INTEGRATING NEWCOMERS

Join Canada's construction workforce.

British Columbia Construction Association

Integrating Newcomers

A comparison of British Columbian and South African millwrights

OS Consulting Inc.

30 March 2016

Funded by:

Immigration, Refugees and Citizenship Canada

Financé par :

Immigration, Réfugiés et Citoyenneté Canada

Contents

List of Tables

List of figures

Summary

A category pulls together many phenomena in a manner that benefits the creature in whose mind it resides. It allows invisible aspects of objects, actions, and situations to be "seen". Categorization gives one the feeling of understanding a situation one is in by providing a clear perspective on it, allowing hidden items and qualities to be detected … future events anticipated … and the consequences of actions to be foreseen. Categorization thus helps one draw conclusions and to guess about how a situation is likely to evolve.

Hofstadter and Sander[1]

Introduction

The British Columbia Construction Association (BCCA), through its *Integrating Newcomers* initiative, is interested in establishing equivalencies and identifying gaps between South African credentials and Canadian (specifically BC) credentials.

This paper compares the training and certification of British Columbia (BC) and South African Industrial Mechanic / Millwrights. Where possible 6 kinds of programs were taken into account, namely:

- British Columbia apprenticeship program
- British Columbia "Challenger" program
- South African NC (V), TVET[2] (college-based)
- South African Section 26 (D)[3] (time-bound apprenticeship)
- South African Learnership/NC (employment-based, not time-bound, work-school program)
- South African Section 28 (Recognition of Prior Learning: RPL)

These programs lead to a single credential in each country. The BC programs lead to the Red Seal endorsement. The South African programs lead to a Level 4 Trade Certificate, which, interestingly is also called "red seal". Note, however, that RPL achievers sometimes receive a credential with a different name, for example "certificate" instead of "diploma".

Methodology

We conducted the comparisons using documents from three sets sources: BC's Industry Training Authority and Ottawa's Red Seal websites for Canadian content - Program Overview and Challenge process and requirements, and the NOA, Essential Skills, and Ellis Chart, respectively. And for South African materials, we consulted the TVETs, QCTO, HET, SAQA, CETA, and NAMB[4] websites – these cover (roughly) technical colleges, quality assurance, higher education, qualifications levels, construction education and training sector, and testing, respectively.

---

[1] Douglas Hofstadter and Emmanuel Sander (2013); *Surfaces and Essences*, Basic Books, p.14,

[2] TVET stands for colleges that offer Technical and Vocational Education and Training (TVET replaces the term FET (colleges): Further Education and Training)

[3] Refers to Section 26 (D) of the Skills Development ACT (SDA)

[4] QCTO stands for "Quality Council for Trades and Occupations"; HET (a ministry) stands for "Higher Education and Training"; SAQA stands for "South African Qualification Authority"; CETA (a sector council) stands for "Construction Education and Training Authority; and NAMB stands for "National Artisan Moderation Body"

The comparison is in four parts: First Impressions, Essential Skills, Comparing Program Levels, and Examinations and Certification. In First Impressions we used the documents to conduct a meta-analysis: we wanted to know about similarities and differences in philosophies, program delivery, length, organization, emphasis and high level content. In Essential Skills, we rated each program against each essential skill to represent the likelihood that a graduated Industrial Mechanic / Millwright had mastered the skill. In Program Levels we rated each program against the BC/ITA's Program Overview elements, rating first the general areas of competence then the competencies. And in Examinations and Certification we compared the formal requirements for certification, examinations, and the certification granted. We discuss briefly the structure of examinations, problems associated with the examinations, and the validity and reliability of these examinations.

We created two tools to help us with these tasks. We developed a 10-point rating system color-coded to indicate rough safety and training implications, and cross-referenced to the South African ratings. And we developed a glossary of terms to reflect how we understood training, testing, and certification terms in English and South African.

Findings

There are 2 interesting aspects to the "generic" findings we gloss on below: the South African training and certification system, and the knowledge, skills, and abilities of holders of the South African millwright credential.

The training and certification system

The trades training and certification system in South Africa has been in flux since 1998 when a new Act came into force. As it is now, it is a complicated, yet-to-be-finalized system with many interlocking agencies sharing in the creation, specification, implementation, delivery, and testing activities for any tradesworkers/artisans training program. It is however, a national system so intra-jurisdictional issues, like those commonly encountered in Canada, do not apply.

The system before 1998

Before 1998, apprentices were formally indentured (under Section 13) to a single employer for the duration of the apprenticeship. Apprentices employed by companies under Section 13, would complete N-courses to cover the trade theory component at public or private Technical and Vocational Education and Training (FET/TVET) Colleges, and do their practical training at Sector Education and Training Authority (SETA) / Quality Council for Trades and Occupations (QCTO)-accredited skills development providers.

Certification was awarded by SETAs (and the Department of Labor then HET) after completing all of the requirements and within the period of indenture. Since October 2013, the QCTO issues all Trade certificates.

Unlike apprentices, workers using the RPL route (a.k.a. Section 28 candidates) did not have to collect all of their work experience in a prescribed period of time but would have to pass the same final trade tests as the apprentices.

The system after 1998 (mainly in the past decade)

In 2009, HET was established and SETAs – who have "delivered" learnerships since 2000 - and FETs/TVETs became part of the legislative competence of HET as a starting point in changing tradesworker/artisan development in South Africa. The NQF Act replaced the SAQA Act of 1995 and three Quality Councils[5] were established to replace the previous Education and Training Quality Assurance (ETQA) function. QCTO is now responsible for quality assurance and the certification process for new trade and occupational qualifications.

QCTO appoints industry partners to coordinate the development of the requirements and related documentation and specifications for the training of tradesworkers/artisans. And NAMB has the statutory to develop Trade Tests for all the trade qualifications once registered by SAQA.

Once a candidate complies with the above-mentioned, he/she will be allowed access to an external integrated summative assessment (the trade test) conducted at any QCTO accredited Trade Test provider.

Impacts of the changes

Since the acceptance of a competency-based model for education and training in 1985, South Africa has been steadily moving towards a full NVQ system like that of the United Kingdom for the training tradesworkers/artisans. This move was – and still is - to counter the traditional time-based apprenticeship approach and places greater reliance on modular "applied competence", that is the ability to perform in the appropriate context, rather than having been in the trade for a defined length of time and attending a fixed number of hours of in-school training.

Starting in 1994, this philosophy has led to the creation and refinement of a 10-point National Qualification Framework (NQF), and pegging tradesworkers/artisans training and certification to this framework by registering the qualifications' requirements and testing parameters.

This approach makes comparisons with competency-based systems that are more time-focused, like in British Columbia, difficult – there is scant mention of time in the documentation beyond "months". And it also makes comparisons difficult as the match between South African registered qualifications within a program might not all be at the same NQF level, or match one-to-one competencies listed in British Columbian documents.

Knowledge, Skills, and Abilities (KSA)

The South African Millwright is an able general Industrial Mechanic / Millwright with advanced electrical/electronic skills and electric motors but short on other Prime Mover technologies. And a just-graduated South African Millwright, regardless of route, will be short of time in the trade when compared to a British Columbia Industrial Mechanic / Millwright. The exception might be a South African RPL graduated Industrial Mechanic / Millwright, who might have had to collect many hours on the job in order to qualify for the final examinations.

[5] The other 2 QCs are UMALUSI (Council for Quality Assurance of General and Further Education and Training), and CHE (Council on Higher Education)

In all cases, the South African Millwright has attended "school" for much longer periods of time: 3 years for the NC(V) graduate, 12+ months for the apprentice, and 18 months for the learnership graduate. This compares to 7 months for BC graduate of the apprenticeship system and no school at all for the Challenger (the same is true, usually, for a South African RPL graduate). That is because in South Africa, the NC(V) and apprentice Millwrights are expected to take general math, science, and English in addition to trade-specific courses and shop and field work. By contrast, BC apprentices enter the block release training system usually after they exit the K-12 system, and the Challengers do not take any formal training that we know of.

The South African millwright program strongly emphasizes hand skills. For example, the NC(V) program is split 60:40 shop:theory. With some topics covered in major part in the shop, e.g. design and construction of pneumatic circuits, fault-finding on hydraulic systems, etc.

The South African program elements are extremely detailed and very prescriptive as they are aligned to registered sub-qualifications, each of which is tested independently and by outside/accredited assessors.

In BC, there is a tacit "exchange rate" between hours on the job and hours at school; in BC the schooling for apprentices is short and the hours are costly. Whereas in BC one can exchange work hours for school hours – it is the basis of the challenge process, in South Africa, essential schooling must be taken regardless of work hours and route taken. And BC apprentices' and Challengers' most onerous program component is hours on tools, roughly the opposite of the South African approach.

In both BC and South Africa, certification is granted on the strength of one or several examinations. In BC, it is a single summative paper and pencil exam, accessed once the training institutions' formative tests (soon to be standardized paper-and-pencil tests) have been passed. In South Africa a comprehensive battery of formative written and practical tests throughout the training program, and a summative set of tests at the conclusion of the training.

Gaps

The gaps we flag below are those for a South African Millwright coming to BC. Throughout the analysis, we make the trivial point that, for some of the gaps like health and safety, a BC Industrial Mechanic / Millwright moving to South Africa would show the same gap. Notwithstanding this fact, the gap analysis would have yielded substantially different results if we had conducted using either the NOA or the South African program as a reference rather than the BC apprenticeship program overview. But these differences could be attributed, in part, to structural differences in the documentary sources used.

Language

Despite the English requirement in the South African program, a South African Millwright, while possibly competent in basic English, might lack the technical language skills or "jargon" of the trade in BC – and s/he will not be familiar with some of the common Prime Movers such as internal combustion engines or turbine-related language. This language gap might be more or less pronounced depending on the dominant working language at work (there are 11 official languages in South Africa) – school programs appear to be delivered in English.

Health and safety

Health and Safety legislation, regulations, and their implementation seem similar in South Africa and in British Columbia, although OSH is a Ministry of Labour activity there as opposed to an independent regulator here. While there are similarities at the personal level (e.g., Personal Protective Equipment (PPE), Fall Arrest, etc.), at the worksite level (e.g., dust, asbestos, noise, etc.), and at the application of the regulations, a South African Millwright would miss the differences between the South African approach and the BC approach, probably on account of those similarities.

Codes and standards

Like Health and Safety, building codes and standards are (often) jurisdiction-specific. A South African Millwright coming to BC would be fully aware that there are codes and standards, would know how to look things up, would know how to apply code and standards requirements to his or her work, but would not know the specifics of the codes and standards that pertain in BC.

Measurement system

South Africa is a MKS or metric country. South African Millwrights do not know the FPS or imperial system (save for the "S" of second). BC Industrial Mechanic / Millwrights work in both imperial and metric; even the Red Seal exam provides all dimensions in both metric and imperial systems. And BC Industrial Mechanic / Millwrights use lifting and hoisting equipment that is tested and tagged in imperial (if it is from the United States), use imperial load charts, and calculate their load limits using pounds.

Equipment installation

South African Millwrights install sub-assemblies, but do not appear to have to site, move, lift, install, align, and secure whole assemblies/machines.

Commissioning whole assemblies

South African Millwrights commission sub-assemblies, but do not appear to have to commission whole assemblies/machines.

Welding

South African Millwrights cut and weld using oxy-fuel equipment and Metal Arc (some) but do not appear to have any experience with plasma cutting Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), or Gas Tungsten Arc Welding (GTAW). South African Millwrights, however braze and solder – done as part of the advanced electrical/electronic training they take.

Prime movers

South African Millwrights have superior skills when it comes to electric motors. They do not, however cover combustion engines or turbines.

Secondary mover systems

South African Millwrights do not appear to deal with vacuum systems, compressors, fans, blowers, or conveyors at all.

Vibration analysis

South African Millwrights conduct equipment efficiency tests but these do not appear to include vibration analysis.

First impressions

In this section, we conduct gross comparisons between the South African and BC programs. We compare the programs' stated conceptions or philosophies, trade descriptions, credential worth, and program lengths and mixes. Throughout, we consider "just graduated" Industrial Mechanic / Millwrights as our subjects. We realize that all graduated Industrial Mechanic / Millwrights have had different learning trajectories most likely leading to different abilities, but, given the lack of profiling data – and the scope of this analysis – we have used published program content and standards as normative tools: all graduates of a program are the same.

Using the saw "an Industrial Mechanic / Millwright is an Industrial Mechanic / Millwright is an Industrial Mechanic / Millwright" or even "if it looks like an Industrial Mechanic / Millwright, talks like an Industrial Mechanic / Millwright, acts like an Industrial Mechanic / Millwright, then it must be an Industrial Mechanic / Millwright" to circumscribe what the trade is – for our purpose to be able to compare South African and British Columbian Industrial Mechanic / Millwrights – would be naïve at best, dissembling at worst.

But it allowed us to be in a position to conduct an analysis of the similarities and differences between the two programs / certifications. And we will be able to use this analysis to develop a set of recommendations to make the equivalencies (and differences) pertinent to Industrial Mechanic / Millwrights when they switch jurisdictions.

Program conceptions

Here we compare how the Canadian and South African education and training and governmental institutions apprehend their trade learners and, ultimately, grant them a credential. Beyond the face value of, say, a South African Trade Certificate/"red seal" or a CofQ, the credentials carry a social worth that is a direct legatee of the philosophy and pathway that led to the credential. Expressions such as "book learning" or "academic", especially when used as a qualifier adduced to a credential, have currency in the world of trades, where it is not valued as highly as "on-the-job" – and this credential social depreciation is levelled from both in-school and on-the-job perspectives.

The fact that there is a social value attached to credentials is based on the assumption that different paths taken to a credential, job, or career yield a different, in our case, Industrial Mechanic / Millwright. And to the extent that this difference goes beyond presence or absence of skills, it makes for a different tradesperson notwithstanding personality traits.

A stated goal of education in South Africa, and artisan training programs are no exception, is directed at employment (or at the very least at reducing unemployment). Fixed term South African apprenticeship contracts obligate the employer to hold on to the indentured apprentice for the duration of the training, a thing that has become harder as economic conditions in South Africa have deteriorated. The NC(V), and especially the Learnerships are a response to these economic drivers. The South African programs, in general, are a mean to get younger leaners (between 16 and 25; learnerships, animated by the SETAs

will consider learners of up to 35 years) a better chance to get a job. By contrast, in BC, apprenticeships are not single-employer obligate and the system is more geared at providing theoretical underpinnings in a trade to current workers than trying to find training berths for the unemployed (this is by no means an absolute).

The South African programs are all education and training-dominant, and industry training requirements are to anchor this training, as well as ensure employability. By contrast, the BC system (and we assume, by association, other Canadian jurisdictions) is based on workplace skills obtained through the job, and training, when taken, is meant to elucidate these practical, workplace skills. We could see the two systems as a Janus analog: the training programs are what separates the two faces, they are the gate or door to the world of work as a tradesworker/artisan; looking forward to employment in South Africa and looking back to work done in BC.

The South African system deals with plain, full time students or students who are chipping away at the requirements, all hoping to qualify for full-time, steady, well-paid jobs. By contrast, the BC system deals with workers who happen to be released from work for in-school training at variable intervals.

Table 1. Rough comparison of some of the conceptions of South African and BC programs

Component	South African program	BC Program
Program aim	Employment	Skilled worker
Training approach	Theory and shop + jobsite	Practice
Training emphasis	Employability skills	Hand skills
Training regimen	Lock-step, qualifications-based	Open
Training delivery	Alternating (apprenticeship)	Block release (apprenticeship)
	Modular alternating (learnership)	
	Full time school + OJT	
Training duration	2.5, 3, 4.5 years	4 – 5 years[6]
Main training vector	Classroom + shops (NC(V))	Work / jobs
Learner status	Employee under contract (apprenticeship)	Employee (apprenticeship)
	SETA sponsored	
	TVET student	
Credential	National	Provincial + national endorsement
Pass / Completion rates	39.3% (2012)[7]	45%

[6] http://www.statcan.gc.ca/pub/81-004-x/2010002/article/11253-eng.htm accessed 3 December 2015

[7] http://www.dhet.gov.za/DHET%20Statistics%20Publication/Statistics%20on%20Post-School%20Education%20and%20Training%20in%20South%20Africa%202012.pdf accessed 23 March 2016

What is an Industrial Mechanic / Millwright?

