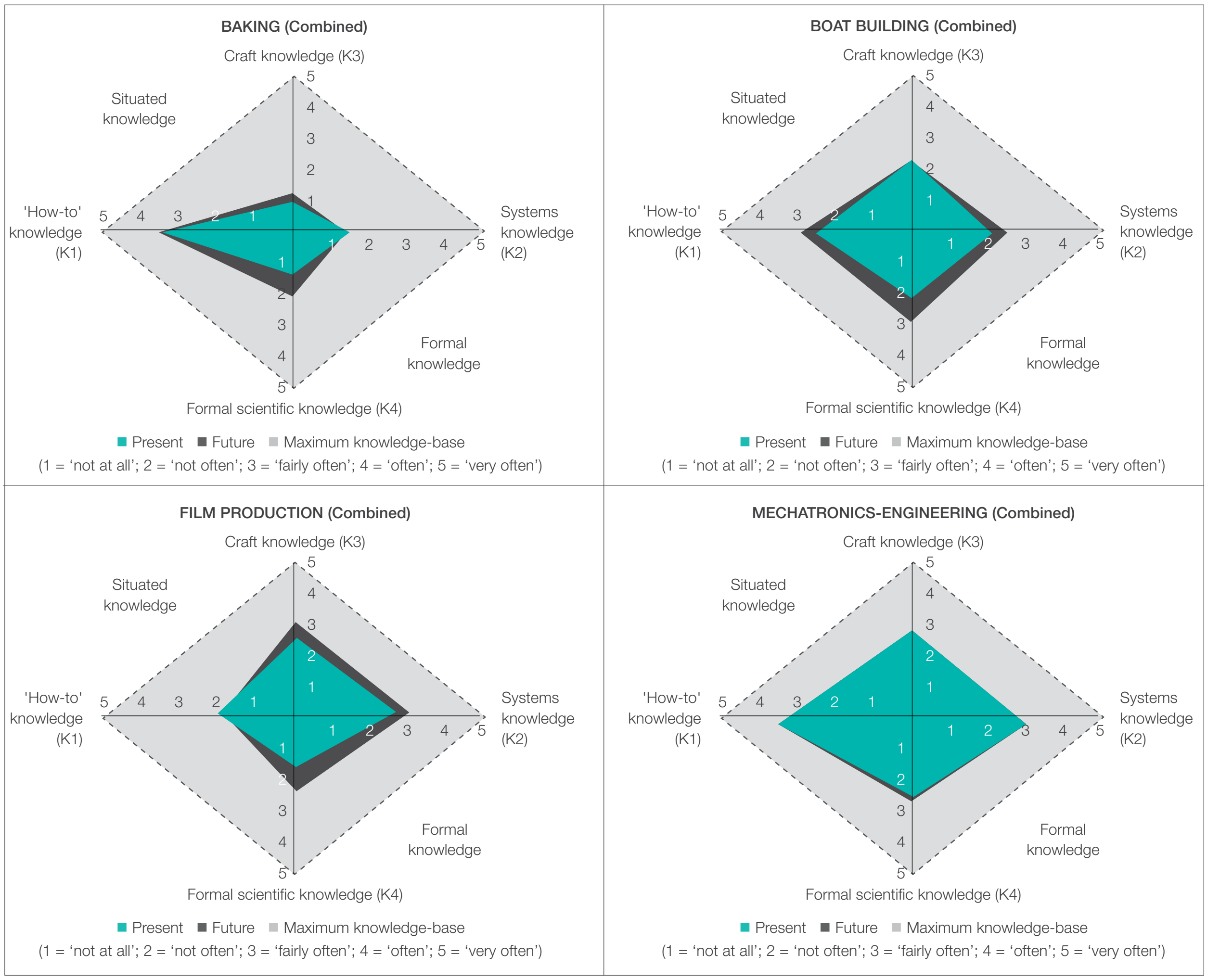
Note: Where the future trend line (grey) falls on top of the present trend line (blue), only the grey line will show. The vertical axis depicts frequency of use on a scale of 1 to 5: 5 = 'very often' | 4 = 'often' | 3 = 'fairly often' | 2 = 'not often' | 1 = 'not at all'.

Differentiated knowledge bases

The previous section showed that all types of knowledge are present in each sector, to a lesser or greater degree. When these 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.

The composite set of graphs presented in Figure 18 provides a spatial representation of the depth and breadth of each knowledge base and the changes envisaged in the future. While comparative analysis is not the aim, it is useful to note similiarities and differences. (Knowledge graphs that distinguish between small and medium/large sites in each sector are attached as Annexures A to D.)

Figure 18: A spatial representation of the depth and breadth of each knowledge base



- **Baking** is a highly mechanised and automated industry, with a more recent revival of artisanal baking and the introduction of informal baking complementing mass production. In all types of baking, the knowledge base consists mostly of 'how-to' knowledge (K1) acquired through 'on-job' training. In this sector, particularly, it should be noted how strongly changes anticipated reflect the desire of the workforce to have opportunities for formal training. The Sector Report on Baking comments that:

  There is no way of knowing when any type of baker is fully trained; there is no moment when a baker can say: 'I am now a fully trained Type X baker.' There is no trade test or any other method that allows a baker officially to use the title of baker. (Spies 2015: 35)

- **Boat building** is a sector in the process of setting up its first apprenticeship training programme, having previously imported formally trained and certified boat builders as well as relying on situated knowledge gained through 'on-job' training. The artisanal knowledge base is evenly spread across all four types of knowledge. It is anticipated that a closer integration of design with production and an emphasis on innovation will drive the knowledge base upwards 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. It is envisaged that National Senior Certificate (NSC) Grade 12 Mathematics and Science will become vital as an entry requirement to skilled work at the intermediate level in this sector.

- **Film production** has undergone fundamental technical changes in the last decade as a result of a shift from analogue to digital format. Much of the knowledge base at artisanal level is procedural and equipment-related (K2). As this is a freelance industry, camera assistants operate as independent contractors and are 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 (e.g. pre-production, production and post-production) that enhances technical expertise.

- **Mechatronics (in engineering),** which provides technical services and maintenance in an automated workplace environment, has a deeper knowledge base than the other sectors. 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).

  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. Investment in technology is also expensive and maintenance, modification and adaptation of equipment are undertaken to support cost savings. This slows down the process of rapid technological change.

Occupational variations in artisanal and technical work

The findings so far begin to show the demarcations of each of the four sectors studied. Variations become even clearer through the types of artisanal and technical work found in each sector. Although we started off investigating only one trade or occupation per sector, in each study we found variants of a particular trade or occupation. This was to be expected, given that type and size of market, type and size of business, and type of work organisation and equipment/technology all play a part in marking out work in different ways. What is of significance for the purposes of this study is that such variations are seldom taken into account when occupations are listed or discussed. In a later chapter, we will argue that considering the notion of 'occupation' at a general level only has far-reaching consequences when it comes to work-readiness and education and training provision.

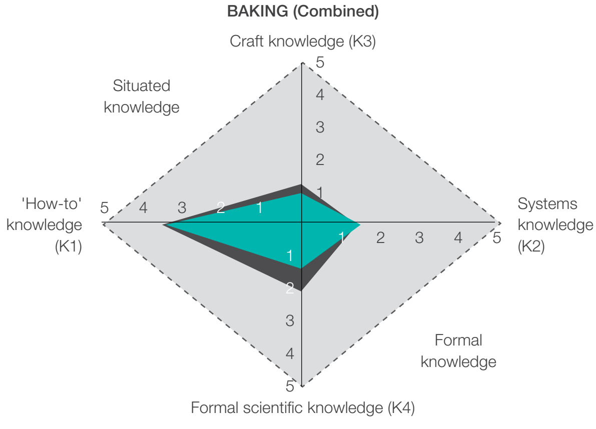
In the discussion that follows, we set out the occupational variants found in relation to the listed trade or occupation investigated in each sectoral sample of small and medium/large sites. For each sector, we draw attention again to the shape of the knowledge base where the findings for all sites have been combined, and we then indicate and explain the different artisanal and technical occupational variants found under each occupational title investigated.

Baking sector

Trade investigated: 681201 Confectionery Baker (as listed in *Government Gazette*, Vol. 566, No. 35625, 31 August 2012)

Knowledge base

Figure 19: The knowledge base on which the baker-artisan draws



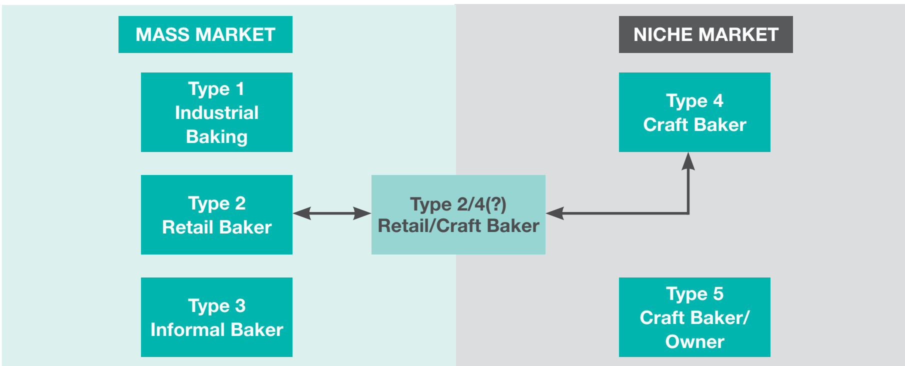
(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

The knowledge base of this sector is restricted in terms of both breadth and depth. The strongest knowledge type found in this sector is K1, which refers to situated 'how-to' knowledge learnt on the job and usually not written down. (See Annexure A for knowledge graphs that relate to small and large sites in the baking sector.)

The LMIP Baking Sector Study (Spies 2015) identifies five different occupational variants of 'baker' in a sector where there is a strong distinction between mass production and niche production for local and national markets. Even though some of these variants would now be classified as semi-skilled or unskilled jobs, all five variants are included to show that they all originally derived from 'baker' as an artisan category that has existed since time immemorial. 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 (Tennison 2014). The typology (as below) names the different types and a descriptive table follows.

Current work types[5]

Figure 20: Typology of the baker-artisan



The description of each type is done in terms of labour process variation.

Table 4: Forms of labour process found in the work of bakers

MASS MARKETS			
Type	Division of labour	Tools	Materials
Type 1: Industrial baking	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	Baking is a fully mechanised process carried out through the use of increasingly sophisticated production equipment	Basic baking materials of flour, water and yeast, and a special cocktail of secret ingredients
Type 2: Retail baker	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	Ovens, proovers, mixers, and tools like moulders and dividers	Basic baking materials of flour, water and yeast, as well as premixed ingredients and freezer-to-oven products
Type 3: Informal baker	Baker bakes bread and other products at home and sells to township community. Everything is done by hand, from mixing ingredients to shaping and baking products	Oven and possibly a mixer	Basic baking materials of flour, water and yeast
NICHE MARKETS			
Type	Division of labour	Tools	Materials
Type 4: Craft baker	Baker bakes all or most of the products sold or served at the business: bread, croissants and patisserie. Everything is done by hand, from mixing ingredients to shaping and baking products	Electric or wood ovens; mixers; pastry-sheet machine	Stoneground flour, water, yeast, cultures, farm butter and cream, and free-range eggs
Type 5: Craft baker/ owner	Baker bakes some or most of the products sold or served at the business: bread, croissants and patisserie Everything is done by hand, from mixing ingredients to shaping and baking products Is also the owner and is in charge of marketing, finances, future-planning, new products, and general organisation of the business	Electric or wood ovens; mixers; pastry-sheet machine	Stoneground flour, water, yeast, cultures, farm butter and cream, and free-range eggs

5 The typology and description of 'types' that follow have been taken directly from the LMIP Sector Report: Tourism and Hospitality (Trade: 681201 Confectionery Baker) and should be referenced as Spies 2015: 25–27.

The 'baker' typology 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 that 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.

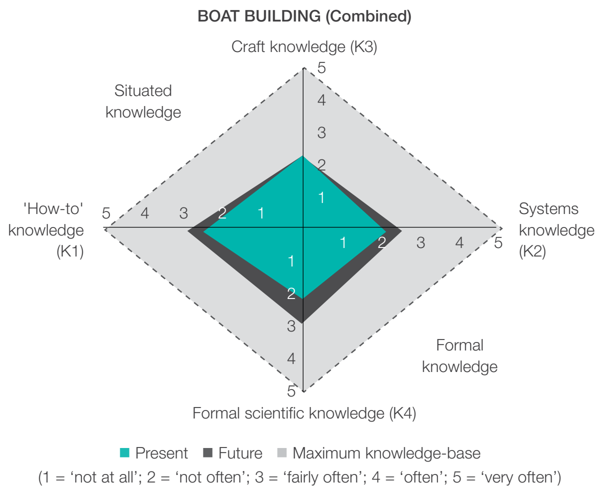
The introduction of the *Type 3 Informal Baker* is also a recent commercial innovation. Using cheaper materials and resembling craft at a surface level, the short duration of the training of a few days is not comparable with the apprenticing relation that produces the *Type 4 Craft baker.* It is, however, 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.

Boat-building sector

Trade investigated: 684907 Boat Builder and Repairer (as listed in *Government Gazette*, Vol. 566, No. 35625, 31 August 2012)

Knowledge base

Figure 21: The knowledge base of the boat-builder artisan



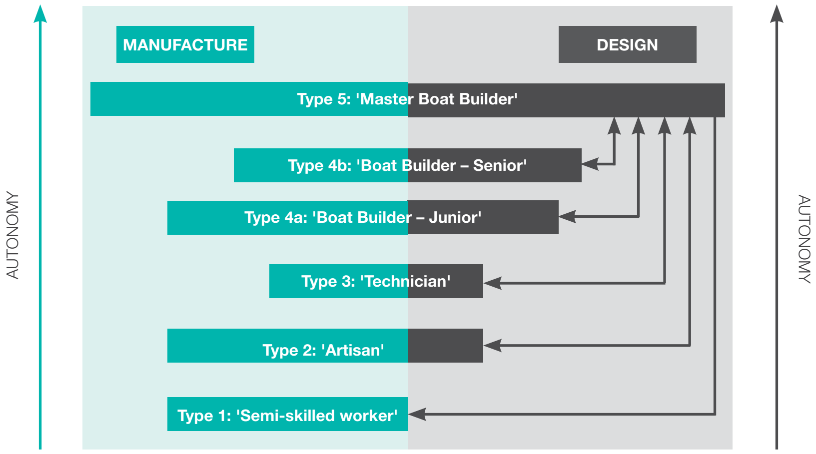
The knowledge base on which this sector draws is fairly evenly distributed, even though, currently, not at a deep level. Future trends indicate that a combination of systems knowledge (K2) and formal scientific knowledge (K4) will be a requirement for work codified in SOPs and meeting ISO standards.

(See Annexure B for knowledge graphs that relate to small and medium/large sites in the boat-building sector.)

While the introduction of the first formal apprenticeship in the boat-building sector is linked to the occupational title of 'boat builder', the LMIP Boat Building Sector Study (Davidson 2015) identifies four occupational variants of 'boat builder' in a sector where there is a trend towards a closer relation between manufacture and design.

Current work types[6]

Figure 22: Typology of boat-building artisans



The description of types refers to labour process variation and the degree of work autonomy.

Table 5: Forms of labour process found in the work of boat builders

<table>
<tr><th>Type 1
(Semi-skilled Worker)</th><th>Type 2
(Artisan)</th><th>Type 4
(Boat Builder Junior and Senior)</th><th>Type 5
(Master Boat Builder)</th></tr>
<tr><td rowspan="3">Assistant/semi-skilled worker
Works with hand tools on basic, repetitive tasks
Materials define the work
Follows instructions closely.
Closely monitored at risk moments
Specialised for a task/ function</td><td rowspan="3">General, qualified artisan with on-job training specialisation in boat-building
Generally works with power tools and drawing interpretation
Contextual specialisation in marine environment, e.g. marine carpenter, marine fitter, marine fabricator, marine pattern-maker
Multiskilled; can do different tasks within a team context (which is more likely in a small company)
Can apply knowledge and therefore can problem-solve in a new way
Moves within the industry</td><td>Professional, emergent and imported. Cross-skilled and knows the whole boat
Craft-based (aspirational)
Marine environment specialisation
Multiskilled; understands all tasks and can visualise end product in context
Formal knowledge base and employs relational logic
Years of on-job training experience
Has supervisory role or structural component assembly role
Level of autonomy</td><td rowspan="3">Professional (technical or business orientation)
Business, production, technical and design oversight
Links work of all types
Oversight of materials, quality and performance
Manufacture/design interface</td></tr>
<tr><th>Type 3 (Technical)</th></tr>
<tr><td>Boat-building Technician
Work strongly determined by tools, equipment and materials
Intermittent. Sometimes outsourced.
Did not show strongly in the sites, but it is emerging
Systems and marine context specialisation
Strong knowledge base gained in different ways and significant on-job training experience
Generally works on systems installation and repair
Problem identification and problem-solving
High autonomy</td></tr>
</table>

All types work as part of a team, with combinations of types varying according to yard size, nature of production and management style.