Taking for granted that not all Industrial Mechanic / Millwrights are absolutely equal when they graduate, we can nevertheless "pretend" that they are and that they are thus solely due to the different training pathway they've taken. This approach will allow us to conduct rough and more detailed analyses of the similarities and differences between the two programs and certifications.

To illustrate this point, here are (excerpt of) definitions of "Industrial Mechanic / Millwright" which we found in the three (+) major sources of information we've used in this report:

- Industry Training Authority (ITA) - British Columbia
  - Millwrights install, repair, overhaul and maintain machinery and heavy mechanical equipment, such as conveyor systems in diverse settings including repair shops, plants, construction sites, mines, logging operations, ski hills and most production and manufacturing facilities. Millwright is designated as Industrial Mechanic (Millwright) under the Inter-provincial Red Seal program. Millwrights also perform routine maintenance activities, such as cleaning and lubricating equipment, adjusting valves and seals, and investigating breakdowns. (Industry Training Authority, "ITA", Industrial Mechanic (Millwright) webpage, accessed 29 March 2016)
  - Millwright" means a person who dismantles, moves, installs, lays out, repairs, commissions, overhauls, and maintains all machinery and heavy mechanical equipment, including power transmissions, conveyors, hoists, pumps compressors, alignment, fluid power and vibration analysis. (Industry Training Authority, "ITA", Industrial Mechanic / Millwright Program Outline, 2013)
- National Occupational Analysis (NOA) - (Canadian / federal)
  - Industrial mechanics (millwrights) work on industrial machinery and mechanical equipment and components. This equipment may include mechanical, pneumatic, hydraulic, fuel, lubrication, cooling and exhaust systems and equipment. Some components worked on include pumps, fans, tanks, conveyors, presses, generators, and pneumatic and hydraulic controls.
    Industrial mechanics (millwrights) are responsible for assembling, installing, aligning, maintaining, repairing, troubleshooting, inspecting, dismantling and moving this machinery and equipment. Troubleshooting may include diagnosing irregularities and malfunctions, making adjustments, and repairing or replacing parts. Cleaning, adjusting and lubricating machinery are also important maintenance tasks of this trade.
    Other tasks that may be performed in this trade include welding, cutting, rigging and machining as required. Industrial mechanics (millwrights) may prepare bases for equipment.
    Hoisting and lifting equipment such as cranes, jacks and forklifts is commonly used to position large machines or machine parts. … (Employment and Social Development Canada, National Occupational Analysis - Industrial Mechanic / Millwright, "NOA", 2013)
- QCTO (2014)
  - A Millwright installs, maintains, troubleshoots and repairs stationary industrial machinery in production and manufacturing environments.
    Alternative titles used by Industry: Electro Mechanician, Ground Electro Mechanician, Machine Tool Millwright, Millwright (Electromechanician)

- SAQA (2015; Qualification 23663 - National Certificate: Millwright, NQF Level 4)
    - This qualification is intended for application in the mining industry, and has a primary operational application in the engineering field.
      Recipients of this qualification, in one of the specialisation areas, are able to conduct the essential operations associated with engineering maintenance, repairs, manufacturing and trouble shooting in any one of the following specialisation areas: Metalliferous, Coal, Diamonds, and Opencast.
      People credited with this qualification are able to:
        - Identify and use engineering tools and equipment
        - Trouble shoot on engineering plan and equipment
        - Maintain engineering equipment
        - Install engineering equipment
        - Repair engineering equipment
        - Manufacture engineering components
        - Understand environmental issues
        - Understand engineering processes
        - Communicate in an engineering environment

Rough comparisons – Trade description

Using the trade descriptions, we've tried to identify large qualitative differences between the Canadian, BC, and South African trade practices. The large differences can point to gaps that might be filled by upgrade training programs when Industrial Mechanic / Millwrights move from one jurisdiction to another.

Not all Industrial Mechanic / Millwrights are the same as we noted above. Regardless of jurisdiction, training and certification attest that a certain level has been reached at some time. But each Industrial Mechanic / Millwright's extant skill set will be a function of (i) his/her job experience(s) after the training, and (ii) the length of time since certification. We are calling this effect "skills erosion": a state of affairs due to the differential worker exposure to specific work practices over time.

South African Millwrights present an additional difficulty: not all qualifications/competencies that make up the credential are at the same NQF level. While the trade credential itself is at NQF Level 4, some constituent qualifications are at NQF Level 2 or 3 (e.g., "Fit, adjust and maintain industrial machinery" (NQF Level 2), "Diagnose, find and repair faults in industrial machinery" (NQF Level 3), etc.)

It remains that there are clearly identifiable areas in the Canadian programs such as specialized welding, most prime movers, whole assembly installation, conveyors, lubrication theory, etc., that are not explicitly part of the South African program – but they are mentioned under the heading "resources" or "applied knowledge" in some of the competencies.

Similarity – Work scope

All descriptions make it clear that Industrial Mechanic / Millwrights fix industrial machinery, usually in primary industries – a more marked factor in South Africa. And while BC Millwrights work on electric motors, they do not to the extent that the South African Millwrights do. In both jurisdictions millwrights are expected to fabricate parts that are not readily available, but the emphasis is different, more in South Africa, less in BC.

Similarity – Work drivers

Both Canadian and South African programs include the use of blueprints, schematics, and drawings to conduct their work.

Difference – Worker safety

Canadian documents emphasize site and personal safety, albeit not in the trade description itself. The Federal document refers the reader to the federal Workplace Hazardous Materials Information System (WHMIS) and to provincial Occupational Health & Safety (OH&S) regulations, while the BC document refers the reader to the WorkSafeBC website.

In contrast, the South African shop and on-the-job descriptions do not mention safety as such. The training programs have a theoretical component devoted to OSH requirements and practices.

An in-depth examination of the differences between the Canadian and South African approaches to safety at work from a training or certification perspective is beyond the scope of this analysis. However, given the similarities – albeit tailored to the South African work environment and practices - between the approaches, it is fair to say that South African workers starting to practice in a Canadian environment would not require top-to-bottom training in safety regulations and processes and on-the-job practices. Canadian workers moving into a South African environment would also require training mainly in the differences in at-work safety practices, and in the structural and legal aspects of worker safety.

Difference – Codes and Standards

Both BC and South African documents make reference to codes and standards. Clearly these will be different based on jurisdictions. But using codes and standards when at work is common practice and millwrights in both jurisdictions should be able to adapt quickly to “new” codes and standards.

Difference – Trade scope

South African Millwrights’ is more centered in electric motors and electronics than the BC Millwrights – besides the program documents, the alternate names under which South African Millwrights go are indicative of this fact. Consequently, South African Millwrights are not exposed to other prime movers such as internal combustion engines or turbines which are part of the BC Millwrights’ program.

South African Millwrights’ trade practices gaps when compared to BC extend to the material handling field where, for example, conveyors are not considered.

Difference – Welding

South African Millwrights make use of gas cutting and welding equipment, but much less of arc welding when compared to BC Millwrights. But South African Millwrights braze and solder as part of their extended training and field practice with electric motors and electronics; the BC Millwrights do not.

Difference – Lifting and hoisting

South African Millwrights do perform lifts but both the training and the practice appears to be restricted to small loads and as a somewhat marginal activity. By contrast, the BC Millwrights perform lifts and hoisting more frequently and with greater loads when they install whole machinery.

Difference – Assembly installation

South African Millwrights install sub-assemblies, but the program and trade descriptions are silent on the topic of siting, positioning, aligning, and leveling whole assemblies, a common practice for BC Millwrights.

Difference – Equipment diagnostics

South African Millwright's major testing and diagnostics is with electrical systems. By contrast, the BC Millwright is expected to be able to conduct predictive maintenance testing, vibration analysis, and rotating equipment balancing.

Rough Comparison – The credential's worth

The worth of a "ticket" is dual: that of having one in the first place, and that of the mean by which it was attained – what we could call an "acquisition value". Usually just having a ticket suffices. However, if any argument arises at as to the worth of the ticket, disagreements hinge on the acquisition value, usually to decrease the ticket's social value. The same holds for the experiential path taken to get the ticket; the reputational value of the employer or the projects worked on weigh heavily on the overall worth attached to the ticket.

As the "Program Conception" section above indicates, credentials appear to be more important economically (and perhaps societally) in South Africa than in BC where what a worker can do, based on his/her experience, usually trumps a "ticket". But the BC experience might not be the same as that in Canadian jurisdictions that have "compulsory trades" like Alberta; there, having a ticket – or being a registered apprentice - is necessary to practice.

Both in BC and in South Africa the credential is held for life. South African credentials, however, are better articulated than in BC and Canada when qualifications overlap trades – even if this is not eminently evident from our study. This is true for all South African pathways, with the exception perhaps of the RPL which sometimes yields an "equivalent" credential, i.e. is called something different.

Finally, South African credentials are issued by the national government and have currency everywhere in South Africa. By contrast, a BC Industrial Mechanic / Millwright may face different fees and processes depending on the Canadian jurisdiction he/she wants to have the BC credential recognized.

Rough Comparisons – Program mix and length

In British Columbia[8], there are 2 main paths to get certified as an Industrial Mechanic / Millwright: a formal course of study (apprenticeship), and an informal, workplace-based route (challenge) – for simplicity's sake, we have ignored the branching and bridging available to leaners along the way. The main differences between the two pathways are (i) the open-endedness of the workplace-based route, and (ii) the exchange of schooling for additional experiential hours. The exchange rate[9], as it were, is 3.93 hours of work for each hour of school (see Table 2 and Figure 1 below).

[8] We specify British Columbia because the requirements differ from jurisdiction to jurisdiction for apprenticeship from 3 years and 6000 (QC) hours to 4 years and 8000 hours (see Ellis Chart at http://www.ellischart.ca/home.jsp?lang=en); and for the challenge with undefined years and 9720 work hours in BC vs. 6 years, 9,600 hours, and proof of 70% trade skills in Manitoba.

[9] The exchange rate, normed to the BC requirements, is a rough temporal measure we used to equate on-job experience and in-school training. The exchange rate is calculated as $(H_A-H_C)/H_{IS}$, where H_A are on-job

In South Africa credentials are granted upon completion of a state-sanctioned program and state- and industry-sanctioned theoretical and practical examinations. There is no exchange rate since learners are expected to reach the same educational and practical goals, regardless of route, and since the examinations are similar.

Briefly, it seems that in British Columbia, school-based training is disesteemed - can be replaced wholly by workplace experience - but worth a lot, whereas in South Africa school-based training is a must, that can be replaced by workplace training only for RPL applicants – and workplace experience is highly structured and monitored: the workplace has to be approved by the relevant SETA and a completed and signed workplace log book is required to access qualifications examinations.

Comparing the programs and using the British Columbia exchange rate – comparing a South African credential[10] for BC, and norming to the minimum BC requirement for hours in the trade, The NC(V) shows a slight advantage (+0.56 year), whereas both of the other programs fall short. The best match, at this gross analytical level, is with the NC(V) credential acquired through a TVET route a +0.56-year[11] BC workplace overage equivalent. The Section 26(D) and learnership programs fall short (-0.62 and -2.04 years respectively) perhaps a reflection of the program overall duration more than anything else. We have to point out again that the timeframe of these programs is much looser than it is in BC since all of the qualifications are competence-based, and the ability of a learner to complete faster or slower than another learner could result in substantially different completion times, making the calculations we performed inaccurate.

Given the school-centric nature of South African programs, and taking into account some of the differences/gaps noted above, it seems that a school-based program supplemented by a structured workplace-based "practice" period for incoming South African Millwrights is the best approach.

Table 2. Program comparison in weeks, hours (adjusted for statutory holidays, BC workweek at 40 hrs; South African work week at 40 hrs) - with an exchange mechanism for workplace hours – Note that Red Seal CofQ stands for the challenge credential access.

	Jurisdiction				
	British Columbia		South Africa		
	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)	Section 26(D)	Learnership
Program Elements					
Duration (years)	4	5	4.5	2.5	3
Duration (weeks)	208	247.5	234	130	156
In-school (weeks/year)	7	0	21	19	24

apprenticeship hours, H_C are minimum required hours for a challenge (i.e. without attending school), and H_{IS} are total in-school hours during the apprenticeship.

[10] From here on we do not include the RPL-based credential as it there are no "standards" that allow for an easy comparison: each RPL credential is in a way unique, even if the holder has passed the examinations

[11] "Year" is defined loosely as 50 weeks (accounting for 2 weeks of annual vacation) each at 41.8 hours for a total hours of 2080 hours (the figure used for calculations in this part of the analysis) – hours at work are undefined / unregulated, in the sense of minima or maxima, save for obligations under the BC Labor Code and/or Collective Agreements for unionized workplaces. In-school for BC apprentices is nominally set at 30 hours/week but contact time may vary from institution to institution depending on Collective Agreement

	Jurisdiction				
	British Columbia		South Africa		
	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)	Section 26(D)	Learnership
In-school (total weeks)	28	0	96	48	72
In-school (total hours)	840	0	2880	1440	2160
At Work (hours/year)	1650	2080	667	1200	1000
At Work (total weeks)	165	247.5	75	75	75
At Work (total hours)	6600	9900	3000	3000	3000
Extra work hours		3300		0	
"Exchange rate"		3.93		0.00	
Extra school hours SA-CofA			2040		
Extra school hours NC(V) - Section 26(D)			1440		
Extra school hours NC(V) - Learnership			720		
BC Exchange rate value NC(V)			7237		
BC Exchange rate value Section 26(D)			5109		
BC Exchange rate value Learnership			2554		
NetBC workplace "value"	9900	9900	10237	8109	5554
Difference	0	0	517	-1611	-4166

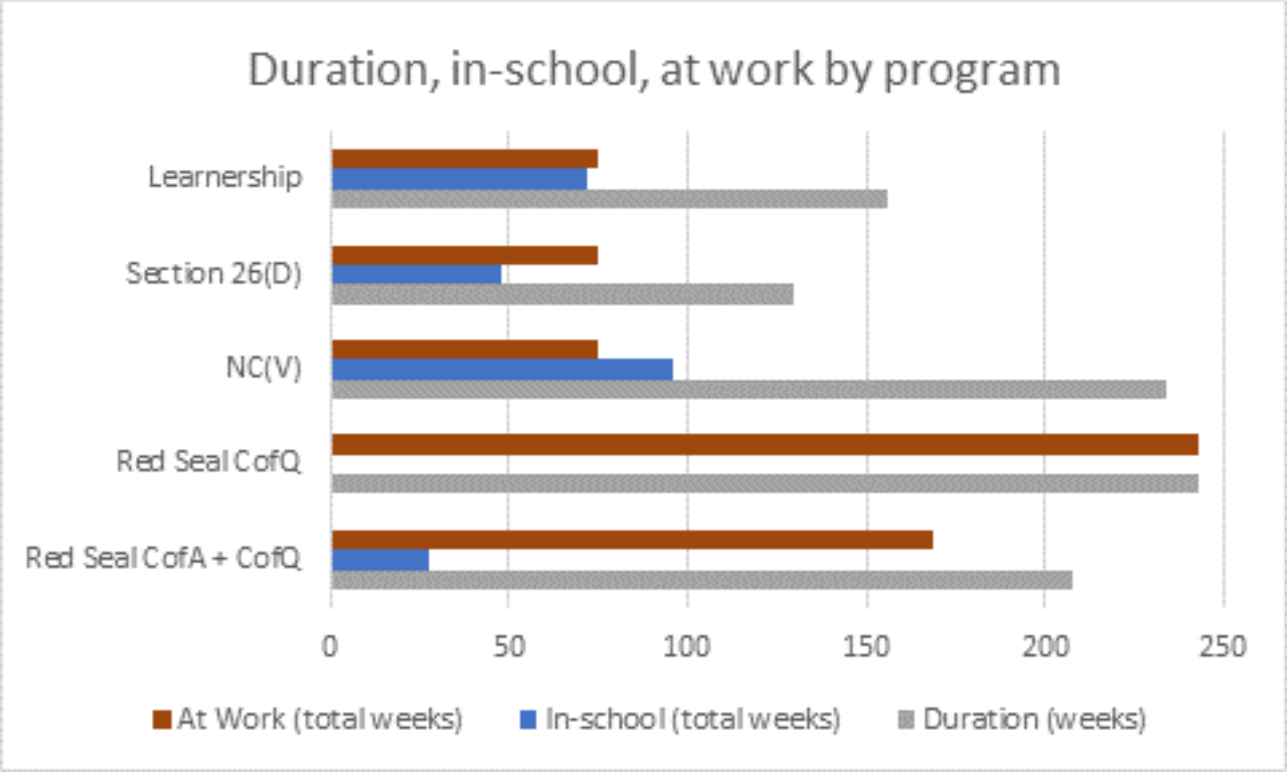

Figure 1. Comparison of program duration, in-school, and on-the-job length in weeks