As in the baking industry, boat-building covers a wide occupational range that shows the impact of mass-production labour processes.

Type 1 refers to *narrow specialisation* at the level of semi-skilled work.

6 The typology and description of 'types' that follow have been taken directly from the LMIP Sector Report: Boat Building (Trade: 684907 Boat Builder and Repairer) and should be referenced as Davidson 2015: 20–23.

The traditional trades are represented by *Type 2 Artisans* with marine contextualisation, obtained through extensive work experience as an additional requirement.

The *Type 4 Boat Builder* is an emerging type that requires expertise in all aspects of boat-building processes. This type signals the continuation of the age-old craft of boat-building, but under conditions of advanced technology that require a formal knowledge base.

The *Type 3 Technician* is also an emerging type brought about by increasing systems complexity through shifts towards ICT-based technologies. 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. On-job experience and supplier training and retraining are considered vital.

The *Type 5 Master Boat Builder is* a professional boat builder who has entered the industry from a related professional field such as engineering or from a business background. At this level, a key dimension is the manufacture–design interface.

Historically, this sector has not trained formally and, prior to 2006, certified boat builders were imported. The fairly recently registered *Yacht and Boat Building* qualification is closely aligned with international boat-building curricula and is offered as a learnership at NQF (National Qualifications Framework) Levels 2, 3 and 4. The recent listing of *Boat Builder and Repairer* as a trade will introduce an apprenticeship and a formal trade test.

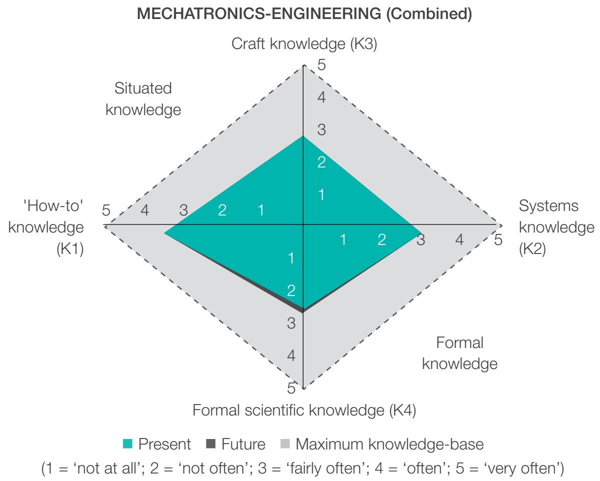
Future expectations are that a professionalisation process has commenced that is eventually expected to lift industry standards to a level where NSC Grade 12 Mathematics and Science will be standard requirements for formal entry to the sector. At the same time, 'on-job' training and experience will continue to be highy valued.

Engineering (mechatronics) sector

Trade investigated: 671203 Mechatronics Technician (as listed in *Government Gazette*, Vol. 566, No. 35625, 31/08/2012)

Knowledge base

Figure 23: The knowledge base of the mechatronics artisan

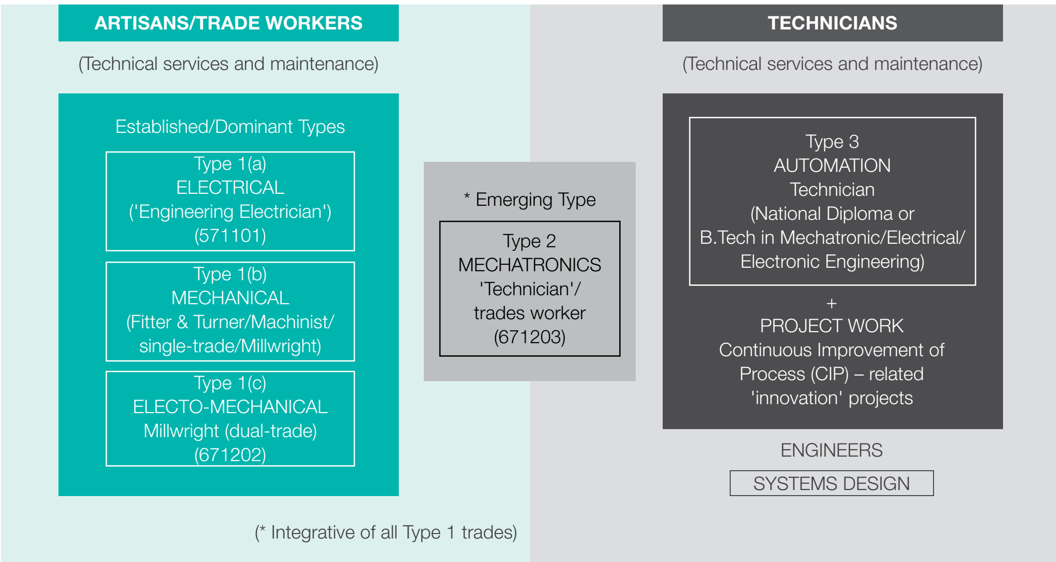


The graph in Figure 23 reflects the most complex knowledge base of the four sectors investigated, in that all four types of knowledge are utilised evenly in diagnostics and problem-solving. Future trends indicate that the knowledge base will continue to be stable and that drastic change is not anticipated. This is indicative of a knowledge base that has developed consistently over time. (See Annexure C for knowledge graphs that relate to small and medium/large sites in the engineering (mechatronics) sector.) The LMIP Mechatronics in the Engineering Sector Study (Garisch 2015) shows an occupational split between artisans and technicians involved in technical services and maintenance that is possibly the reason for the even split between different types of knowledge. A new trade of Mechatronics Technician (OFO Code 671203) has been designated, with qualifications at TVET (technical and vocational education and training) college level. This trade is intended to slot in on a level above the traditional trades, but below that of professional automation technicians.[7]

The typology (as below) names the different types, which are then described in the discussion that follows.

Current work types

Figure 24: Typology of technical workers in an automated work environment



The description of each type is done in terms of fault-finding and problem-solving in technical services and maintenance provided in an automated engineering workplace.

Type 1: Engineering Artisan
In conventional engineering workplaces where production is essentially electromechanical systems-based with varying levels of digital control of production equipment and processes, technical services and maintenance support functions are performed either by a dedicated electrical and mechanical artisan or in a combined manner by a dual-trade millwright, or electro-mechanician as alternative title. They are the practical and hands-on staff in relation to installation, maintenance, servicing and repair of the electrical and mechanical components of production machinery or equipment. These artisans make up the first line of defence with regard to fault-finding and problem-solving, or repair in cases of breakdowns caused by equipment failure or error. If they cannot resolve the problem in a prescribed period of time, the problem is escalated to the next level in the hierarchy of technical and professional personnel.
Type 2: Mechatronics Technician (OFO Code 671203)
The proposed new job of mechatronics technician is intended to slot in at a level above the traditional trades, effectively replacing such artisans, but below that of professional automation systems-aligned technicians. 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. 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 electromechanical-aligned trades, as well as in relation to automation-related or computerised control functions associated with mechatronic systems, but at a lower level

7 The typology and description of 'types' that follow have been taken directly from the LMIP Sector Report: Engineering (Trade: 671203 Mechatronics Technician) and should be referenced as Garisch 2015: 28–30.

Type 2: Mechatronics Technician (OFO Code 671203)
than that at which the automation or mechatronics technician operates. Type 2 will have a working knowledge of programming and software-related aspects, for example understanding error codes on the PLC (programmable logic controller) and conducting computerised diagnostics, but will not actually do programming. (At the moment, this is an emerging type encountered at one site only. Substantial evidence of the impact of this 'combination' artisan type was thus not available for the study.)
Type 3: Automation Technician
The work of the automation technician, a generic term used in relation to persons holding a national diploma in automation-related engineering, for example mechanical, electronic, electrical or mechatronic engineering, is essentially fourfold in focus: • Testing of new equipment or machinery for functionality: whether integration between the field device, the PLC and the SCADA system (remote network-based 'proactive' fault detection) adheres to predetermined specifications. • Continuous monitoring and analysis of production and operations equipment and process-related performance data in respect of individual machines and in overall systems and network contexts in order to ensure that the production line runs at preset optimal levels or parameters. • Fault detection, root-cause analysis, problem-fixing and reporting in the event of major breakdowns. This involves scrutinising logs and performance data relating to equipment and processes. *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. In respect of the latter, the technician consults with the in-house dedicated expert programmer who is responsible for overall higher-level network-related programming. Project work comprises the bulk of the technician's work and is essentially programmatic-related. Conducting independent research is reportedly becoming a key requirement.*

Two crucial differences distinguish mechatronics (in engineering) from the other three sector studies. The first is that mechatronics (as studied in engineering) 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 and it is by no means certain whether the introduction of the new NQF Level 4 artisan qualification will dilute or strengthen the boundary between artisans and technicians. At the sites visited, the dominant view is that mechatronic technician (NQF Level 6) sets 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).

Film production

Trade investigated: Camera Assistant (not gazetted)

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. The sector is reportedly 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 or not, begin as runners or production assistants and remain there for at least one season in order 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 then 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 2007)[8]

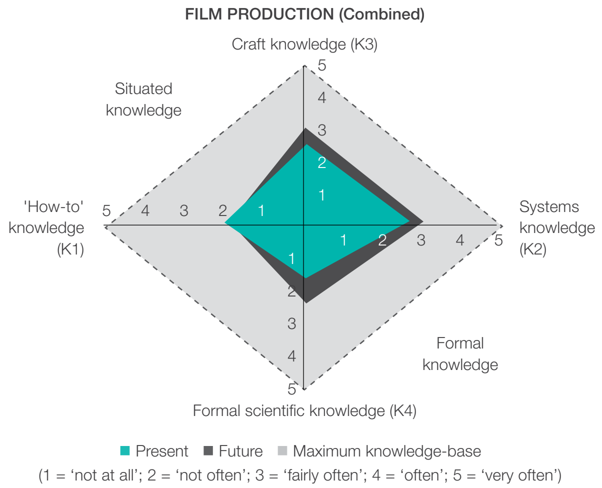
In line with the above description, the LMIP Film Production Sector Study (Gallagher 2015) reports on a strong distinction between commercial film production for international content and community-based, local-content film production.

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 one hand, and the training of aspirant film-makers who come from disadvantaged backgrounds without the means for formal education. Here, these film-makers are exposed to all aspects of film. (Gallagher 2015: 6)

In order to capture these two very different components of the film industry, the study reports on the occupational titles '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.

Knowledge base

Figure 25: The knowledge base of the film-production artisan



This process of digitalisation in the context of film is 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 into the camera, has revolutionised this sector. As can be

8 In Gordon A, Gamble J, Angelis D & Garisch C (2007) *Workplace training and learning case studies.* Unpublished research report commissioned by the Western Cape Department of Economic Development and Tourism; also cited by Gamble J (2012) *Models and pathways to institutionalise apprenticeships*. Labour Market Intelligence Partnership (LMIP) Working Paper 30, p. 23.

seen from the graph in Figure 24, digitalisation, as a rapidly evolving technology, logically places an emphasis on formal systems knowledge (K2).

(See Annexure D for knowledge graphs that relate to small and large sites in the film-production sector.)

The typology (as below) names the different artisan types, and the table that follows describes each one.

Current work types[9]

Figure 26, which presents the typology of film-maker artisans, divides the sector into two subsectors. Two types of artisan film-makers are identified, each with two subsections.

Figure 26: Typology of the film-maker artisan

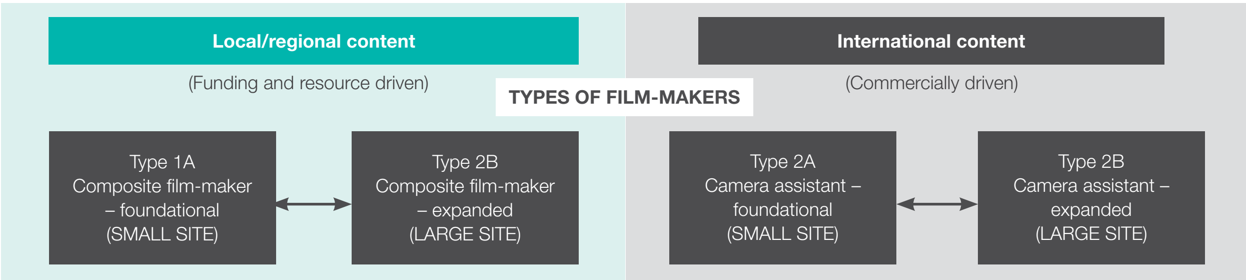


Table 6 includes information about how different film-production companies divide their labour and which tools they use.

Table 6: Types of film-maker artisans and the labour process

Funding- and resource-driven companies focusing on local/regional content, with emphasis on training of aspirant film-makers from disadvantaged backgrounds		
Film-maker type	Division of labour	Tools
Type 1A: Composite film-maker (all-rounder) Production of local content at a small site	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. The film-maker is able to use own initiative and operates with a high degree of autonomy.	Camera gear, sound gear, lighting gear, editing suites, sound-mixing equipment, and web and social media
Type 1B: Composite film-maker (more specialist focus) Production of local content at a large site	The composite film-maker at a large site has increasingly expanded expertise and primarily operates the camera and post-production editing of footage. The 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. The film-maker is able to use own initiative and operates mainly independently.	Camera gear, sound gear, lighting gear, editing suites, sound-mixing equipment, and web and social media
Commercially driven sites focusing on international content		
Type 2A: Camera assistant (all-rounder) Production of international content at a small site	Camera assistant acts as an assistant to the camera operator or the director of photography (DOP). Performs production duties, but can from time to time perform post-production duties. Full digitalisation and latest technology are evident. Conception and execution mainly separated, but can combine. Limited decision-making, but higher risk due to participation in duties beyond that of camera assistant. Limited autonomy, as this job falls under management of camera operator/DOP.	Dollies, trolleys, electronic clapperboards, pens, notebooks, lenses, cameras, and, occasionally, editing suites and software
Type 2B: Camera assistant (more specialist focus) Production of international content at a large site	Camera assistant has specialist knowledge and main duties are as an assistant to the camera operator. Work takes place within multiple camera-crew teams. Strictly production – no contact with camera while in operation. Full digitalisation and advanced technology are used. Conception and execution entirely separated. Autonomy and decision-making not evident. Limited risk due to presence of video technician and digital imaging technician (DIT).	Dollies, trolleys, lenses, notebooks, pens, electronic clapperboards

9 The typology and description of ‘types’ that follow have been taken directly from the LMIP Sector Report: Film and Television Production (Trade: Camera Assistant) and should be referenced as Gallagher 2015: 35–36.

As in mechatronics (in engineering), film production is characterised by advanced-technology use. Unlike mechatronics, a perceived deepening of the formal knowledge base does not translate into a call for a higher level of qualification. At commercially driven sites, digitalisation has created new positions in the camera crew, such as that of the DIT and the data wrangler. The DIT is the camera department crew member who works in collaboration with the DOP on work flow, camera settings, signal integrity and image manipulation in order 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 the 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 in which a conscious 'redress' strategy was encountered in response to a need for script-writing and film-making that deals 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', with each responding to a different market and with no continuity between them.

Summary of key findings: Work futures for artisans and technicians

Sub-question 3: What kind of diagnostic and problem-solving knowledge and skills will flexible work futures require of artisans and technicians?

Finding 6: Opposing, but simultaneous, work-change trends
The study found evidence of two opposing trends: a shift 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 down-skilling.

Finding 7: Occupational diversification
The effect of patterns of upskilling and down-skilling 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.

Finding 8: Differentiated knowledge and skill within and between sectors
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. This has a significant impact on training and development pathways. The knowledge and skill bases of small and medium/large enterprises in the same sector also show degrees of difference.

In the next chapter, we turn to an investigation of how artisans and technicians become work-ready. This will complete the four levels of enquiry undertaken in the study. The final chapter will offer a discussion and recommendations.

5. QUALIFICATIONS FUTURES FOR ARTISANS AND TECHNICIANS

Introduction

Sub-question 4: How will artisans and technicians become work-ready?

This chapter puts forward composite findings on how artisans and technicians currently become work-ready. Rather than to conduct an exhaustive survey of training opportunities, the aim was to obtain an overview pertinent to each sector in order to report on alignment between education and training demand and supply. Information was obtained mainly through desktop research, augmented by telephonic and face-to-face interviews. Details about the qualifications mentioned in Table 7 are contained in the respective Sector Reports.

Current artisanal educational, training and development (ETD) provisioning and qualifications

Table 7 provides an overview of types of training and development utilised in each sector. The categories were not preselected. They emerged from the information gathered.