Essential skills

What are "Essential Skills"?[12]

"Essential skills are the skills needed for work, learning and life. They are used in nearly every job and at different levels of complexity.
There are nine essential skills" (see Table 3):

Table 3. Essential skills defined at the Federal level

Skill	Description / Competency
Reading	Read short handwritten notes and text entries on forms, e.g. read short descriptions on maintenance forms of work completed and troubles encountered.
	Read instructions and warnings written on signs, labels and packaging, e.g. read labels affixed to cleaning fluids to learn first aid procedures.
	Read memos and notices, e.g. read memos to learn about scheduled power shutdowns, proposed meetings and upcoming health and safety workshops.
	Read trade journals, brochures and website articles to learn about new products and stay up-to-date on new technology.
	Read technical bulletins, e.g. read technical bulletins issued by manufacturers to learn how to troubleshoot equipment faults.
	Read a variety of operating, troubleshooting and repair manuals, e.g. read operating manuals to obtain assembly, repair and operating instructions for pumps, transmissions and other types of equipment.
	Read regulations and standards, e.g. read regulations and standards issued by the Technical Safety Standards Association and the Canadian Welding Bureau to learn about the regulations and code requirements that impact their work.
Document Use	Scan labels on product packaging, equipment, drawings and panels to locate specifications, voltages and identification numbers.
	Observe warning signs and symbols.
	Locate data in lists, tables and schedules.
	May interpret graphs.
	Enter data into a variety of forms.
	Locate data, such as specifications, classifications and material coefficients, in complex tables.
	Interpret complex schematic drawings.
	Study complex scale drawings.
Numeracy	Take measurements of dimension and temperature using common measuring tools, such as rulers, tapes and thermometers.
	Compare measurements, such as temperature, pressure and rotations per minute, to acceptable ranges.
	Estimate weights and distances.
	May calculate expense claims for tools and supplies and for travel to remote work

[12] http://www.red-seal.ca/resources/.2ss.2nt.3.1l-eng.html and http://www.esdc.gc.ca/en/essential_skills/tools/industrial_mechanic_fs.page accessed 30 March 2016

Skill	Description / Competency
	sites, workshops and courses.
	May schedule tasks for construction, repair and maintenance projects.
	Calculate distances, totals, maximums and minimums and quantities required.
	Calculate summary measures.
	Estimate time required to complete installation and repair tasks.
	Use specialized tools, such as micrometers, angle finders, feeler gauges and dial indicators to take precise measurements to thousandths of an inch.
	Collect and analyze data to evaluate system functions and troubleshoot faults.
	Calculate loads, capacities and dimensions for mechanical components and systems.
Writing	Write brief text entries in entry forms and log books.
	May write email messages to supervisors, co-workers and suppliers.
	Write text entries in forms and log books.
	Write incident reports.
	May write detailed maintenance and repair procedures to help co-workers plan and execute maintenance tasks and repairs.
Oral Communication	Talk to suppliers and contractors.
	Exchange information with co-workers.
	May discuss ongoing work with clients, advise them about maintenance and propose equipment modifications.
	Discuss safety, productivity, major repairs and procedures during meetings with co-workers, supervisors, engineers and clients.
	Provide detailed instructions.
	Exchange technical information.
Working with Others	Industrial mechanics and construction millwrights perform many of their tasks independently. They also form teams with co-workers, clients and contractors when necessary to install and overhaul larger pieces of equipment and complete industrial systems. They may supervise and train apprentices and junior mechanics.
Thinking	Decide task sequences and priorities.
	They inform co-workers and safety personnel about their unsafe work conditions observations and concerns. They perform other work until the unsafe condition is rectified.
	They locate the required specifications by talking to suppliers, engineers and supervisors. They may visit manufacturers' websites to locate missing information.
	Choose among refurbish, repair and replacement options for worn and defective parts, such as hoses, motors, valves, belts, pins, bolts and bushings.
	Refuse to perform tasks they judge to be unfeasible and unsafe.
	Evaluate the safety of their work environments.
	Evaluate the condition of parts and equipment.
	Assess feasibility of designs for small modifications to equipment and machinery.
	Receive their work assignments from their supervisors and plan their own job tasks within that framework.
	Find information about equipment by reviewing manufacturers' websites, catalogues

Skill	Description / Competency
	and pricelists and by talking to suppliers, co-workers and other tradespeople.
	Locate information on installation projects by reviewing scale drawings, reading work orders and speaking with co-workers, customers and other tradespeople.
	Find that parts needed for maintenance and repairs are unavailable. They fabricate replacement parts and modify parts from other machines.
	Select materials and methods to maintain, repair and improve industrial equipment and systems.
	Evaluate the performance of major industrial systems and plant equipment, such as hoists, conveyors, pumps, ventilators and hydraulic systems.
	Find technical information needed to troubleshoot equipment faults by running tests, studying diagnostic flowcharts and schematic drawings, reading equipment manuals and by speaking with co-workers, suppliers and help desk technicians.
Digital Technology	May use distributed control systems interfaced with programmable logic controllers to monitor operating levels, such as temperatures, pressures, flow rates and volumes in machinery and systems.
	Use calculators and personal digital assistant (PDA) devices to complete numeracy-related tasks, such as calculating material requirements.
	May use hand-held devices, such as vibration data collectors and analyzers, to collect displacement, acceleration and velocity data.
	May use hand-held devices, such as ultrasonic flaw detectors and thermal imagers, to locate and troubleshoot equipment faults.
	May use word processing programs to write, edit and format text for incident reports and maintenance procedures.
	May use databases to retrieve maintenance schedules and enter information about work completed.
	May use computer-assisted design (CAD), manufacturing and machining programs, such as AutoCAD to modify scale drawings.
	May use communication software to exchange email messages and attachments with supervisors, clients and suppliers.
	May use the Internet to access training courses and seminars offered by training institutions, unions, suppliers, associations and employers.
	Use Internet browsers and search engines to access technical service bulletins, codes, specifications and troubleshooting guides.
	May access online articles posted by suppliers, manufacturers and associations to stay current on industry trends and practices.
	May use the Internet to access and share information on industry-related web forums and blogs.
Continuous Learning	As new equipment and tools and changing regulations are a regular feature of their work environments, industrial mechanics and construction millwrights must learn continuously. They read manuals and bulletins to stay abreast of developments in their field. They also learn informally by exchanging information with co-workers and suppliers. They attend training workshops on new equipment

Skill	Description / Competency
	and safety procedures, as required by their employers. They may also take courses on their own initiative to learn and improve related technical skills, such as welding and pump repair.

The essential skills have trade-specific wording and emphases. The list put together for Industrial Mechanic / Millwrights will be rated here, and the same rating applied for the trade-specific knowledge skills analysis will be used (See Appendix 1 for details).

Rating essential skills

We used the following assumptions and protocols to rate the essential skills:

- Ratings are applied to holders of the credential, i.e., CofQ with Red Seal endorsement, NC(V), Section 26(D), or Learnership.
- The rating and color coding used is that shown in Appendix 1 Tables 6 and 7.
- Assign a rating of 7 / 70%[13] for a skill that has been delivered during the (formal) training.
- Assign a rating of 7 / 70% for a skill that is listed in the NOA – and possibly tested in the Red Seal examination - for BC challengers.
- Assign a rating of 8 / 80% for a skill for which there is evidence of advanced training or that the skill must be practiced in complete autonomy.
- Assign a rating of 1 for those skills that do not appear in the documents but is likely mastered.
- Assign a rating of 0 if the skill is clearly out of scope.
- Use Grade 9 + technical training to rate South African learners – but normed to Grade 12 since the required NQF Level 4 (the most common in the Trades programs) is equivalent to Grade 12 in South Africa
- Use Grade 10[14] + technical training to rate BC apprentices
- Maximum rating is 9 / 90% indicating that the Industrial Mechanic / Millwright could teach others the skill being rated.
- Ratings were assigned regardless of language, only for presence and level.

Essential skills ratings results

The results are presented by skills and competency in Table 4, and summarized by skill category in Figure 2 below.

Table 4. Comparison of BC apprentice, BC challenge, and South African programs against Essential Skills for Industrial Mechanic / Millwrights

[13] We used 7 / 70% to mimic the cut score required for certification on Red Seal examinations; we also defined 7 / 70% as a Industrial Mechanic / Millwright's the putative ability to do the task on his/her own.

[14] The ITA website states: Recommended Education The following education is recommended for apprentices entering this occupation. These are not prerequisites, but rather a desired level of skill or knowledge that will contribute to success in the industry … Grade 10 or equivalent including English 10, Mathematics 10, and Science 10.

Essential Skill	Competency	Max rating	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)
Reading	Read short handwritten notes and text entries on forms	9	7	7	7
	Read instructions and warnings written on signs, labels and packaging	9	7	7	7
	Read memos and notices	9	7	7	7
	Read trade journals, brochures and website articles to learn about new products and stay up-to-date on new technology	9	1	1	1
	Read technical bulletins	9	1	1	1
	Read a variety of operating, troubleshooting and repair manuals	9	7	7	7
	Read regulations and standards	9	7	7	7
		63	37	37	37
		100%	59%	59%	59%
Document use	Scan labels on product packaging, equipment, drawings and panels to locate specifications, voltages and identification numbers	9	7	7	7
	Observe warning signs and symbols	9	7	7	7
	Locate data in lists, tables and schedules	9	7	7	7
	May interpret graphs	9	1	1	1
	Enter data into a variety of forms	9	7	7	7
	Locate data, such as specifications, classifications and material coefficients, in complex tables	9	7	7	1
	Interpret complex schematic drawings	9	7	7	7
	Study complex scale drawings	9	7	7	7
		72	50	50	44
			69%	69%	61%
Numeracy	Take measurements of dimension and temperature using common measuring tools, such as rulers, tapes and thermometers	9	7	7	7
	Compare measurements, such as temperature, pressure and rotations per minute, to acceptable ranges	9	7	7	7
	Estimate weights and distances	9	7	7	1
	May calculate expense claims for tools and supplies and for travel to remote work sites, workshops and courses	9	1	1	1
	May schedule tasks for construction, repair and maintenance projects.	9	1	1	1
	Calculate distances, totals, maximums and minimums and quantities required	9	7	7	7
	Calculate summary measures	9	7	7	7

Essential Skill	Competency	Max rating	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)
	Estimate time required to complete installation and repair tasks	9	1	1	1
	Use specialized tools, such as micrometers, angle finders, feeler gauges and dial indicators to take precise measurements to thousandths of an inch	9	7	7	1
	Collect and analyze data to evaluate system functions and troubleshoot faults	9	7	7	7
	Calculate loads, capacities and dimensions for mechanical components and systems	9	7	7	7
		81	45	45	33
			56%	56%	41%
Writing	Write brief text entries in entry forms and log books	9	1	1	7
	May write email messages to supervisors, co-workers and suppliers	9	7	7	1
	Write text entries in forms and log books	9	1	1	7
	Write incident reports	9	1	1	1
	May write detailed maintenance and repair procedures to help co-workers plan and execute maintenance tasks and repairs	9	1	1	1
		45	11	11	17
			24%	24%	38%
Oral communication	Talk to suppliers and contractors	9	1	1	1
	Exchange information with co-workers	9	7	7	7
	May discuss ongoing work with clients, advise them about maintenance and propose equipment modifications	9	1	1	1
	Discuss safety, productivity, major repairs and procedures during meetings with co-workers, supervisors, engineers and clients	9	7	7	7
	Provide detailed instructions	9	1	1	1
	Exchange technical information	9	7	7	7
		54	24	24	24
			44%	44%	44%
Working with others	Industrial mechanics and construction millwrights perform many of their tasks independently. They also form teams with co-workers, clients and contractors when necessary to install and overhaul larger pieces of equipment and complete industrial systems. They may supervise and train apprentices and junior mechanics.	9	1	1	1
		9	1	1	1
			11%	11%	11%

Essential Skill	Competency	Max rating	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)
Thinking	Decide task sequences and priorities	9	7	7	1
	They inform co-workers and safety personnel about their unsafe work conditions observations and concerns. They perform other work until the unsafe condition is rectified	9	7	7	1
	They locate the required specifications by talking to suppliers, engineers and supervisors. They may visit manufacturers' websites to locate missing information	9	7	1	1
	Choose among refurbish, repair and replacement options for worn and defective parts, such as hoses, motors, valves, belts, pins, bolts and bushings.	9	1	1	1
	Refuse to perform tasks they judge to be unfeasible and unsafe	9	7	7	1
	Evaluate the safety of their work environments	9	7	7	7
	Evaluate the condition of parts and equipment	9	7	7	7
	Assess feasibility of designs for small modifications to equipment and machinery	9	1	1	1
	Receive their work assignments from their supervisors and plan their own job tasks within that framework	9	7	1	1
	Find information about equipment by reviewing manufacturers' websites, catalogues and pricelists and by talking to suppliers, co-workers and other tradespeople	9	7	1	1
	Locate information on installation projects by reviewing scale drawings, reading work orders and speaking with co-workers, customers and other tradespeople	9	7	7	7
	Find that parts needed for maintenance and repairs are unavailable. They fabricate replacement parts and modify parts from other machines	9	7	7	7
	Select materials and methods to maintain, repair and improve industrial equipment and systems	9	1	7	7
	Evaluate the performance of major industrial systems and plant equipment, such as hoists, conveyors, pumps, ventilators and hydraulic systems	9	7	7	1
	Find technical information needed to troubleshoot equipment faults by running tests, studying diagnostic flowcharts and schematic drawings, reading equipment manuals and by speaking with co-workers, suppliers and help desk technicians	9	7	1	1
		135	87	69	45
			64%	51%	33%

Essential Skill	Competency	Max rating	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)
Digital technology	May use distributed control systems interfaced with programmable logic controllers to monitor operating levels, such as temperatures, pressures, flow rates and volumes in machinery and systems	9	1	1	7
	Use calculators and personal digital assistant (PDA) devices to complete numeracy-related tasks, such as calculating material requirements	9	1	1	7
	May use hand-held devices, such as vibration data collectors and analyzers, to collect displacement, acceleration and velocity data	9	7	7	1
	May use hand-held devices, such as ultrasonic flaw detectors and thermal imagers, to locate and troubleshoot equipment faults	9	1	1	1
	May use word processing programs to write, edit and format text for incident reports and maintenance procedures	9	1	1	7
	May use databases to retrieve maintenance schedules and enter information about work completed	9	1	1	1
	May use computer-assisted design (CAD), manufacturing and machining programs, such as AutoCAD to modify scale drawings	9	1	1	1
	May use communication software to exchange email messages and attachments with supervisors, clients and suppliers	9	7	7	1
	May use the Internet to access training courses and seminars offered by training institutions, unions, suppliers, associations and employers	9	1	1	1
	Use Internet browsers and search engines to access technical service bulletins, codes, specifications and troubleshooting guides	9	1	1	1
	May access online articles posted by suppliers, manufacturers and associations to stay current on industry trends and practices	9	1	1	1
	May use the Internet to access and share information on industry-related web forums and blogs	9	1	1	1
		108	24	24	30
			22%	22%	28%

Essential Skill	Competency	Max rating	Red Seal CofA + CofQ	Red Seal CofQ	NC(V)
Continuous learning	As new equipment and tools and changing regulations are a regular feature of their work environments, industrial mechanics and construction millwrights must learn continuously. They read manuals and bulletins to stay abreast of developments in their field. They also learn informally by exchanging information with co-workers and suppliers. They attend training workshops on new equipment and safety procedures, as required by their employers. They may also take courses on their own initiative to learn and improve related technical skills, such as welding and pump repair.	9	1	1	1
		9	1	1	1
			11%	11%	11%