Table 7: Summary of artisanal education, training and development opportunities in four sectors

<table>
<tr><th>SECTOR</th><th>TRADES</th><th>Entry qualification required</th><th>Relevant qualification(s) registered on NQF</th><th>On-job training</th><th>In-house courses</th><th>Short courses (external)</th><th>Supplier training</th></tr>
<tr><td>Hospitality</td><td>Baker</td><td></td><td>National Certificates (Various)
NQF Levels 2–4</td><td>√</td><td></td><td>√</td><td>√</td></tr>
<tr><td>Boat-building</td><td>Boat Builder</td><td></td><td>National Certificate
NQF Levels 2–4</td><td>√</td><td>√</td><td></td><td>√</td></tr>
<tr><td rowspan="2">Film</td><td>Film-maker</td><td></td><td rowspan="2">FET Certificate (NQF Level 4)
National Certificate (NQF Level 5)
National Diploma (NQF Level 6)</td><td>√</td><td></td><td>√</td><td>√</td></tr>
<tr><td>Camera Assistant</td><td></td><td>√</td><td></td><td>√</td><td>√</td></tr>
<tr><td rowspan="2">Engineering (automated work environment)</td><td>‘Automation-orientated’ Artisan</td><td>√</td><td>FET Certificate (NCV Level 4)*
merSETA Mechatronics Learnerships NQF Level 4 (Trade Worker) & NQF Level 5 (‘Technician’)*</td><td>√</td><td>√
(Medium and large firms)</td><td></td><td>√</td></tr>
<tr><td>Automation Technician*</td><td>√</td><td>National (Professional) Diploma (NQF Level 6)</td><td>√</td><td></td><td>√
(Programming)</td><td>√</td></tr>
</table>

(For artisan development in automation or mechatronic systems-based engineering work environments, both artisan and technician are considered, as the relevant ‘mechatronics’ qualification is still under review. It was reported that this is because it has been recognised that the qualification needs to be pitched at a higher level than that of the traditional engineering trades.)*

The trends indicated in Table 7 are significant:

- **On-job training at the point of job entry emerges as the main vehicle for ensuring workplace-aligned knowledge and competence.** This applies to persons entering the labour market without relevant, initial formal training and also, to some degree at least, to those who enter the workplace with a requisite formal qualification. It is reported that, in many cases, work-readiness and the sanction to work independently are only achieved after two to five years of on-job training, in-house development.
- **In three of the four sectors, an initial, industry-specific or industry-aligned qualification is not a requirement for job entry.** Two main reasons were offered in explanation: either technical work performance has not been formalised or codified, with a resultant lack of qualification development, or qualifications have been developed and registered on the NQF but, for some reason, their impact on the development of artisans has been negligible. The following underlying factors or gaps in provisioning emerged with regard to lack of uptake by prospective artisans and technicians or by relevant industries as a whole:
  - Actual delivery occurs on an extremely limited basis or is not deemed of an acceptable quality and standard to be recognised by industry (whether based on historical prejudice or whether reality-assessed).
  - The scope and focus of curricula are not perceived to be adequately aligned with industry needs or requirements.
  - Accurate classification of a particular trade, to the extent that it is possible in cases where a range of types present themselves or when dealing with a composite trade, presents an obstacle to qualification development.
- **Supplier training in specific pieces of equipment is an emerging and rapidly growing provider practice.** In some cases, there is a requirement for self-acquired supplier training, often via the Internet; in other cases, such training is employer-supported.

Summary of key findings: Qualifications futures for artisans and technicians

Sub-question 4: How will artisans and technicians become work-ready?

Finding 9: A range of NQF-registered qualifications, but limited provision
Each sector has a range of formal qualifications registered on NQF Levels 2 to 6, but there is little systematic evidence of delivery and take-up.

Finding 10: On-job training and supplier training the dominant modes of provision
In all four sectors, on-job training and informal learning remain the dominant modes of education and training, with supplier-provided training in specific items of equipment or technology identified as a fast-growing trend.

The final chapter, Chapter 6, offers a discussion and interpretation of trends noted in the above findings and puts forward exploratory proposals towards answering the policy question about the re-establishment of a ‘good artisan-training system’ (DHET 2013: xvi).

6. DISCUSSION AND RECOMMENDATIONS

Introduction

By looking at work itself rather than at programmes and curricula that prepare people for work, this study has taken a demand-side view of *work and qualifications futures for artisans and technicians*. In order to ensure a representative picture, the study selected four quite different sectors for investigation. The mix included established as well as emerging sectors, large and small enterprises, sectors with established qualification pathways for artisans and technicians, as well as sectors where training is mostly informal and provided on the job.

What do the findings of the study tell us about skills planning that refer to artisan-training systems for the future?

In this, the final chapter, we consider the implications of the study's findings and use this as a basis for considering the policy question of what would make a good artisan-training system for the 21st century. The discussion and proposals are offered in an exploratory spirit and are intended to stimulate rather than pre-empt further discussion and debate.

Discussion: A demand-side view of work and qualifications futures for artisans and technicians

Will employers invest in education and training for artisans and technicians?

At first glance, it appears as if the findings of the study predict a vibrant training and development future. An increase in the general level of workplace literacy in terms of reading and writing in English, ICT (information and communications technology) expertise, and technical and social communication will lift the level of general education required for workplace entry. This, in turn, will lift the general education base available in and to workplaces for further training and development.

Participation in globalised markets and the resultant internationalisation of quality standards have a lot to do with workplace literacy expectations of the future in terms of fluency in internationalised technical vocabularies, ICT expertise and access to information. More participative internal organisational cultures and increased shop-floor contact with informed customers who have done their homework on the Internet prior to entering into purchasing negotiations will also be influential in terms of the communicative and technical competence expected of all employees.

A second trend that appears to emphasise an upskilling pattern refers to a deepening of the knowledge base required for the diagnostics and problem-solving tasks undertaken by artisans and tehcnicians in some sectors. Internationally benchmarked systems knowledge (K2) that is underpinned by formal education in mathematics and science (K4) is the new form of technical mastery required in workplaces. In terms of this trend, the depth and breadth of skills, knowledge and understanding required by a skilled employee will shift the focus from an emphasis on having a formal qualification for workplace entry to a concern about the form, content and level of knowledge and skill represented by such a qualification. Having a technical and vocational educational and training (TVET) qualification will no longer be sufficient – it is the connection between TVET and general education and schooling that shifts the educational requirement from a narrow focus on skills to a composite and broad understanding of different types of knowledge and skill.

This may turn out to be an overly optimistic scenario.

While growth trends in all sectors would seem to bode well for work and qualifications futures of artisans and technicians, it is significant that the three factors viewed by all sectors as having the highest potential positive or negative impact on future growth are all factors beyond the direct control of enterprises/employers. Business unease about the connection between the global economic climate, regional and local political stability and market volatility, linked to employment trends that anticipate a reduction in permanent or core staff and a drive towards cost savings through subcontracting, outsourcing and casualisation, do not paint an overly optimistic picture about sectoral intent to invest in training and development.

We need to link this trend to two other trends that provided warning signals. The first is the prediction of a shift to 'low-risk', routine and standardised work through mechanisation, automation and digitalisation. In this scenario, skilled work is often reduced to semi-skilled and even unskilled work.

The second is the continued predominance of on-job training, in-house and external short-course training as preferred employee-development pathways, with supplier-provided, equipment-related training as an emerging option. Neither of these trends sketches a work environment in which the technical mastery described in the first scenario is a necessary requirement for the majority of workers.

A conclusion that can be drawn is that business enterprise investment in formal education and training, even though indicated as a required future trend, will depend as much on the trust that the employers have in the formal education and training supply side as it will depend on strategic and financial decisions about whether to invest in people or in technology that can replace people.

Craft apprenticeships as a common thread

Two crucial differences between mechatronics (in engineering) and the other three sector studies have already been noted. The first is that mechatronics (as studied in engineering) refers to technical services and maintenance functions and not to direct production functions. It is 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. Work demarcations follow formal qualifications.

While the engineering or metal trades are often the focus of investigation in relation to artisan training, it is important to note the findings of the other three sector studies. The sector study on *mechatronics (in engineering)* indicates an upward shift in the conceptual knowledge base of mechatronics-related, artisan-type work in order to move it towards specialisation at the technician end of the engineering spectrum and away from the traditional artisanal trades, but 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 person called a 'baker' almost no longer exists 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 *Boat Building*, the boat builder as a person who requires expertise in all aspects of boat-building is emerging strongly as a preferred work and training model in an industry where production and design are moving closer together. An apprenticeship is currently under development. 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 down-skilled what were previously regarded as artisan-level jobs.