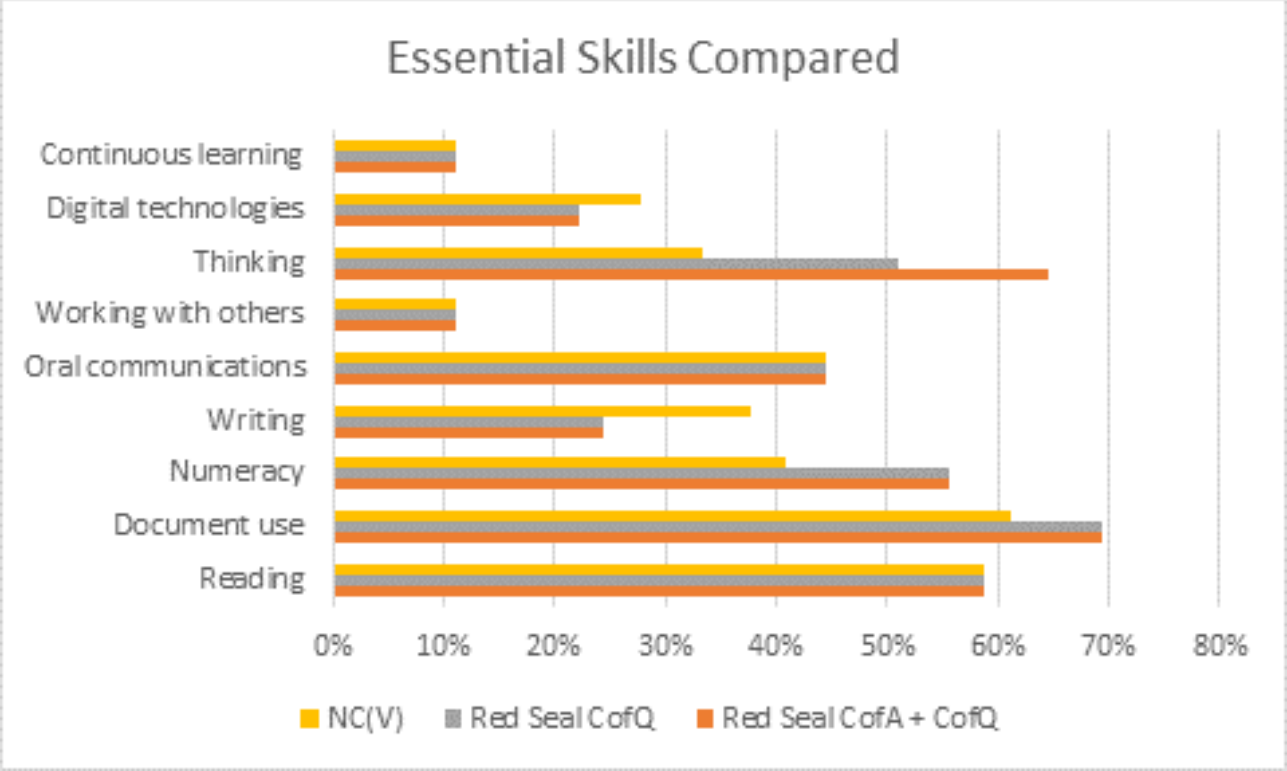

Figure 2. Essential skills compared as a match percentage by skill; BC Apprenticeship, BC Challenge, and South African NC(V)

Essential skills ratings interpretation – general remarks

Essential skills for Industrial Mechanic / Millwrights reflect what they would need to be able to work safely, effectively and efficiently. These skills also reflect those cognitive abilities that would be required to have a career as a millwright. Many of those skills are those developed through compulsory

education. One thinks of formal skills such as reading, writing, counting, manipulating symbols and formulae, distilling data from diverse sources and media, developing relationship skills, and making sense of complex situations as must-haves. But we have to recognize that many of these skills are further refined or broadened when young students navigate the sea of digital data, form, develop, and maintain friendships.

Yet the formal, cognitive skills, are acquired at school. Further, in general, we expect that once a student leaves the K-12 system they have been internalized.

Essential skills ratings interpretation – specific remarks

The 3Rs

Both the BC Program Outline (PO) and the NOA reflect that assumption. Granted, the BC PO sets aside some time to review (or learn for the first time) basic mathematical concepts, and, through interpretive exercises of documents develops reading – and perhaps writing – skills. The NOA simply lists the skills / knowledge as a presumed ability.

In contrast, the South African programs, even though the minimum entry level might be lower than those recommended for BC (Grade 9 vs. Grade 10), require the learners to meet secondary education qualifications in math science and English at a minimum. The breadth and depth of the courses South African would-be Industrial Mechanic / Millwrights take either at the TVETs appears to exceed what the BC applied programs offer.

Language skills

It stands to reason that a South African graduate who had not practiced English at work and whose native language is one the 11 official languages in South Africa (Afrikaans, Zulu, and English are most common) would find it, at first, difficult to function in an English only-speaking environment, even if he/she had the millwright skills.

Units of measurement

BC Industrial Mechanic / Millwrights work using imperial measurements. But they are at ease with the International System of Units (SI). Not so in South Africa: South African Industrial Mechanic / Millwrights work exclusively in the SI system (it converted to the metric system in 1922).

Digital technology

In South Africa, there seems to be little emphasis on computers in general, even if basic skills are listed in the TVET programs. At the personal level, this is probably more a reflection of the ability of people to afford digital technology for the home; there is no doubt that the TVETs have computer labs and use them in the training programs. It is unclear how common expensive electronic tools are available in the workplace in South Africa. In BC, however, the use of siting, leveling, and diagnostic laser and electronic tools – and of portable tools - is emphasized but the rest of technology tools are not emphasized or, at times, mentioned.

Troubleshooting – Thinking skills

There is no doubt that millwrights in both South Africa and BC have to use thinking skills in order to "fault finding" or "diagnostic", but the range of the skills listed in the Essential Skills document cannot be easily reconciled with the program documents.

The same considerations might apply to writing and numeracy skills

Working with others

There is no doubt that millwrights in both South Africa and BC have to, at least sometimes, use teamwork skills in order to complete (large) jobs, even if there seems to be an emphasis on working independently, but the range of the skills listed in the Essential Skills document cannot be easily reconciled with the program documents.

Continuous learning

Under this heading, as well as under the "Reading" heading, the Essential Skills document lists reading trade magazines and technical publications to stay up to date. It is not impossible that this takes place but it is unlikely given the access (both time and money) constraints, especially in South Africa. But it is likely that faced with such documents millwrights in both jurisdictions could read, understand, and learn from them.

Comparing program levels – Trade skills

Here we compare the program elements to identify commonalities, differences, and gaps between the BC apprenticeship, the BC challenge (relying on the NOA), and the South African NC(V). While all programs are structured hierarchically, the nomenclature and number of levels vary from program to program. Table 5 below summarizes the levels and how we compared them. Blanks in the table indicate that there was no direct comparison possible, or that the comparison would yield over-complicated results. For example, we decided that the "Block" level at the NOA, which arguably better corresponds to General Areas of Competence (GACs), was better left out of the comparative analysis.

An additional level of difficulty is that the BC, federal, and South African documents are structurally – where structure is most likely reflective of the "philosophy" of the documents' authors – quite different. For example, the BC PO, called a "Program Overview" listing "suggested time allocations", is tailored to the delivery of technical training for BC apprentices – and is, most probably the results of some sort of ITA-channelled consensus between industry and all the training institutions that deliver the training. Like the BC PO, the NOA is also a jurisdictionally-mediated consensual product but limits itself to a Task Analysis depicting the "average" Canadian Industrial Mechanic / Millwright; and the NOA makes no pretense to link up with the world of training. And the South African are a reasoned collection of modules each made up of "registered" qualifications: they describe what behaviors are expected in the trade and assemble them into a training (and assessment) program.

Moreover, the South African programs are all aligned to the Curriculum document approved by COQTO. This document lists each of the knowledge and "shop" modules broken down further into competencies which are then cross-referenced to content elements – all of these are numbered and registered with the national body. While the NOA also lists key competencies and knowledge, it does so using a cursory list of statements, none of which are cross-referenced to each other or specific knowledge. Finally, the BC PO mixes things in a random fashion: "Use Trade Math", "Describe Materials", and "Maintain lubricating systems" are structurally equivalent in the PO – all competencies. The BC approach is similar to that used in South Africa but not as rigorous.

We conducted the analysis using the BC PO as the reference document. That is, we looked in the NOA and the South African program documents for similarities to the BC GACs and Competencies and listed those. From the South African curriculum, we used both the Knowledge and Practical "sub-modules". For example, to equate the BC PO "A4 – Follow Safe Working Practices", we had to use sub-sub-modules for the knowledge component (KM-02-KT02 "Concepts related to the performance of work", KM-01-KT02 "Safety, health, environment, risk and quality principles in the workplace", PM-01-PS01 "Perform basic first aid", and PM-01-PS03 "Read and respond to safety signage").

The numerical ratings, as previously, was taken from Table 15 (Appendix 1). Also, as before, when rating safety competencies, we rated them according to the training/credentialing jurisdiction. Clearly, a South African Industrial Mechanic / Millwright coming to BC would require an orientation to "the way BC does business" such as regulations, but not in the basics like working at heights, wearing PPE, preventing accidents, etc. The same would apply to a BC Industrial Mechanic / Millwright moving to South Africa.

As we used the BC PO as the reference, we have assigned a value of 7 – using the same rationale as above - to all of the competencies there, and assigned estimated ratings to the NOA and South African program elements with reference to the BC rating or, when possible, absolutely.

Table 5. Comparative program structure elements by name – highlighted cells indicate elements used in the analysis

	Jurisdiction		
Program elements	British Columbia - BCPO	Red Seal/Federal - NOA	COQTO - Industrial Mechanic / Millwright
		Block	Knowledge
			Practical Skill
			Work Experience
	GAC - "Line"	Task	Modules
			"Sub-module"
	Competency	Sub-task	Competencies
	Learning tasks	Key competencies	
	Content	Knowledge	Knowledge modules
			Applied knowledge
	Objective		Assessment criteria

Comparing General Areas of Competence (GAC) – Knowledge & Abilities

Using the BC Program Overview (BC PO) as the reference, we searched the NOA and Curriculum for equivalent entries. The rationale to assign ratings to the NOA and South African equivalents was a follows:

- Use 9 if they appear to be much superior in "breadth and depth" (total autonomy; innovative).
- Use 8 if they appear to be superior in "breadth and depth" (more content; more activities; greater difficulty).
- Use 7 if they appear to be the same in "breadth and depth".
- Use 6 if they appear to be inferior in "breadth and depth" (less content; fewer activities; simpler).
- Use 0 if there is no direct reference to the GAC or competency.

It is important to keep in mind that the ratings are here to help summarize complex, ill-matched documents in a single indicator. The numbers are not indicative of the trade as a whole or individual Industrial Mechanic / Millwrights, nor are they suitable to establish some sort of pecking order in either the jurisdictions, programs, credentials, or people.

As the scale is ordinal, we have steered away from mathematical manipulations except to normalize counts – using the categorical number of entries over the largest number of entries as a reverse factor - in order to get a clearer picture. Reporting counts and the attached ratings provides an overall picture of the differences and might help in making decisions about remedial interventions.

However, we have added an "average rating" calculated value to provide a very rough – and mathematically unjustifiable; see Appendix 2 under "quantitative" for details – measure of comparison between the 3 programs.

Results

By definition, the BC PO has the largest number of "7" (13 normed to 25). The NOA has "8" (4 normed to 5) and the South African has 1 (normed to 1). Also, both the NOA and the South African programs have "7", (11 normed to 13 and 5 normed to 5, respectively). Both the NOA and the South African program have some "6" (4 normed to 5 and 10 normed to 10, respectively). And both the NOA and the South African show "0" entries (2 normed to 2 for both). The detailed entries are provided in Table 6, the summary count in Table 7, and the normed counts in Figure 3.

Table 6. Rated comparisons at the GAC level - BC PO is the reference; colors and ratings as above, expounded in Appendix 1

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Line		Rating	Task		Rating		Sub-modules (NC(V))	Rating
A	Work Practices	7	1	Performs safety related functions	6	KM-01	Workplace fundamentals	6
			4	Performs measuring and layout	6	KM-02	The Millwright's world of work	6
B	Trade Science	7	3	Performs routine trade tasks	6	KM-03	Basic Engineering theory	7
			4	Performs measuring and layout	6	KM-04	Fitting theory	7
C	Use Tools	7	2	Maintains and uses tools and equipment	7	KM-05	Tools and equipment for electrical work	6
D	Lubricants, Seals and Bearings	7			0			0
E	Install Equipment	7			0			0
F	Cut, Fit and Fabricate	7	5	Performs cutting and welding operations.	7	PM-02	Fabricate components using power tools and machinery	6
G	Maintain Prime Movers	7	8	Services prime movers	7	KM-08	Rotating electrical machinery	8
						PM-05	Work with electrical components	7
						PM-06	Install and connect electrical equipment, switch- and control gear	7
						PM-07	Work with electronic components	7
H	Service Power Transmissions	7	9	Services shafts, bearings and seals	8	KM-08	Rotating electrical machinery	6
			10	Services couplings, clutches and brakes	8	PM-08	Disassemble, clean and inspect mechanical sub-assemblies and machines	6
			11	Services chain and belt drive systems	8	PM-09	Replace components and assemble mechanical sub-assemblies and machines	6

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Line		Rating	Task		Rating		Sub-modules (NC(V))	Rating
			12	Services gear systems	8			
I	Service Fluid Power	7	13	Services fans and blowers.	6	PM-08	Disassemble, clean and inspect mechanical sub-assemblies and machines	6
			18	Services hydraulic systems	7	PM-09	Replace components and assemble mechanical sub-assemblies and machines	6
			19	Services pneumatic and vacuum systems	7			
J	Service Compressors	7	14	Services compressors	7	PM-08	Disassemble, clean and inspect mechanical sub-assemblies and machines	6
						PM-09	Replace components and assemble mechanical sub-assemblies and machines	6
K	Service Pumps	7	15	Services pumps	7	PM-08	Disassemble, clean and inspect mechanical sub-assemblies and machines	6
						PM-09	Replace components and assemble mechanical sub-assemblies and machines	6
L	Service Material Handling Systems	7	16	Services conveying systems.	7	PM-08	Disassemble, clean and inspect mechanical sub-assemblies and machines	6
			17	Services process tanks and containers	7	PM-09	Replace components and assemble mechanical sub-assemblies and machines	6
M	Operational Equipment Effectiveness	7	20	Performs preventive and predictive maintenance	7	PM-10	Do fault-finding on mechanical sub-assemblies and machines	6
			21	Performs specialized testing and analysis	7	PM-12	Perform fault-finding on and repair electrical and electronic circuits	6

Table 7. Summary count of comparison ratings at the GAC level – BC PO is the reference

	British Columbia – BC PO	Red Seal / Federal - NOA	SA Curriculum - NC(V)
Total number ratings	13	22	25
Total of ratings	91	139	145
Ratings of 8	0	4	1
Ratings of 7	13	11	5
Ratings of 6	0	4	10
Ratings of 0	0	2	2
Average rating	7	6.3	5.8

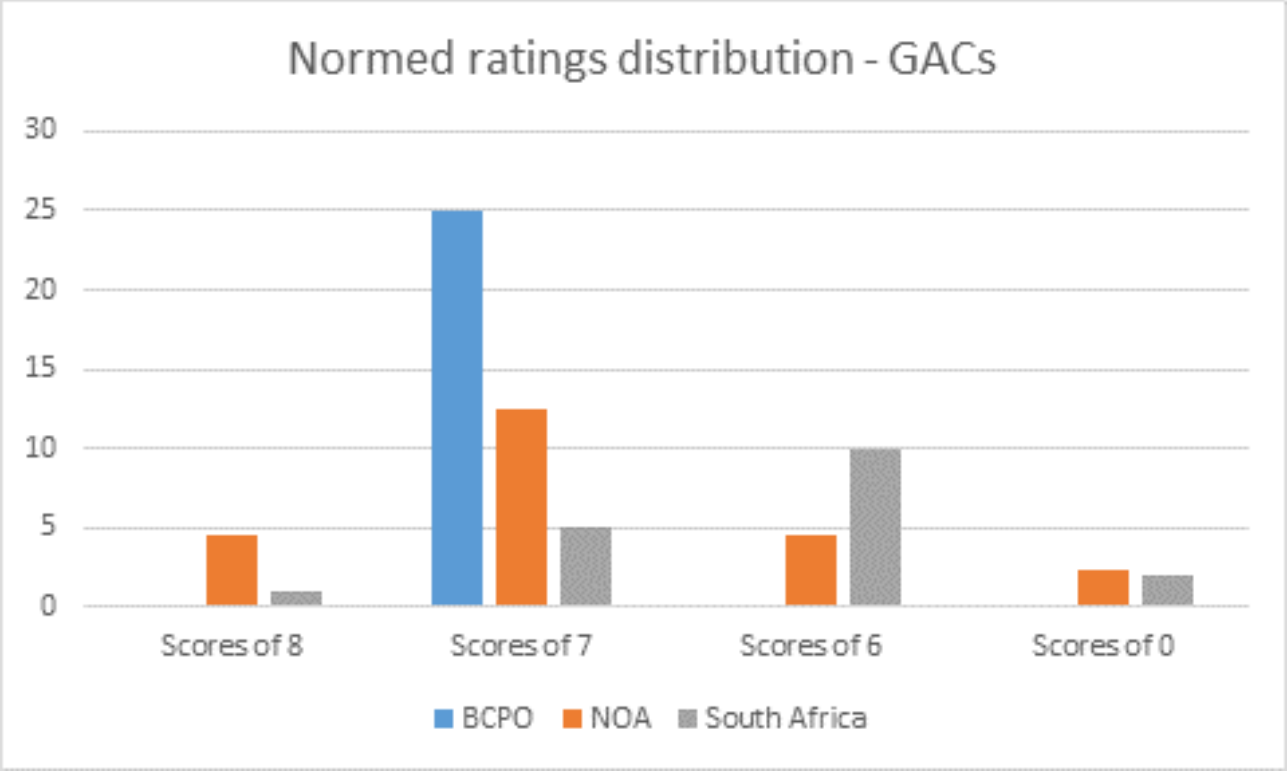

Figure 3. Normed ratings distribution for BC's apprentice program (BCPO), the BC Challenger program (NOA), and the South African – at the GAC / Task / Sub-module level

Comparing competencies – Hands-on skills & knowledge

Using the BC Program Overview (BC PO) as the reference, we searched the NOA and Réferentiel for equivalent entries. The rationale to assign ratings to the NOA and South African equivalents was a follows:

- Use 9 if they appear to be much superior in "breadth and depth" (total autonomy; innovative).

- Use 8 if they appear to be superior in "breadth and depth" (more content; more activities; greater difficulty).
- Use 7 if they appear to be the same in "breadth and depth".
- Use 6 if they appear to be inferior in "breadth and depth" (less content; fewer activities; simpler; or covered as a small (weight<5%) theory event).
- Use 0 if there is no direct reference to the GAC or competency.

It is important to keep in mind that the ratings are here to help summarize complex, ill-matched documents in a single indicator. The numbers are not indicative of the trade as a whole or individual Industrial Mechanic / Millwrights, nor are they suitable to establish some sort of pecking order in either the jurisdictions, programs, credentials, or people.

As the scale is ordinal, we have steered away from mathematical manipulations except to normalize counts – using the categorical number of entries over the largest number of entries as a reverse factor - in order to get a clearer picture. Reporting counts and the attached ratings provides an overall picture of the differences and might help in making decisions about remedial interventions.

However, we have added an "average rating" calculated value to provide a very rough – and mathematically unjustifiable; see Appendix 1 for details – measure of comparison between the 3 programs.

Results

By definition, the BC PO has the largest number of "7" (81 normed to 138). Only South Africa has "9" (2 normed to 2). The NOA has a substantial number of "8", South Africa fewer (44 normed to 55 and 21 normed to 21, respectively). Also, the NOA and the South African program have a significant number of "7" (16 normed to 20 and 57 normed to 57, respectively). And the NOA and the South African program both have some "6" (2 normed to 3 and 16 normed to 16, respectively) but many "0" entries (48 normed to 60 and 42 normed to 42, respectively). The detailed entries are provided in Table 8, the summary count in Table 9, and the normed counts in Figure 4.

Table 8. Rated comparisons at the competency level - BC PO is the reference; colors and ratings as above, expounded in Appendix 1

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
A1	Explain Federal/Provincial Occupational Health & Safety Regulations Safety Practices	7			0	KM-01-KT04	Concepts related to the performance of work	6
A2	Explain & Apply Environmental Regulations	7	1.03	Protects the environment.	6	KM-01-KT04	Concepts related to the performance of work	6

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
A3	Use Personal Protective Equipment	7	1.01	Uses personal protective equipment (PPE) and safety equipment.	7	KM-01-KT04	Concepts related to the performance of work	6
A4	Follow Safe Working Practices	7	1.04	Performs lock-out/tag-out and zero energy procedures	7	KM-02-KT02	Concepts related to the performance of work	6
						KM-01-KT02	Safety, health, environment, risk and quality principles in the workplace	7
						PM-01-PS01	Perform basic first aid	7
						PM-01-PS03	Read and respond to safety signage	7
A5	Use Communication and Teamwork Skills	7			0	KM-02-KT04	Organisation of work	7
A6	Interpret Plans and Sketches	7	3.08	Uses mechanical drawings and schematics	7	KM-03-KT01	Engineering drawings	6
A7	Use Reference Resources	7			0			0
A8	Plan Job Requirements	7	3.01	Plans work	7			0
B1	Use Trade Math	7			0			0
B2	Use Trade Science	7			0			0
B3	Describe Materials	7			0	KM-03-KT02	Engineering materials	7
B4	Explain Simple Machines	7			0			0
B5	Use Fits and Tolerances	7			0			0
B6	Use Fasteners	7	3.05	Uses fastening and retaining devices	7	KM-03-KT06	Types and functions of locking devices	6
B7	Describe Theory of Electricity and Electronics	7			0	KM-06-KT01	Fundamentals of electricity	8
						KM-06-KT02	Electronics	8
C1	Use Hand Tools	7	2.01	Maintains hand and portable power tools.	7	KM-03-KT03	Engineering tools and equipment	7
C2	Use Measuring and Layout Tools and Instruments	7	2.02	Maintains precision measuring and layout tools	7	KM-03-KT03	Engineering tools and equipment	7
						KM-05-KT01	Hand tools and power tools	7
						KM-05-KT02	Measuring and testing instruments	7

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
C3	Use Portable Power Tools	7	2.01	Maintains hand and portable power tools.	7	KM-03-KT03	Engineering tools and equipment	7
C4	Use Fixed Shop Machines and Equipment	7	2.05	Uses shop machines	7	KM-03-KT03	Engineering tools and equipment	7
C5	Use Mobile Access Equipment	7	2.03	Maintains rigging, hoisting/lifting and moving equipment	7	PM-01-PS04	Identify, use and care for lifting and support equipment	7
D1	Select Lubricants	7	3.03	Lubricates systems and components	6			0
D2	Maintain Lubricating System	7			0	PM-09-PS07	Replace lubrication components and assemble lubrication systems	8
D3	Select Seals, Gaskets and Packing	7			0	KM-04-KT01	Static and dynamic seals and gaskets	6
D4	Install and Maintain Seals	7			0	PA0103 (e.g.)	Identify gearbox components, parts, seals, lubricants and specifications of these that must be available for repair	7
D5	Select Bearings	7			0	PM-09-PS06	Replace bearings	7
D6	Install and Maintain Bearings	7			0	PM-09-PS06	Replace bearings	7
E1	Use Safe Rigging Practices	7	6.03	Selects hoisting/lifting and moving equipment	8	KM-03-KT04	Basic lifting concepts	6
			7.01	Secures area	8			
			7.03	Performs hoist/lift and move	8			
E2	Describe Layout and Securing of Equipment	7			0			0
E3	Describe Equipment Foundations	7			0			0
E4	Explain Levelling and Alignment Procedures	7			0			0
E5	Level, Align and Secure Equipment	7			0			0
E6	Describe Procedures for Commissioning Equipment	7			0			0

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
E7	Commission Equipment	7	22.01	Commissions mechanical systems and components, and material handling/process systems	8	671202000-PM-14	Install and commission mechanical sub-assemblies and machines	7
			22.02	Commissions hydraulic, pneumatic and vacuum systems	8			
F1	Describe Welding Practices	7			0	KM-03-KT07	Principles, equipment and methods of arc welding, gas welding, cutting, brazing and silver soldering	7
F2	Use and Maintain OxyFuel Cutting, Welding and Heating Equipment	7	2.04	Maintains welding equipment	7	KM-03-KT07	Principles, equipment and methods of arc welding, gas welding, cutting, brazing and silver soldering	7
			5.01	Cuts material with gas and plasma arc cutting equipment	8	PM-03-PS01-10	Fabricate simple components of workpieces using basic hand skills and hand tools	8
			5.02	Joins material using gas welding equipment	8	PM-02-PS01-12	Fabricate components of workpieces using power tools and machinery	8
F3	Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment	7	5.03	Welds material using arc welding equipment	7			0
F4	Use and Maintain Plasma Arc Cutting Equipment	7	5.01	Cuts material with gas and plasma arc cutting equipment	7			0
F5	Use and Maintain Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW) Equipment	7	5.04	Welds material with gas metal arc welding (GMAW (MIG)) equipment	7			0
G1	Explain Prime Mover Theory	7	8.01	Installs prime movers	8	KM-06-KT03	Electrical appliances	6
			8.02	Diagnoses prime movers	8			
			8.03	Repairs prime movers	8			
G2	Describe Electric Motors	7			0	KM-08-KT01	Rotating electrical machinery - AC motors	8

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
						KM-08-KT02	Rotating electrical machinery - DC motors	8
						KM-08-KT03	Rotating electrical machinery - alternators and generators	8
G3	Maintain Electric Motors	7			0	PM-05-PS02	Identify and care for electrical equipment	8
						PM-06-PS08	Install and connect DC and single and 3-phase AC motors	8
						PM-07-PS06	Install, connect, and programme variable speed drives	8
						PM-12-PS02	Replace or repair defective electrical components	8
						PM-13-PS01	Dismantle and test DC and AC motors, generators, alternators and transformers	9
						PM-13-PS02	re-assemble DC and AC motors, generators, alternators and transformers	9
G4	Describe Internal Combustion Engines	7			0			0
G5	Describe the Maintenance of Internal Combustion Engines	7			0			0
G6	Describe Turbines	7			0			0
G7	Describe the Maintenance of Turbines	7			0			0
G8	Describe Power Turbines	7			0			0
H1	Describe Power Transmission Theory	7			0			0
H2	Service Couplings	7	10.03	Repairs couplings, clutches and brakes	8			0
H3	Service Gear Drives	7	12.04	Maintains gear systems	8	KM-04-KT04	Types and applications of drives	6
						KM-04-KT06	Mechanical working principles, types and applications of reduction gearboxes	7

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
						PM-08-PS02	Disassemble, clean and inspect gearboxes	7
						PM-11-PS01	Repair gearboxes	7
						PM-08-PS06	Disassemble, clean and inspect drives	7
						PM-09-PS04	Replace drive components and assemble drives	7
						PM-14-PS01	Install and commissions gearboxes	8
H4	Service Belt Drives	7	11.04	Maintains chain and belt drive systems	8	KM-04-KT04	Types and applications of drives	6
H5	Service Clutches and Brakes	7	10.03	Repairs couplings, clutches and brakes	8	KM-04-KT07	Mechanical working principles, types and applications of clutches	7
						KM-04-KT08	Mechanical working principles, types and applications of brakes	7
						PM-08-PS04	Disassemble, clean and inspect brakes	7
						PM-09-PS03	Replace brake components and assemble brakes	7
						PM-10-PS03	Do fault-finding on brakes	7
						PM-11-PS03	Repair brakes	7
						PM-14-PS03	Install and commissions brakes	8
						PM-08-PS05	Disassemble, clean and inspect clutches	7
						PM-09-PS04	Replace clutch components and assemble clutches	7
						PM-10-PS05	Do fault-finding on clutches	7
						PM-11-PS04	Repair clutches	7
						PM-14-PS04	Install and commission clutches	8
H6	Service Chain Drives	7	11.04	Maintains chain and belt drive systems	8	KM-04-KT04	Types and applications of drives	6
H7	Service Drive Shafts	7	9.04	Maintains shafts, bearings and seals	8	KM-04-KT04	Types and applications of drives	6

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
						PM-10-PS05	Do fault-finding on drives	7
						PM-11-PS05	Repair drives	7
						PM-14-PS05	Install and commission drives	8
I1	Explain Hydraulic Theory	7			0			0
I2	Interpret Hydraulic Schematics	7			0			0
I3	Describe Hydraulic Components	7			0	KM-04-KT10	Mechanical working principles, types and applications of hydraulic systems	7
I4	Identify Hydraulic Pumps	7	18.02	Diagnoses hydraulic systems	8	KM-04-KT05	Types and applications of pumps	6
						PM-08-PS03	Disassemble, clean and inspect pumps	7
						PM-09-PS02	Replace pump components and assemble pumps	7
						PM-10-PS02	Do fault-finding on pumps	7
						PM-11-PS02	Repair pumps	7
						PM-14-PS02	Install and commission pumps	7
I5	Describe, Assemble and Maintain Hydraulic Circuits	7	18.03	Repairs hydraulic systems	8	KM-04-KT03	Types and applications of valves	6
			18.04	Maintains hydraulic systems	8	PM-04-PS01	Build and test basic hydraulic circuits	7
						PM-08-PS10	Clean and inspect hydraulic systems	7
						PM-08-PS11	Clean and inspect valves	7
						PM-09-PS08	Replace hydraulic components and assemble hydraulic systems	7
						PM-10-PS09	Do fault-finding on hydraulic systems	7
						PM-11-PS07	Repair hydraulic systems	7
						PM-14-PS07	Install hydraulic system components and commission hydraulic systems	8

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
						PM-17-PS01	Design and construct hydraulic circuits	8
I6	Explain Pneumatic Theory	7			0			0
I7	Describe Pneumatic Components	7			0	KM-04-KT11	Mechanical working principles, types and applications of pneumatic systems	7
I8	Interpret Pneumatic Schematics	7			0			
I9	Identify Pneumatic Pumps	7			0			
I10	Assemble, Maintain and Troubleshoot Pneumatic Circuits	7	19.01	Installs pneumatic and vacuum system	8	PM-04-PS02	Build and test basic pneumatic circuits	7
			19.02	Diagnoses pneumatic and vacuum systems	8	PM-08-PS10	Clean and inspect pneumatic systems	7
			19.03	Repairs pneumatic and vacuum systems	8	PM-08-PS11	Clean and inspect valves	7
			19.04	Maintains pneumatic and vacuum systems	8	PM-09-PS09	Replace pneumatic components and assemble pneumatic systems	7
						PM-10-PS09	Replace valve components and assemble valve	7
						PM-10-PS09	Do fault-finding on pneumatic systems	7
						PM-11-PS08	Repair pneumatic systems	7
						PM-14-PS08	Install pneumatic system components and commission pneumatic systems	8
						PM-17-PS02	Design and construct pneumatic circuits	8
I11	Explain the Theory of Vacuum and Vacuum Systems	7			0			0
I12	Interpret Vacuum Symbols	7			0			0
I13	Identify Vacuum System Components	7			0			0
I14	Describe Vacuum Systems	7			0			0
I15	Maintain and Troubleshoot Vacuum Systems	7	19.01	Installs pneumatic and vacuum system	8			0
			19.02	Diagnoses pneumatic and vacuum systems	8			