Implications of the continued value attached to all-round expertise are worth considering in terms of the importance it attaches to apprenticeship as a mode of learning. These findings are in line with international findings on the continued positive image held by the general public and by employers of 'apprenticeship' as a means of work-readiness preparation (Maguire 1999), and this despite the decline of opportunities for all-round expertise and a definite down-skilling trend towards routinised work. Studies have also found that employers 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).

So, what would a 'good artisan-training system' look like?

As in other countries, this study has shown work-related knowledge and skill to be complex and multifaceted, involving different and sometimes contradictory dimensions.

A good artisan-training system therefore needs to be a diversified system with multiple entry and exit points and different types of delivery. Single artisanal trade qualifications will not be sufficient. 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, or they may produce too low a level of expertise to satisfy the work needs of industry.

The recommendations that flow from these conclusions are that:

(1) Rather than continuing with a dual mode of delivery in terms of both apprenticeships and learnerships, 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.

(2) Different levels and types of apprenticeship will be required to serve the simultaneous coexistence of 'high-risk' and 'low-risk' work in the same sector and, sometimes, in the same workplace.

(3) A foundational apprenticeship should be introduced in all sectors. Foundational apprenticeships need not be tied to cutting-edge technology and equipment and need not require NSC (National Senior Certificate) pass marks in mathematics and science. All workers should be able to enter through a recognition-of-prior-learning (RPL) process. Successful achievement at this level will signal a baseline of knowledge and skills available to the sector.

(4) A foundational apprenticeship could be followed by an intermediate and/or advanced apprenticeship with more stringent entry requirements so as to provide sectoral progression pathways and developmental opportunities.

(5) Where necessary, bridging programmes may need to be introduced as a proxy for the continuity between school and TVET that is the marker of successful training systems at intermediate labour market levels in industrialised countries.

(6) In addition, formally registered and recognised short courses will need a definite space and integrity of their own. This type of provision, including the training offered by suppliers, will provide the narrower skills base required in routinised and highly standardised work environments. If courses and modules are arranged into recognised part or whole qualifications, the short-course route will provide a further training and articulation pathway for workers trained on the job who have achieved high levels of technical competence in specific areas but who do not have formal 'trade papers' that allow labour market mobility.

Conclusion

Many more implications of the study could be drawn out and proposals put forward. The intent of this chapter was not to attempt to offer exhaustive recommendations, but rather to show the important contribution to systems planning that can be made by limited, qualitative sector studies. Cumulative research of this nature could provide an important resource for the interpretation of macro-trends identified in quantitative, model-based projections and/or employer surveys. 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 the starting point, but refers to actual work processes and their differences in large and small enterprises.

REFERENCES

Bohlinger S (2007/2008) Competences as the core element of the European Qualifications Framework. *European Journal of Vocational Training* 42/43: 96–112

Braham P (1992) The divisions of labour and occupational change. In J. Allen, P.Braham & P. Lewis (Eds). *Political and Economic Forms of Modernity.* Cambridge: Polity Press in association with The Open University.

Brown A & Keep E (1999) *Review of vocational education and training research in the United Kingdom*. Brussels: European Commission

Castells M (2001) The new global economy. In J. Muller, N. Cloete & S. Badat (Eds). *Challenges of Globalisation: South African debates with Manuel Castells.* Cape Town: Maskew Millar Longman.

Collins R (1992) Sociological insight: an introduction to non-obvious sociology. Second edition. New York: Oxford University Press.

Davidson V (2015) Work and qualifications futures for artisans and technicians. Sector report: boat building (trade 684907 boat builder and repairer). Unpublished research report. Labour Market Intelligence Partnership. Human Sciences Research Council.

Deissinger T (1994) The evolution of the modern vocational training systems in England and Germany: A comparative view. *Compare* 24(1): 17–36

DHET (Department of Higher Education and Training) (2013) *White Paper for post-school education and training: Building an expanded, effective and integrated post-school system*. Pretoria: DHET.

Dowling P (1998) *The sociology of mathematics education: mathematical myth/pedagogic texts*, London: The Falmer Press.

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

Fuller A & Unwin L (2011) The content of apprenticeships. In: T Dolphin & T Lanning (Eds), *Rethinking apprenticeships.* London: Institute for Public Policy Research, pp.29–39

Gallagher J (2015) Work and qualifications futures for artisans and technicians. Sector report: Film production (camera assistant). Unpublished research report. Labour Market Intelligence Partnership. Human Sciences Research Council.

Gamble J (2012) Models and pathways to institutionalise apprenticeships. LMIP Working Paper 30. Available at http://www.lmip.org.za

Garisch C (2015) Work and qualifications futures for artisans and technicians. Sector report: engineering (trade 671203 mechatronics technician). Unpublished research report. Labour Market Intelligence Partnership. Human Sciences Research Council

Green A (1995) Technical education and state formation in nineteenth century England and France. *History of Education*, 24, 2, 123-139.

Kruss G, Wildschut A, Janse Van Rensburg D, Visser M, Haupt G & Roodt J (2012) Developing skills and capabilities through the learnership and apprenticeship pathway systems. Project Synthesis Report. Assessing the Impact of Learnerships and Apprenticeships under NSDSII. Pretoria: Human sciences Research Council.

Layton D (1993) Science education and the new vocationalism. In: E W Jenkins (Ed.), *School science and technology: Some issues and perspectives.* Centre for Studies in Science and Mathematics Education, University of Leeds

Lewis J (1984) *Industrialisation and trade union organisation in South Africa, 1924–55*: *The rise and fall of the South African Trades and Labour Council*. Cambridge: Cambridge University Press

Lundall P (1998) The erosion of apprenticeship training in South Africa. Paper delivered at the 10th world congress of the World Council of Comparative Education Societies, Cape Town, July.

Maguire M (1999) Modern apprenticeships? Just in time, or far too late? In: P Ainley & H Rainbird (Eds), *Apprenticeship: Towards a new paradigm of learning.* London: Kogan Page

Marx K (1976) *Capital: Volume 1.* Paperback edition, London: Penguin Books.

Medway P (1993) Issues in the theory and practice of technology education. In E W Jenkins (Ed.), *School science and technology: Some issues and perspectives.* Centre for Studies in Science and Mathematics Education: University of Leeds

Ouye J (2011) Five Trends that are dramatically changing work and the workplace. Knoll Workplace Research.

Pye D (1968) *The nature and art of workmanship.* Cambridge: Cambridge University Press

Sohn-Rethel A (1978) *Intellectual and manual labour: a critique of epistemology.* London and Basingstoke: The MacMillan Press Ltd.

Spies M (2015) Work and qualifications futures for artisans and technicians. Sector report: tourism and hospitality (trade 681201 confectionary baker). Unpublished research report. Labour Market Intelligence Partnership. Human Sciences Research Council.

Stewart J & Sambrook S (1995) The role of functional analysis in national vocational qualifications: A critical appraisal. *British Journal of Education and Work* 8(2): 93–106

Tennison C (2014) Historical shifts in knowledge, skill and identity in the South African plant baking industry: implications for curriculum. Unpublished Masters dissertation. University of Cape Town.

Thompson P (1989) *The nature of work.* London: MacMillan.

Webster E (1985) *Cast in a racial mould: labour process and trade unionism in the foundries.* Johannesburg: Ravan Press.

Wheelahan L (2008) Can learning outcomes be divorced from processes of learning? Or why training packages make very bad curriculum. Paper presented at the VET in Context: 11th Annual Australian Vocational Education and Training Research Association Conference. Available at https://avetra.org.au/AVETRA%20WORK%2011.04.08/CS1.1%20-%20Leesa%20Wheelahan.pdf

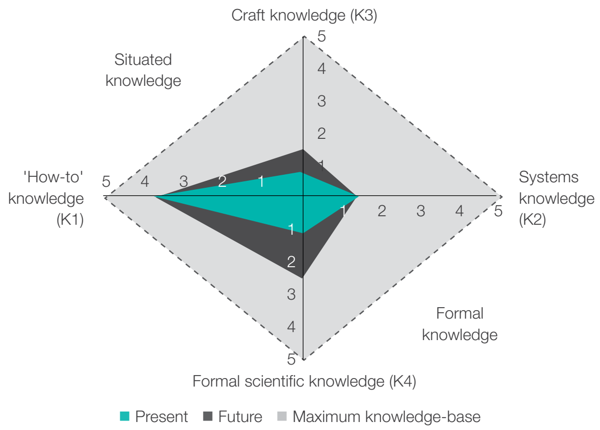
Wolf A (2002) *Does education matter? Myths about education and economic growth.* London: Penguin Books.