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
			19.03	Repairs pneumatic and vacuum systems	8			
			19.04	Maintains pneumatic and vacuum systems	8			
J1	Explain Compressor Theory	7			0			0
J2	Identify and Describe Types of Compressors	7			0			0
J3	Service Compressors	7	14.01	Installs compressors	8			0
			14.02	Diagnoses compressors	8			
			14.03	Repairs compressors	8			
			14.04	Maintains compressors	8			
K1	Explain Pump Theory	7			0			0
K2	Identify Types of Pumps	7			0	KM-04-KT05	Types and applications of pumps	6
K3	Install, Maintain and Troubleshoot Positive Displacement Pumps	7	15.01	Installs pumps	8	PM-08-PS03	Disassemble, clean and inspect pumps	7
K4	Install, Maintain and Troubleshoot Non-Positive Displacement Pumps+	7	15.02	Diagnoses pumps	8			0
			15.03	Repairs pumps	8			
			15.04	Maintains pumps	8			
L1	Explain Material Handling Theory	7			0			0
L2	Maintain Fans and Blowers	7	13.01	Installs fans and blowers	8			0
			13.02	Diagnoses fans and blowers	8			
			13.03	Repairs fans and blowers	8			
			13.04	Maintains fans and blowers	8			
L3	Identify Types of Conveyors	7			0	KM-04-KT12	Types and functions of conveyors	7
L4	Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers	7			0			0
L5	Maintain Conveyor Systems	7	16.01	Installs conveying systems	8			0
			16.02	Diagnoses conveying systems	8			

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum - NC(V)		
Competency		Rating	Sub-task		Rating	Practical skills / topics		Rating
			16.03	Repairs conveying systems	8			
			16.04	Maintains conveying systems	8			
M1	Describe Operational Equipment Effectiveness Processes				0			0
M2	Describe Use of Predictive Maintenance Tools		20.02	Performs predictive maintenance activities	8			0
M3	Identify Equipment and Process Deficiencies				0	PM-15-PS01-06	Test and verify electrical components and systems	8
M4	Perform Vibration Analysis and Rotating Equipment Balancing	7	21.01	Performs vibration analysis procedures	7			0
			2102	Performs balancing procedures	7			

Table 9. Summary count of comparison ratings at the competency level – BC PO is the reference

	British Columbia – BC PO	Red Seal / Federal - NOA	SA Curriculum NC(V)
Total number ratings	81	110	138
Total of ratings	567	476	681
Ratings of 8	0	0	2
Ratings of 7	0	44	21
Ratings of 6	81	16	57
Ratings of 0	0	2	16
Average rating	0	48	42

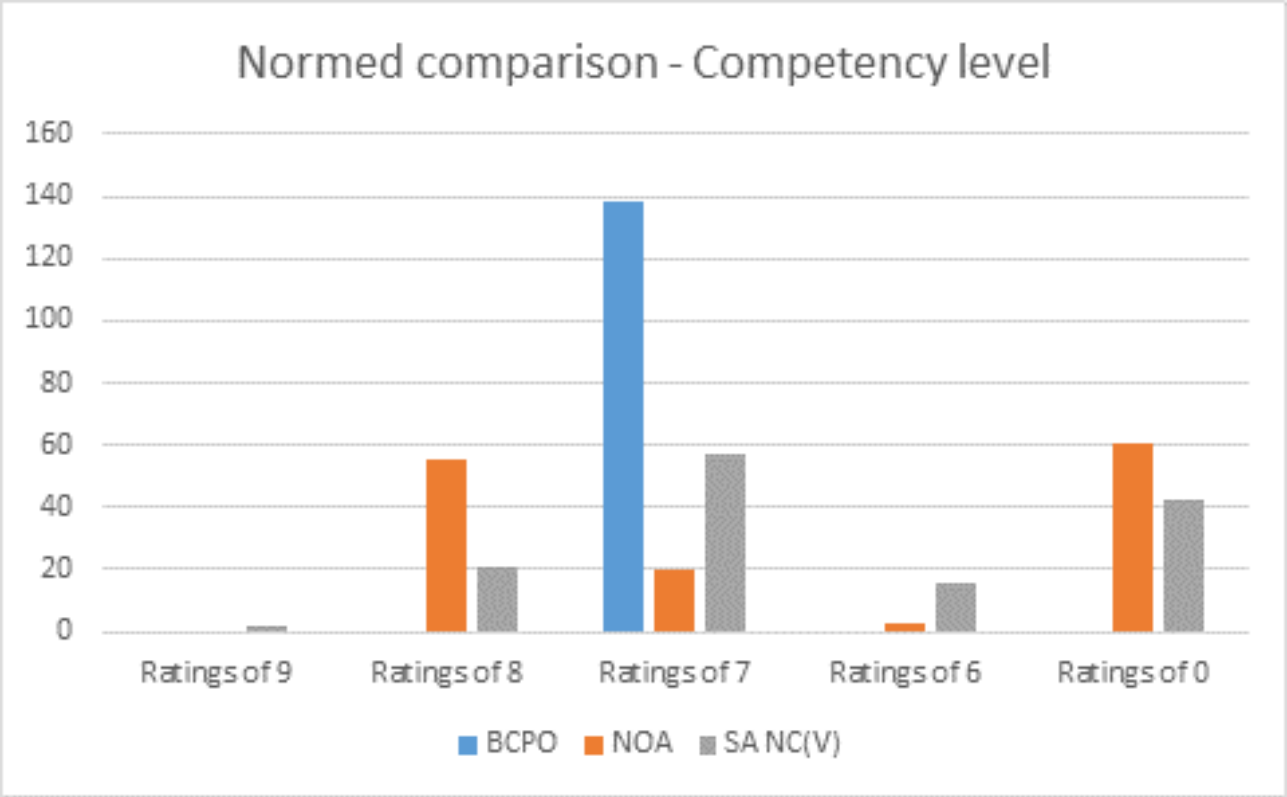

Figure 4. Normed ratings distribution for BC's apprentice program (BCPO), the BC Challenger program (NOA), and the South African NC(V) – at the competency / sub-task / Compétences détaillées level

Gaps - Competencies

When compared to the BC PO, and using the rating protocol explained above, both the NOA and South African programs show gaps. For the purpose of this classification, we have defined as gap any competency that did not match the equivalent BC competency standard rating, i.e. rating<7, or that was not listed or readily surmised from those listed.

Clearly a gap indicated by a rating of 6 ought to be seen as less absolute as one showing a rating of 0. This is because a 0 indicates that the competency is entirely absent the document or program. Table 10 shows the three-way comparison and gap. Tables 11 and 12 show the NOA and South African gaps respectively.

Table 10. Rated gap competencies - BC PO is the reference; colors and ratings as above, expounded in Appendix 1

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
A1	Explain Federal/Provincial Occupational Health & Safety Regulations Safety Practices	7			0	KM-01-KT04	Concepts related to the performance of work	6

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
A2	Explain & Apply Environmental Regulations	7	1.03	Protects the environment.	6	KM-01-KT04	Concepts related to the performance of work	6
A3	Use Personal Protective Equipment	7	1.01	Uses personal protective equipment (PPE) and safety equipment.	7	KM-01-KT04	Concepts related to the performance of work	6
A4	Follow Safe Working Practices	7	1.04	Performs lock-out/tag-out and zero energy procedures	7	KM-02-KT02	Concepts related to the performance of work	6
A5	Use Communication and Teamwork Skills	7			0	KM-02-KT04	Organisation of work	7
A6	Interpret Plans and Sketches	7	3.08	Uses mechanical drawings and schematics	7	KM-03-KT01	Engineering drawings	6
A7	Use Reference Resources	7			0			0
A8	Plan Job Requirements	7	3.01	Plans work	7			0
B1	Use Trade Math	7			0			0
B2	Use Trade Science	7			0			0
B3	Describe Materials	7			0	KM-03-KT02	Engineering materials	7
B4	Explain Simple Machines	7			0			0
B5	Use Fits and Tolerances	7			0			0
B6	Use Fasteners	7	3.05	Uses fastening and retaining devices	7	KM-03-KT06	Types and functions of locking devices	6
B7	Describe Theory of Electricity and Electronics	7			0	KM-06-KT01	Fundamentals of electricity	8
D1	Select Lubricants	7	3.03	Lubricates systems and components	6			0
D2	Maintain Lubricating System	7			0	PM-09-PS07	Replace lubrication components and assemble lubrication systems	8
D3	Select Seals, Gaskets and Packing	7			0	KM-04-KT01	Static and dynamic seals and gaskets	6
D4	Install and Maintain Seals	7			0	PA0103 (e.g.)	Identify gearbox components, parts, seals, lubricants and specifications of these that must be available for repair	7
D5	Select Bearings	7			0	PM-09-PS06	Replace bearings	7

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
D6	Install and Maintain Bearings	7			0	PM-09-PS06	Replace bearings	7
E1	Use Safe Rigging Practices	7	6.03	Selects hoisting/lifting and moving equipment	8	KM-03-KT04	Basic lifting concepts	6
E2	Describe Layout and Securing of Equipment	7			0			0
E3	Describe Equipment Foundations	7			0			0
E4	Explain Levelling and Alignment Procedures	7			0			0
E5	Level, Align and Secure Equipment	7			0			0
E6	Describe Procedures for Commissioning Equipment	7			0			0
F1	Describe Welding Practices	7			0	KM-03-KT07	Principles, equipment and methods of arc welding, gas welding, cutting, brazing and silver soldering	7
F3	Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment	7	5.03	Welds material using arc welding equipment	7			0
F4	Use and Maintain Plasma Arc Cutting Equipment	7	5.01	Cuts material with gas and plasma arc cutting equipment	7			0
F5	Use and Maintain Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW) Equipment	7	5.04	Welds material with gas metal arc welding (GMAW (MIG)) equipment	7			0
G1	Explain Prime Mover Theory	7	8.01	Installs prime movers	8	KM-06-KT03	Electrical appliances	6
G2	Describe Electric Motors	7			0	KM-08-KT01	Rotating electrical machinery - AC motors	8
G3	Maintain Electric Motors	7			0	PM-05-PS02	Identify and care for electrical equipment	8
G4	Describe Internal Combustion Engines	7			0			0
G5	Describe the Maintenance of Internal Combustion Engines	7			0			0
G6	Describe Turbines	7			0			0

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
G7	Describe the Maintenance of Turbines	7			0			0
G8	Describe Power Turbines	7			0			0
H1	Describe Power Transmission Theory	7			0			0
H2	Service Couplings	7	10.03	Repairs couplings, clutches and brakes	8			0
H3	Service Gear Drives	7	12.04	Maintains gear systems	8	KM-04-KT04	Types and applications of drives	6
H4	Service Belt Drives	7	11.04	Maintains chain and belt drive systems	8	KM-04-KT04	Types and applications of drives	6
H6	Service Chain Drives	7	11.04	Maintains chain and belt drive systems	8	KM-04-KT04	Types and applications of drives	6
H7	Service Drive Shafts	7	9.04	Maintains shafts, bearings and seals	8	KM-04-KT04	Types and applications of drives	6
						PM-10-PS05	Do fault-finding on drives	7
						PM-11-PS05	Repair drives	7
						PM-14-PS05	Install and commission drives	8
I1	Explain Hydraulic Theory	7			0			0
I2	Interpret Hydraulic Schematics	7			0			0
I3	Describe Hydraulic Components	7			0	KM-04-KT10	Mechanical working principles, types and applications of hydraulic systems	7
I4	Identify Hydraulic Pumps	7	18.02	Diagnoses hydraulic systems	8	KM-04-KT05	Types and applications of pumps	6
I5	Describe, Assemble and Maintain Hydraulic Circuits	7	18.03	Repairs hydraulic systems	8	KM-04-KT03	Types and applications of valves	6
I6	Explain Pneumatic Theory	7			0			0
I7	Describe Pneumatic Components	7			0	KM-04-KT11	Mechanical working principles, types and applications of pneumatic systems	7
I8	Interpret Pneumatic Schematics	7			0			
I9	Identify Pneumatic Pumps	7			0			

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
I11	Explain the Theory of Vacuum and Vacuum Systems	7			0			0
I12	Interpret Vacuum Symbols	7			0			0
I13	Identify Vacuum System Components	7			0			0
I14	Describe Vacuum Systems	7			0			0
I15	Maintain and Troubleshoot Vacuum Systems	7	19.01	Installs pneumatic and vacuum system	8			0
J1	Explain Compressor Theory	7			0			0
J2	Identify and Describe Types of Compressors	7			0			0
J3	Service Compressors	7	14.01	Installs compressors	8			0
K1	Explain Pump Theory	7			0			0
K2	Identify Types of Pumps	7			0	KM-04-KT05	Types and applications of pumps	6
K3	Install, Maintain and Troubleshoot Positive Displacement Pumps	7	15.01	Installs pumps	8	PM-08-PS03	Disassemble, clean and inspect pumps	7
K4	Install, Maintain and Troubleshoot Non-Positive Displacement Pumps+	7	15.02	Diagnoses pumps	8			0
L1	Explain Material Handling Theory	7			0			0
L2	Maintain Fans and Blowers	7	13.01	Installs fans and blowers	8			0
L3	Identify Types of Conveyors	7			0	KM-04-KT12	Types and functions of conveyors	7
L4	Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers	7			0			0
L5	Maintain Conveyor Systems	7	16.01	Installs conveying systems	8			0
M1	Describe Operational Equipment Effectiveness Processes				0			0
M2	Describe Use of Predictive Maintenance Tools		20.02	Performs predictive maintenance activities	8			0

British Columbia – BC PO			Red Seal / Federal - NOA			South African Curriculum – NC(V)		
Competency		Rating	**Sub-task**		Rating	**Practical skills / topics**		Rating
M3	Identify Equipment and Process Deficiencies				0	PM-15-PS01-06	Test and verify electrical components and systems	8
M4	Perform Vibration Analysis and Rotating Equipment Balancing	7	21.01	Performs vibration analysis procedures	7			0
			2102	Performs balancing procedures	7			

Table 11. Gaps between BC PO and BC Challenger (NOA)

British Columbia – BC PO			Red Seal / Federal - NOA		
Competency		Rating	**Sub-task**		Rating
A1	Explain Federal/Provincial Occupational Health & Safety Regulations Safety Practices	7			0
A2	Explain & Apply Environmental Regulations	7	1.03	Protects the environment.	6
A5	Use Communication and Teamwork Skills	7			0
A7	Use Reference Resources	7			0
B1	Use Trade Math	7			0
B2	Use Trade Science	7			0
B3	Describe Materials	7			0
B4	Explain Simple Machines	7			0
B5	Use Fits and Tolerances	7			0
B7	Describe Theory of Electricity and Electronics	7			0
D1	Select Lubricants	7	3.03	Lubricates systems and components	6
D2	Maintain Lubricating System	7			0
D3	Select Seals, Gaskets and Packing	7			0
D4	Install and Maintain Seals	7			0
D5	Select Bearings	7			0
D6	Install and Maintain Bearings	7			0
E2	Describe Layout and Securing of Equipment	7			0
E3	Describe Equipment Foundations	7			0
E4	Explain Levelling and Alignment Procedures	7			0

British Columbia – BC PO			Red Seal / Federal - NOA		
Competency		Rating	**Sub-task**		Rating
E5	Level, Align and Secure Equipment	7			0
E6	Describe Procedures for Commissioning Equipment	7			0
F1	Describe Welding Practices	7			0
G2	Describe Electric Motors	7			0
G3	Maintain Electric Motors	7			0
G4	Describe Internal Combustion Engines	7			0
G5	Describe the Maintenance of Internal Combustion Engines	7			0
G6	Describe Turbines	7			0
G7	Describe the Maintenance of Turbines	7			0
G8	Describe Power Turbines	7			0
H1	Describe Power Transmission Theory	7			0
I1	Explain Hydraulic Theory	7			0
I2	Interpret Hydraulic Schematics	7			0
I3	Describe Hydraulic Components	7			0
I6	Explain Pneumatic Theory	7			0
I7	Describe Pneumatic Components	7			0
I8	Interpret Pneumatic Schematics	7			0
I9	Identify Pneumatic Pumps	7			0
I11	Explain the Theory of Vacuum and Vacuum Systems	7			0
I12	Interpret Vacuum Symbols	7			0
I13	Identify Vacuum System Components	7			0
I14	Describe Vacuum Systems	7			0
J1	Explain Compressor Theory	7			0
J2	Identify and Describe Types of Compressors	7			0
K1	Explain Pump Theory	7			0
K2	Identify Types of Pumps	7			0
L1	Explain Material Handling Theory	7			0
L3	Identify Types of Conveyors	7			0