ANNEXURES

ANNEXURE A: BAKING

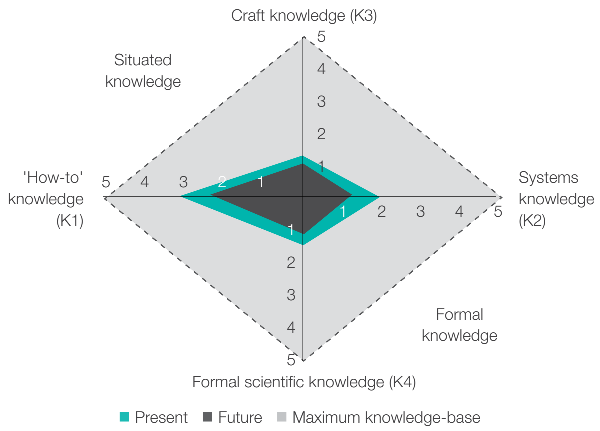
KNOWLEDGE BASE TREND ANALYSIS

BAKING (Small firms)



(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

BAKING (Large/Medium firms)



(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

COMPOSITE KNOWLEDGE BASE TREND ANALYSIS

K1 'HOW-TO' KNOWLEDGE (SPECIFIC PROCEDURES)

BAKING Overall average	Current 3.6	Future 3.3	SMALL SITES Average	Current 3.8	Future 3.8	LARGE SITES Average	Current 3.2	Future 2.5

K2 SYSTEMS KNOWLEDGE (GENERAL PROCEDURES)

BAKING Overall average	Current 1.6	Future 1.4	SMALL SITES Average	Current 1.4	Future 1.4	LARGE SITES Average	Current 2.0	Future 1.3

K3 CRAFT KNOWLEDGE (SPECIFIC PRINCIPLES)

BAKING Overall average	Current 1.0	Future 1.3	SMALL SITES Average	Current 0.8	Future 1.5	LARGE SITES Average	Current 1.2	Future 1.0

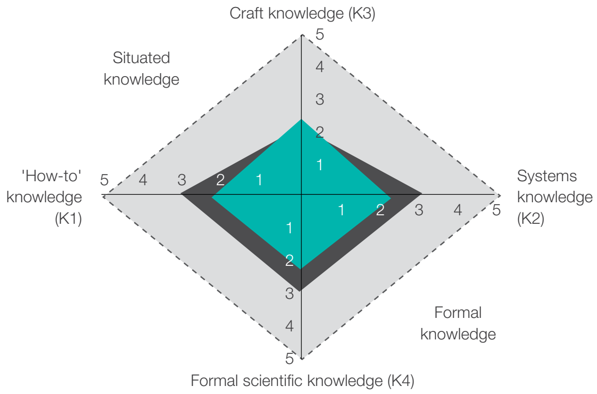
K4 FORMAL SCIENTIFIC KNOWLEDGE (GENERAL PRINCIPLES)

BAKING Overall average	Current 1.3	Future 2.1	SMALL SITES Average	Current 1.2	Future 2.7	LARGE SITES Average	Current 1.5	Future 1.2

ANNEXURE B: BOAT BUILDING

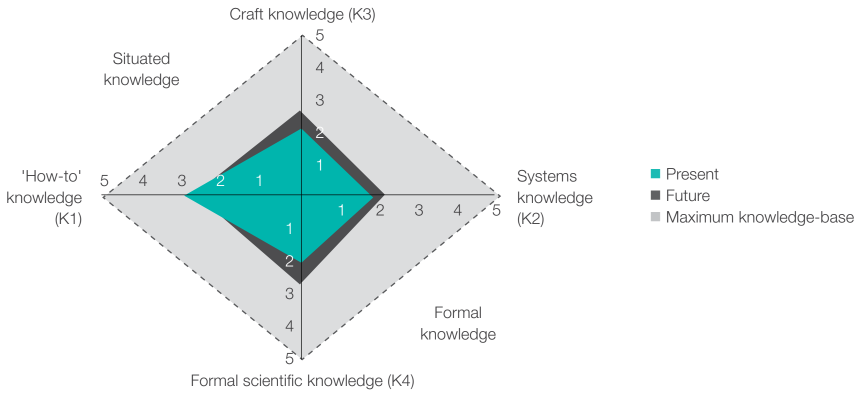
KNOWLEDGE BASE TREND ANALYSIS

BOAT BUILDING (Small firms)



■ Present ■ Future ■ Maximum knowledge-base
(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

BOAT BUILDING (Large/Medium firms)



■ Present ■ Future ■ Maximum knowledge-base
(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

COMPOSITE KNOWLEDGE BASE TREND ANALYSIS

K1 'HOW-TO' KNOWLEDGE (SPECIFIC PROCEDURES)

BOAT BUILDING Overall average	Current 2.6	Future 2.9	SMALL SITES Average	Current 2.3	Future 3.1	LARGE SITES Average	Current 3.0	Future 2.7

K2 SYSTEMS KNOWLEDGE (GENERAL PROCEDURES)

BOAT BUILDING Overall average	Current 2.1	Future 2.6	SMALL SITES Average	Current 2.3	Future 3.1	LARGE SITES Average	Current 1.8	Future 2.2

K3 CRAFT KNOWLEDGE (SPECIFIC PRINCIPLES)

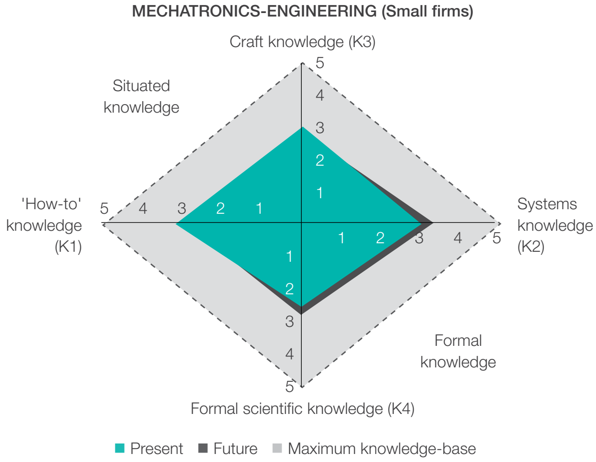
BOAT BUILDING Overall average	Current 2.3	Future 2.3	SMALL SITES Average	Current 2.5	Future 2.0	LARGE SITES Average	Current 2.2	Future 2.6

K4 FORMAL SCIENTIFIC KNOWLEDGE (GENERAL PRINCIPLES)

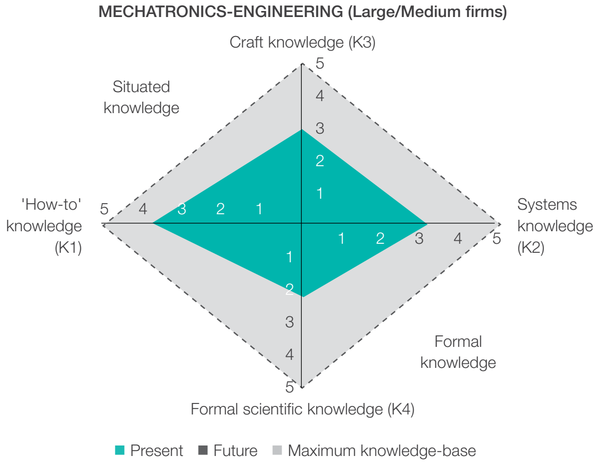
BOAT BUILDING Overall average	Current 2.1	Future 2.9	SMALL SITES Average	Current 2.2	Future 3.0	LARGE SITES Average	Current 2.1	Future 2.8

ANNEXURE C: MECHATRONICS (IN ENGINEERING)

KNOWLEDGE BASE TREND ANALYSIS



(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')



(1 = 'not at all'; 2 = 'not often'; 3 = 'fairly often'; 4 = 'often'; 5 = 'very often')

COMPOSITE KNOWLEDGE BASE TREND ANALYSIS

K1 'HOW-TO' KNOWLEDGE (SPECIFIC PROCEDURES)

MECHATRONICS Overall average	Current 3.5	Future 3.2	SMALL SITES Average	Current 3.3	Future 2.8	LARGE SITES Average	Current 3.8	Future 3.8

K2 SYSTEMS KNOWLEDGE (GENERAL PROCEDURES)