British Columbia – BC PO			Red Seal / Federal - NOA		
Competency		Rating	**Sub-task**		Rating
L4	Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers	7			0
M1	Describe Operational Equipment Effectiveness Processes				0
M3	Identify Equipment and Process Deficiencies				0

Table 12. Gaps between the BC PO and the NC(V)

British Columbia – BC PO			South African Curriculum – NC(V)		
Competency		Rating	**Practical skills / topics**		Rating
A1	Explain Federal/Provincial Occupational Health & Safety Regulations Safety Practices	7	KM-01-KT04	Concepts related to the performance of work	6
A2	Explain & Apply Environmental Regulations	7	KM-01-KT04	Concepts related to the performance of work	6
A3	Use Personal Protective Equipment	7	KM-01-KT04	Concepts related to the performance of work	6
A4	Follow Safe Working Practices	7	KM-02-KT02	Concepts related to the performance of work	6
A6	Interpret Plans and Sketches	7	KM-03-KT01	Engineering drawings	6
A7	Use Reference Resources	7			0
A8	Plan Job Requirements	7			0
B1	Use Trade Math	7			0
B2	Use Trade Science	7			0
B4	Explain Simple Machines	7			0
B5	Use Fits and Tolerances	7			0
B6	Use Fasteners	7	KM-03-KT06	Types and functions of locking devices	6
D1	Select Lubricants	7			0
D3	Select Seals, Gaskets and Packing	7	KM-04-KT01	Static and dynamic seals and gaskets	6

British Columbia – BC PO			South African Curriculum – NC(V)		
Competency		Rating	**Practical skills / topics**		Rating
E1	Use Safe Rigging Practices	7	KM-03-KT04	Basic lifting concepts	6
E2	Describe Layout and Securing of Equipment	7			0
E3	Describe Equipment Foundations	7			0
E4	Explain Levelling and Alignment Procedures	7			0
E5	Level, Align and Secure Equipment	7			0
E6	Describe Procedures for Commissioning Equipment	7			0
F3	Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment	7			0
F4	Use and Maintain Plasma Arc Cutting Equipment	7			0
F5	Use and Maintain Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW) Equipment	7			0
G1	Explain Prime Mover Theory	7	KM-06-KT03	Electrical appliances	6
G4	Describe Internal Combustion Engines	7			0
G5	Describe the Maintenance of Internal Combustion Engines	7			0
G6	Describe Turbines	7			0
G7	Describe the Maintenance of Turbines	7			0
G8	Describe Power Turbines	7			0
H1	Describe Power Transmission Theory	7			0
H2	Service Couplings	7			0
H3	Service Gear Drives	7	KM-04-KT04	Types and applications of drives	6

British Columbia – BC PO			South African Curriculum – NC(V)		
Competency		Rating	**Practical skills / topics**		Rating
H4	Service Belt Drives	7	KM-04-KT04	Types and applications of drives	6
H6	Service Chain Drives	7	KM-04-KT04	Types and applications of drives	6
H7	Service Drive Shafts	7	KM-04-KT04	Types and applications of drives	6
I1	Explain Hydraulic Theory	7			0
I2	Interpret Hydraulic Schematics	7			0
I4	Identify Hydraulic Pumps	7	KM-04-KT05	Types and applications of pumps	6
I5	Describe, Assemble and Maintain Hydraulic Circuits	7	KM-04-KT03	Types and applications of valves	6
I6	Explain Pneumatic Theory	7			0
I11	Explain the Theory of Vacuum and Vacuum Systems	7			0
I12	Interpret Vacuum Symbols	7			0
I13	Identify Vacuum System Components	7			0
I14	Describe Vacuum Systems	7			0
I15	Maintain and Troubleshoot Vacuum Systems	7			0
J1	Explain Compressor Theory	7			0
J2	Identify and Describe Types of Compressors	7			0
J3	Service Compressors	7			0
K1	Explain Pump Theory	7			0
K2	Identify Types of Pumps	7	KM-04-KT05	Types and applications of pumps	6
K4	Install, Maintain and Troubleshoot Non-Positive Displacement Pumps+	7			0
L1	Explain Material Handling Theory	7			0
L2	Maintain Fans and Blowers	7			0

British Columbia – BC PO			South African Curriculum – NC(V)		
Competency		Rating	**Practical skills / topics**		Rating
L4	Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers	7			0
L5	Maintain Conveyor Systems	7			0
M1	Describe Operational Equipment Effectiveness Processes				0
M2	Describe Use of Predictive Maintenance Tools				0
M4	Perform Vibration Analysis and Rotating Equipment Balancing	7			0

Conclusions

BC PO and NOA

The gaps we identified, especially those between the BC PO and the NOA could be due to structural differences between the two documents. Indeed, the BC PO states that it is aligned to the NOA. In addition, the BC PO has a number of "competencies" that would be best incorporated into other competencies, for example "Describe", "identify", etc. These abilities are required to, say, troubleshoot or service and since they are ancillary, do not show at our level of analysis. It is probably fair to say that the gaps identified above are due to the poor quality of the BC document paired with the level of analysis.

But we should nevertheless examine these gaps because challengers to the certification in BC have, in general, no trade schooling, and the NOA is the only training proxy we can use.

For example, we know that safety regulations and codes vary from jurisdiction to jurisdiction, and that only those Pan-Canadian regulations and codes might be tested on the Red Seal examination. A BC-specific gap is possible for those challengers who have worked mostly out of BC.

BC PO and NC(V)

The gaps identified here are reflective of the differences in the training programs' structure. In effect, we are saying that someone who has been trained in a domain has the ability to recognize and adapt to changes to and in that domain. On the other hand, someone who was never exposed to the domain would be oblivious to its elements, hence would be insensitive to its subtleties, let alone to any change. We are also saying that it is easier to train someone familiar with a domain than someone with no acquaintance to that domain at all. And this is true regardless of the myth of having to "un-learn" things: there is no need to wipe the slate clean to learn new things.

The differences between safety legislation and regulations and codes and standards are significant, as are potential language differences – even if a South African student whose mother tongue is not English but took English as prescribed; the problem might be more acute for those students who did not take English at all (i.e. RPL graduates). But the South African Industrial Mechanic / Millwright has been well-trained in interpreting and applying these codes and standards. Bridging gaps due to jurisdictional and language differences is a trivial finding, even if it is one that needs to be addressed.

The real gaps, those representing missing (or unmentioned) curriculum bits in South Africa, are, in decreasing order of importance: machinery installation, non-electrical prime movers, welding, material handling, vacuum systems, and the imperial system. Some of these gaps, given the depth of the South African program elements could be closed fairly quickly: South African Millwright have all the required transferable skills.

We also need to keep in mind that the 18 months' work experience that NC(V) students – and maybe the other streams' students as well – undertake is focused on the "electro-mechanical" aspects of the trade. This, in addition to the theoretical gaps noted above will require of incoming South African Millwright to have to ramp up very quickly on a steep learning curve.

Examination and Certification

Credentialing in BC

Apprentices

Apprentices are required to pass each of 4 levels (blocks) of in-school training. At the time of this writing, the practical and theory tests were institution-specific, but coordinated through a BC Articulation Committee for the trade. The Industry Training Authority (ITA) intends to impose standardized level theory tests starting in 2016. There is no standardized practical test: instructors assign cumulative marks for in-school projects (similar but not standardized).

Successful completion of the Level 4 in-school final exam gives access to the Red Seal examination, the only certification mechanism for Industrial Mechanic / Millwrights in BC.

The Red Seal - Apprentices and challengers

Introduction

Apprentices and approved challengers are required to write the Red Seal examination in order to get a BC Industrial Mechanic / Millwright credential. There is no partial credit, no part credential.

The Red Seal examination is a timed "paper and pencil" test. All questions on the examination are machine-scorable multiple choice.

The Red Seal Certification examination is based on the National Occupational Analysis (NOA). The NOA is broken down into a numbers of blocks, tasks, and sub-tasks. Examination questions are based on the sub-tasks, the number of questions on each sub-task is based on a national mathematical average of estimated time spent on task by the Industrial Mechanic / Millwrights in each jurisdiction, curved to the total number of question on the examination.

There is no weighting of any section of the Red Seal examination based on either heightened safety implications or criticality of task. There is no jurisdictional examination overlay for the Red Seal examination.

Red Seal examinations are prepared cooperatively between all Canadian jurisdictions but are hosted by a designated jurisdiction (designate status for any Red Seal examination is assigned through the CCDA[15]'s Product Committee's ISEC[16]). Red Seal examinations are item bank-generated; that is for each examinable sub-task of the NOA a number of items are developed and then randomly assigned to an instrument based on a ToS[17] that mirrors the NOA percentages.

Bank-generated examinations are more comprehensive and more "difficult[18]" than many of the "before-bank" examinations: items address more areas of the trade at more varied/complex levels than in one-off, instructor-developed examinations.

Problems

It is generally assumed that the ability to pass the examination[19] can be directly attributed to a candidate's work experience: that there is a direct proportional relationship between the level, scope, and quality of on-the-job training (OJT) and experience, and performance on the examination. It is also assumed that the instructional content (and activities) delivered by the institutions reflect the National Occupational Analysis (NOA) - our analysis shows this to be a dubious assumption, at best.

There are a number of problems with these assumptions. First, it is questionable if a pencil and paper test can stand as a proxy for practical ability. Second, it is unclear whether the candidates are able, for the purpose of the test only, to conceptualize what they do in order to answer a "word" problem. Third, domain hierarchy is neither considered nor established. And fourth, the NOA sub-tasks are not worded clearly enough to permit domain definition (e.g. "G21.01 Removes existing materials").

The third and fourth problems are of interest to the Industrial Mechanic / Millwright Red Seal examination because they are borne out of examination development design and practice. As a pencil and paper test, the Industrial Mechanic / Millwright IP assumes that all candidates can read, thus making the examination a test of literacy. As well, many items require candidates to apply mathematical concepts in order to identify (not necessarily generate as they would on the job) the correct answer, as such, the Red Seal is a test of numeracy. These two domains are listed in the Essential Skills, but these are not tested for, nor are they part of the requirement for challengers, but they are tested in conjunction with the job skills. All Red Seal examinations are made up of items that test an indeterminate number of domains in an indeterminate fashion.

Success on the Red Seal examination means the candidate scored >70%. All Red Seal examinations have this unique cut score. The cut score is not adjusted to the compounded psychometric profile of the

[15] Canadian Council of Directors of Apprenticeship
[16] The *Interprovincial Standards Examination Committee* is made up of provincial/territorial government representatives
[17] A *Table of Specifications* is developed by the host jurisdiction and assigns weights and taxonomic item levels to sub-tasks
[18] Where "difficulty" is a perceptual measure from the candidates' perspective rather than statistically derived through Item Response or Classical theories
[19] 70% aggregate cut score for all Red Seal examinations

items used for the examination – items are not differentially weighted. And, while results are available at the task level, the score obtained is the unweighted ratio of correct answers over number of questions at the sub-task level.

Validity

Validity is a measure of confidence in the inferences made based on a test score. With high stakes tests (like the Red Seal), it is crucial that test developers and administrators ensure inferences drawn from test scores are accurate. In the case of Industrial Mechanic / Millwrights, a score <70% means that the candidate is not a competent Industrial Mechanic / Millwright, a serious professional issue.

Validation studies are recommended prior to the introduction of any test and should be mandatory for high stakes tests like the Industrial Mechanic / Millwright Red Seal. Usually three types of validation studies are conducted: content, criterion-related, and construct. With Red Seal examinations in general, only a cursory content validation is conducted when local experts review items.

Some may argue that the use of subject matter experts (SMEs) during item development is a validation exercise. This is a spurious argument, as content validation exercises ought to be conducted by independent judges, not the people who developed the items. Moreover, there is no indication that the SMEs are fully cognizant of all domains tested, are representative of the population of Industrial Mechanic / Millwrights, or are able to precisely determine what is being tested.

Reliability

If a test is an accurate measure of an individual's ability[20], then any candidate's observed scores should be consistent over a number of tries on the same test or parallel, equated tests. Reliability indices are numerical values that provide a statistical measure of the consistency of test scores; one would expect z-scores of a given individual to remain relatively consistent over repeated tries.

Score consistency is affected both by random and systematic errors. Random errors are chance happening and cannot be controlled (but they can be accounted for). Systematic errors are due to either examination flaws or candidates' characteristic (e.g. visual impairment). Red Seal examinations are developed, produced, and implemented without any reliability studies. In fact, some jurisdictions do not track reliability indices, even rudimentary αs or z-scores distributions in or for test-re-test situations.

Credentialing in South Africa

Whether a NC(V), apprentice, learnership, or RPL candidate, all South African millwrights-to-be face the same summative (and formative) tests. Access to these summative tests, their content, duration, and scoring are backstopped by SAQA and COTO's requirements, the central South African bodies for these educational matters. These summative tests are clearly differentiated in law from formative tests, i.e. tests required of learners for progress at school.

These summative tests are fixed in time (preparation for these varies based on the stream the student is in) and place. South African regulations stipulate who, where, when, and how candidates are to be

[20] i.e. that E (the error unrelated to the domain(s) being tested – see footnote 2) is minimized in T=X+E so that the test score (X) is a stable, true reflection of the true score (T),

examined and marked. All summative examinations require a student to pass exams and a battery of practical tests.

For Industrial Mechanic / Millwrights, there are a minimum of six tests (more depending on the stream). At least one of these tests cover scholastic skills: mathematics, science, and English. Another test covers theoretical trade knowledge. The other 5-6 tests take place at an approved testing center, and cover hands-on trade skills selected from a set of "must-haves" listed in the curriculum.

All of these tests are cross-referenced to "end state" competences, and have a prescribed set of givens, conditions (e.g. time allotted, fixed number of pages, types of drawings, take-offs, etc.), and, for practical trade tests, at least one registered assessor.

The products of each test are gathered in a portfolio. Before granting the certification, the marks (and portfolios) are submitted to the appropriate NAMB who will recommend certification to QCTO.

The credentials are issued by QCTO.

Validity

The South African summative tests are "constructed response" tests. That is, and unlike the Red Seal, the candidate must generate his or her own answer or solution to a given problem. In addition, a South African candidate has to demonstrate both cognitive and hands-on abilities. Marks are issued by assessor(s), as opposed to being machine graded, and each assessment element builds an overall picture of the candidate across all terminal competences. The terminal competences are those the training program and the trade require as minimum proof of competence.

Reliability

Having many tests increase challenges to reliability if we added a reliability index for each test and summed those. One of the mechanisms the South African are relying on to increase individual tests' reliability is using multiple assessors across multiple instruments using standardized rubrics supplemented by a (at a minimum) two-tiered[21] marking structure – in effect getting (at least) two inter-rater values.

The South African picture is a composite one spread over six tests and it is unlikely that a candidate in a test-re-test situation would do much differently overall.

BC vs. South Africa

In Table 13 we compare the major elements of the testing and credentialing systems for Industrial Mechanic / Millwrights in BC and in South Africa. Both systems reflect general beliefs and philosophy about education and training.

Briefly, BC, like most North American jurisdictions, consistent with a greater reliance on technology and quantitative, large scale standardized testing uses a machine scorable test. The Red Seal examinations are designed and produced by a broad-based Canadian consensus, and are managed by a local arms-length government agency, ITA, an institution removed from the training institutions and the field. The Red Seal endorsement is meant to qualify the worker.

[21] There are usually 3 classes of requirements: knowledge, practical, and work-based (using a log book).

By contrast, the South African approach is holistic – in the sense of gathering performance data from different cognitive, psycho-motor, and affective domains – and standards-based. The South African testing system reflects the ability to do things that are required in the world of work. It is meant to prove that the graduated student is an able, all-around artisan.