MECHATRONICS Overall average	Current 3.0	Future 3.0	SMALL SITES Average	Current 2.9	Future 3.3	LARGE SITES Average	Current 3.2	Future 3.3

K3 CRAFT KNOWLEDGE (SPECIFIC PRINCIPLES)

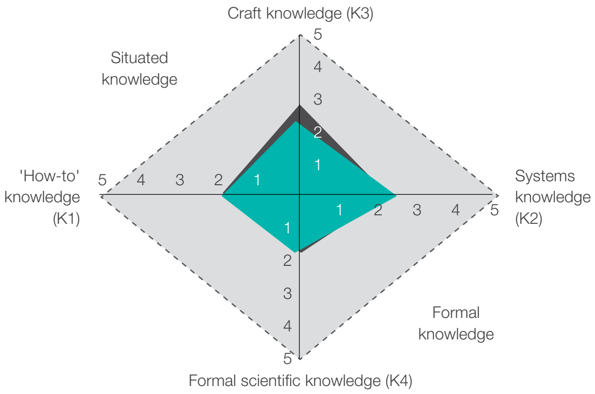
MECHATRONICS Overall average	Current 3.0	Future 3.1	SMALL SITES Average	Current 3.0	Future 3.0	LARGE SITES Average	Current 3.0	Future 3.0

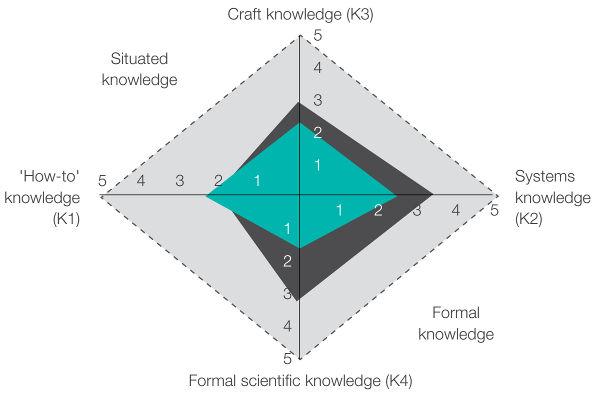
K4 FORMAL SCIENTIFIC KNOWLEDGE (GENERAL PRINCIPLES)

MECHATRONICS Overall average	Current 2.3	Future 2.5	SMALL SITES Average	Current 2.4	Future 2.8	LARGE SITES Average	Current 2.3	Future 2.2

ANNEXURE D: FILM PRODUCTION

KNOWLEDGE BASE TREND ANALYSIS





COMPOSITE KNOWLEDGE BASE TREND ANALYSIS

K1 'HOW-TO' KNOWLEDGE (SPECIFIC PROCEDURES)

FILM PRODUCTION Overall average	Current 2.1	Future 2.0	SMALL SITES Average	Current 1.9	Future 2.0	LARGE SITES Average	Current 2.4	Future 2.0

K2 SYSTEMS KNOWLEDGE (GENERAL PROCEDURES)

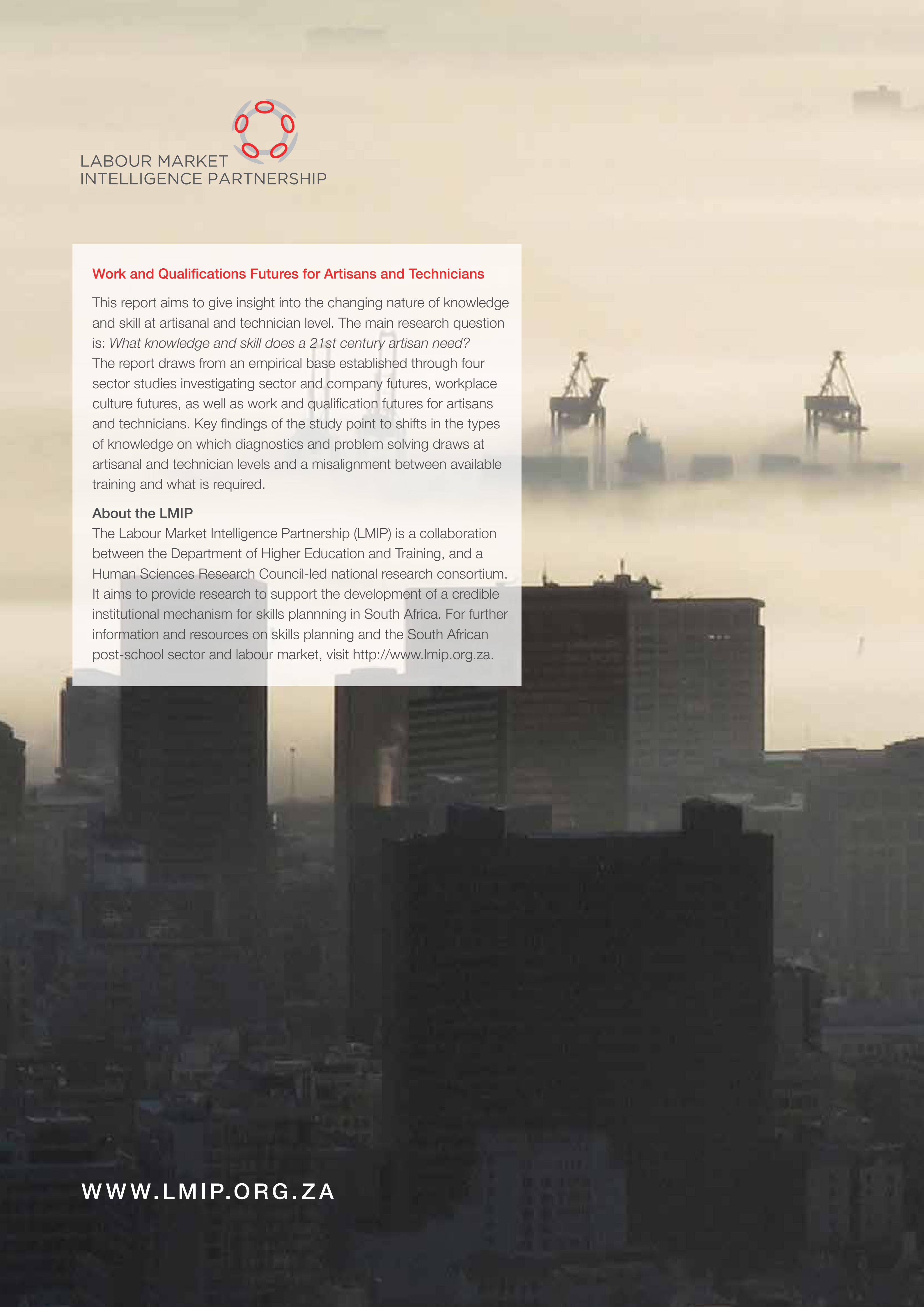
FILM PRODUCTION Overall average	Current 2.6	Future 2.9	SMALL SITES Average	Current 2.6	Future 2.3	LARGE SITES Average	Current 2.5	Future 3.5

K3 CRAFT KNOWLEDGE (SPECIFIC PRINCIPLES)

FILM PRODUCTION Overall average	Current 2.3	Future 2.9	SMALL SITES Average	Current 2.3	Future 2.9	LARGE SITES Average	Current 2.3	Future 2.9

K4 FORMAL SCIENTIFIC KNOWLEDGE (GENERAL PRINCIPLES)

FILM PRODUCTION Overall average	Current 1.8	Future 2.6	SMALL SITES Average	Current 1.8	Future 1.8	LARGE SITES Average	Current 1.7	Future 3.4



LABOUR MARKET
INTELLIGENCE PARTNERSHIP

Work and Qualifications Futures for Artisans and Technicians

This report aims to give insight into the changing nature of knowledge and skill at artisanal and technician level. The main research question is: *What knowledge and skill does a 21st century artisan need?* The report draws from an empirical base established through four sector studies investigating sector and company futures, workplace culture futures, as well as work and qualification futures for artisans and technicians. Key findings of the study point to shifts in the types of knowledge on which diagnostics and problem solving draws at artisanal and technician levels and a misalignment between available training and what is required.

About the LMIP

The Labour Market Intelligence Partnership (LMIP) is a collaboration between the Department of Higher Education and Training, and a Human Sciences Research Council-led national research consortium. It aims to provide research to support the development of a credible institutional mechanism for skills planning in South Africa. For further information and resources on skills planning and the South African post-school sector and labour market, visit http://www.lmip.org.za.

WWW.LMIP.ORG.ZA