Table 13. Comparison of BC and South Africa examination and credentialing

Examination and certification		
Element	BC	South Africa
Exam	Single	Multiple
	Pencil & paper	Pencil & paper
		Hands-on
Domains tested	Multiple unspecified	Multiple specified
	Proxy	Direct
Domain inclusion	Negotiated norm	Criterion
Item type	Selected response	Constructed response
Scoring	Machine	Rubric-based
		Assessor (teams)
		2 tiered (NAMB & CQTO)
Scores	One correct	Gradated
Results	Unique fixed cut score	Compounded
Validity	Medium	Strong
Reliability	Unknown	Strong
Credential	Endorsement	National

APPENDIX 1 - Evaluative framework

The following is a detailed rationale describing the process and product of the evaluative exercise.

What is a rating scale?

A rating scale is a tool that allows an assessor to translate a candidate's achievement into a series of pre-set, defined values.

There are 4 major types of scales, arranged in the following fashion (Bond and Fox, 2007):

- Nominal scales– separate the data of interest in defined, recognizable classes, for example, there is an" A", a "B", a "C", … a "n"
- Ordinal scales – separate nominal data along a quantitative axis, for example A>B>C>…n, therefore, e.g. A>n
- Interval scales – separate ordinal data along a regular quantitative axis, for example A>B>C>…n, such that (A-z)=B, (B-z)=C, (C-z)=D, …, (m-z)=n, and z is invariant or constant but specific to the data (and scale) at hand (e.g. millimeters, cents, seconds, etc.)
- Ratio scales – separate interval data along a quantitative axis, for example A>B>C>…n, such that (A-z)=B, (B-z)=C, (C-z)=D, …, (m-z)=n, and z is invariant or constant across all possible scales

For the purpose of analysis, the scale used is an interval numerical scale based on percentages. While the use of a percentage numerical scale is arbitrary, it is familiar to most people because it is closely aligned with scales used in the public education system. Unlike the public education in North America, we did not use a letter grades scale (i.e. A-F) with a percent range equivalency table (e.g. A = 85-100%). Using the percent scale will allow for both translation to any base 10 numerical scale (say a test based on 20 or 40 marks) and for uncertainty.

In addition, the number of ranks (10) provides evaluators some measure of sensitivity around mid-range performance (5-7).

What is in a rating scale?

Rating scales are comprised of the following 3 elements:

- An ordinal rating value (e.g., 1, 2, 3, … n); omitted here for the sake of simplicity
- A label defining the ordinal points (e.g., 1=10%, 2=20%, 3=40%, … , 10=100%), i.e. an interval of 10% between each point
- One (or a set of) statement(s), or criterion/a, that describe(s) the behavior commensurate with the rating (e.g., 1=10%= "Candidate attempts to bluff through the task; or 'I have never done this type of task, but let me show you how it's done'"

For this exercise we have added another 2 sets of criteria or scales: safety and training. These 2 additional sets are more generic (have fewer details), and allow for evaluation as opposed to assessment. These scales are meant to be used simultaneously and conjunctively. There are 3 reasons for using additional rating criteria:

- Enable the assessor to classify the performance from a (gross) safety perspective (e.g., "Unacceptable", "High", etc.)

- Enable the assessor to classify the performance at a more general level (e.g., "Needs in-school training", "Needs on-the-job training", etc.).
- "Triangulate" the performance rating. For example, we would not accept (and expect) that a candidate be rated competent and an unacceptable safety risk in the workplace simultaneously.

In addition, the 10-point scale is meant to assist users of the evaluation grid in better targeting their intervention(s), for example, on-the-job coaching vs. in-school training (or both).

What rating scales did we use?

For this exercise, we used 3 rating scales and 1 set of statements or criteria. The rating scale elements are as follows:

- Safety
- Training required
- Percent scale (11 anchor points: N/A, 1-10)
- Criteria – description in the vernacular, from a certified tradesworker's perspective of the expected level of comfort and/or familiarity and/or capabilities based on the training and testing attached to each competency.

Safety & Training scales

The "Safety" scale is a 5-point scale risk qualitative estimate, color-coded for ease of reference (where risk is assumed to be linearly, inversely proportional to ability as reflected in the competency-based evaluation). The risk labels, while open to interpretation, are roughly aligned to investigators' ratings when an accident involving a tradesworker occurs.

The Training Scale addresses 6 potential responses for each competency assessed, where 2 responses are hiring-based, 2 responses are training-based, and 2 responses are punctual (commensurate with mandated or legislated training):

Table 14. Color-coded safety and training scales

Risk	Training
Restriction	No training required at this time, restrictions are in place
Unacceptable	Training required is too extensive to justify hiring or restrictions are required
High	Training required is best delivered in a formal, in-school format (followed on-the-job training)
Medium	Training required is best delivered on-the-job (followed by training mandated for the job)

Low	No immediate training is required (except that mandated for the job)
Improbable	No training is required (except that mandated for the job)

Note:

- "Restriction" refers to a job task limits imposed on the tradesworker by the hiring entity and kept in place until the tradesworker is deemed competent.

How did we integrate South African scales?

The South African program consists of three articulated domains (using our translation): Activities and Tasks, Competences and competencies, and Technological knowledge. Only the first and the last of these levels have expected performance scales. Neither of these 2 scales are identical, although they are related – the same is true of the three levels listed just above.

The first scale is binary and separates the performance expectations between someone completing a task under supervision and using an assigned methodology, and someone completing a task independently using the methodology they have selected.

The second scale is a four-point scale that maps out fairly easily to the Interprovincial Standard Examination (IPSE, a.k.a. Red Seal) taxonomy or question classification, itself is a modified/compressed Bloom taxonomy. Roughly, the South African level 1 would correspond to the ability to name, member, recognize, or understand things and concepts. Level 2, in addition to Level 1, would correspond to the ability to apply concepts, perhaps mainly cognitively. Level 3 would correspond to the ability to analyze and apply the things and concepts cognitively and physically. And Level 4 would correspond to the ability to analyze complex tasks and create means to resolve them. These correspondences are captured in Table 7 below.

Combined numerical rating scale

The numerical rating scale has 4 elements:

- Percent (%) rating (estimated) (10%, 20%, … , 100%)
- Descriptors/criteria/vernacular
- Risk
- Training
- And, in addition, is cross-referenced to the South African performance levels

These elements are as follows:

Table 15. Combined scales

Score	Descriptor/vernacular	Risk	Training	South African cross-reference / IPSE/Bloom
N/A	Task is not required for the occupation or job position or headquarter	Restriction if task is part of the trade but location-specific	No training required at this time, restrictions are in place	

Score	Descriptor/vernacular	Risk	Training	South African cross-reference / IPSE/Bloom
0 / 0%	Task is not part of profile; or "I have never done this type of work"	Unacceptable	Training required is too extensive to justify hiring or restrictions are required	
1 / 10%	Task is marginally part of profile; or "I have never done this type of task, but I think I can make it"	Unacceptable	Training required is too extensive to justify hiring or restrictions are required	
2 / 20%	Task is not part of profile but bears some resemblance to some profile task; "I don't know this; show me and talk me through it step by step"	High	Training required is best delivered in a formal, in-school format (followed on-the-job training)	
3 / 30%	Task is not part of profile but is a composite of other tasks; "I've done this quite a while back, you just need talk me through it one step at a time"	High	Training required is best delivered in a formal, in-school format (followed on-the-job training)	
s4 / 40%	Task is part of profile but uncommon / rare; or "Here's how the whole procedure is done, is that correct?"	High	Training required is best delivered in a formal, in-school format (followed on-the-job training)	Technological knowledge[22] – Information level IPSE Tax 1; Bloom 1-2
5 / 50%	Task is part of profile but usually left to specialists; or "I can do this, but I'll probably get stumped and may need help at some point"	Medium	Training required is best delivered on-the-job (followed by training mandated for the job)	Technological knowledge – Expression level IPSE Tax 1→2; Bloom 2→3
6 / 60%	Task is part of profile but usually left to	Medium	Training required is best delivered	Activities and Tasks – Supervised

[22] Our translation – Les savoirs technologiques associés; Niveau d'information; Niveau d'expression; Niveau de la maîtrise d'outils; Niveau de la maîtrise méthodologique

Score	Descriptor/vernacular	Risk	Training	South African cross-reference / IPSE/Bloom
	specialists; or "I can do it on my own, you just need to check when I'm done – I'll probably make a forgivable mistake"		on-the-job (followed by training mandated for the job)	and following an assigned method[23] Technological knowledge – Tool mastery level IPSE Tax 2; Bloom 3-4
7 / 70%	Task is part of profile but frequency of practice varies a lot; or "I can do it on my own, you just need to check when I'm done – I won't make any mistake"	Low	No immediate training is required (except that mandated for the job)	Activities and Tasks – Supervised and following an assigned method Technological knowledge – Tool mastery level IPSE Tax 2; Bloom 3-4
8 / 80%	Task is part of profile and is very common; or "I can do it on my own, you won't have to check my work"	Low	No immediate training is required (except that mandated for the job)	Activities and Tasks – Proficient and chooses method[24] Technological knowledge – Methodological mastery level IPSE Tax 3; Bloom 5-6
9 / 90%	Task is part of profile and tested rigorously; or "I can teach others how to do it"	Improbable	No training is required (except that mandated for the job)	Activities and Tasks – Proficient and chooses method Technological knowledge – Methodological mastery level IPSE Tax 3; Bloom 5-6
10 / 100%	Task is part of profile and subject to re-certification; or "I developed and implemented this procedure"	Improbable	No training is required (except that mandated for the job)	

Notes:

[23] Our translation – Activités et tâches : sous contrôle / sous la responsabilité d'un supérieur hiérarchique / méthode imposée

[24] Our translation – Activités et tâches : maîtrise l'exécution … et peut en choisir la méthode d'exécution

- The numerical standard for an estimated "competent" performance rating is 70%, or the ability to perform safely independently. An estimated "proficient" performance rating is 90% or 100% or that exhibited by a higher level of certification or tenure as a trades instructor.
- Where "forgivable" in the 60% rating vernacular means a procedural misstep or omission; an error that would not have led to or resulted in injury to self, co-workers, or the public and/or damage to equipment or plant.

Further refinements

The analysis conducted herein could be further refined by adding analytical levels, say including learning tasks. Using these levels, it might be possible to move from an ordinal rating to an absolute rating and then conduct mathematical operations on the ratings and add weightings to calculate gaps to a higher – albeit artificial - level. This is explained below.

The numerical indicators above can be handled via arithmetic mean calculations – if they are used in an absolute fashion rather than a comparative or ordinal fashion - and would have the following assumptions embedded:

- All ranks are equally spaced, i.e. it is as difficult to go from a "20%" to a "30%" as it is from a "60%" to a "70%".
- Competence and risk can be represented linearly (in the form of $y=ax+b$).
- All competencies are equally important.
- All competencies are equally risky.
- There is no measurable skills erosion due to jobsite conditions or time elapsed since certification.

Clearly, all of these assumptions might lead to (i) overestimation of competence and, (ii) underestimation of risk. For example, in a worst case scenario, a tradesworker may "score" very high on low risk/low impact competencies, hence "make up" for weaknesses in high risk/high impact competencies.

There are 2 non-mutually exclusive palliatives to address the assumptions' potential impact on gaps/scores:

1. Gating items/competencies
   Simply put, gating items or competencies are "must-haves". For example, an Industrial Mechanic / Millwright who lacks, e.g., NOA Bock F Task 22 "Commissions Equipment", would be considered "incompetent" altogether as mastery of that Task is deemed absolutely necessary to function in a Canadian industrial mechanical environment.
2. Weighting
   Weighting consist in assigning a multiplier to the assessed raw score based on competency criticality and/or risk level (expressed as a "safety score"). At the individual competency level achievement described as a percentage remains the same, but at the aggregate level, the weighting affects the results. Weighting values could be based, say, on percent of instructional time listed in the BCPO, or the Tasks national averages in the NOA.

Table 16. Example of profile results using the all of the ratings to determine a risk factor on a 3-point scale (weighted risk factors were not considered)

Summary of ratings against competencies	Score/Max.	Percent	Risk/Training	Value (=v)	Average Risk (=Σv/n)
3 greens (all at 7/70%)	21/30	70%	Low	3*1=3	2.17
4 yellows (3 at 6/60%, 1 at 5/50%	23/40	58%	Medium	4*2=8	
5 oranges (4 at 4/40%, 1 at 3/30%)	17/50	34%	High	5*3=15	
Overall	61/120	51%	Medium-High	26/12	Medium-High

Comparing 2 "candidates" with similar rating profiles but in a weighted situation:

Table 17. Example of weighted program comparison

GAC	(K) Raw Score		(K) No weight %		Weight (1-5)	(K) Weighted score		(K) Weighted %		(S) Raw Score (SRS)		(S) No weight		Weight (1-5) (W)	(S) Weighted score		(S) Weighted %	
Candidate	A	B	A	B		A	B	A	B	A	B	A	B		A	B	A	B
A	P	P	P	P	∞	P	P	P	P	P	P	P	P	∞	P	P	P	P
B	6	7	60%	70%	4	24	28	60%	70%	2	1	55%	75%	4	8	4	.50	.25
C	4	6	40%	60%	4	16	24	40%	60%	3	2	30%	55%	4	12	8	.75	.50
D	6	5	60%	50%	2	12	10	60%	50%	2	3	55%	30%	2	4	6	.25	.38
E	9	7	90%	70%	1	9	7	90%	70%	0	1	95%	75%	1	0	1	0	.06
Overall	25	25	63%	63%		61	69	55%	63%	7	7	59%	59%		24	19	1.50 67%	1.19 83%

Note: (S) Weighted % is calculated as: $\left\{100\left(\frac{1}{(SRS*W)/(W*SRS_{max})}\right)\right\}$

APPENDIX 2 - Glossary of Terms

Below is a list of terms used throughout the report, cross-referenced to their South African term(s).

Table 18. Glossary of terms

Element	South African	Explanation
Assessment	Évaluation scolaire	• The term assessment is generally used to refer to all activities teachers use to help students learn and to gauge student progress.
Certified/Certification	Qualifié ou diplômé / Certification en tant que …	• Certification refers to the confirmation of certain characteristics of an object, person, or organization. This confirmation is often, but not always, provided by some form of external review, education, assessment, or audit. • One of the most common types of certification in modern society is professional certification, where a person is certified as being able to competently complete a job or task, usually by the passing of an examination. • There are two general types of professional certification: some are valid for a lifetime, once the exam is passed. Others have to be recertified again after a certain period of time. Also, certifications can differ within a profession by the level or specific area of expertise they refer to.
Competence	Aptitude	• Competence is a generic term used to describe an acceptable performance in the appropriate context; it is the ability to do a particular activity to a prescribed standard. • Competence is measured against (a set of) documented criteria. • Competence usually regroups a number of activities or behaviors typical of a job but may not include all job tasks.
Competence (General Area of)	Activité(s)	• General Area of Competence (GAC) are made up of competencies following this rough classification: ○ Competencies related to specific divisions in work assignment or job activities. ○ Competencies that comprise knowledge, skills, and abilities (KSAs) used extensively as part of one or more job activities. ○ Competencies that relate to a generic set of learning activities.
Competency	Tâche / Savoir-faire / Compétence	• Competency and competencies are concepts used to label particular abilities and refer to

		activities.
		• Competency statements always contain a verb that describes what the person does.
		• For operational purposes, competencies:
		  ○ Taken together, fully describe the general area of competence (GAC) they are a part of.
		  ○ Are constituent parts of general areas of competence.
		  ○ Fully describe an independent job unit.
		  ○ Describe what the individual is able to do.
		  ○ Include each and every job skill; fully describe the job in behavioral terms.

Competency (Profile Chart)	Activités et taches professionnelles	• A Competency Profile Chart outlines all competencies that a worker, tradesperson, and (therefore) an apprentice, is expected to perform on the job. It forms the basis for developing a training program.
Content - Program outline	Abrégé du programme pédagogique	• A list of topics required for each learning task.
Content - Materials	Ressources pédagogiques / Matériel didactique	• A comprehensive package (in any medium) of information required to support the delivery of learning tasks.
Course	Cours	• [Is} a short, pithy statement which informs a student about the subject matter, approach, breadth, and applicability of the course [material]. • Focuses on content ... we are looking for a list of topics[25]. • There is no standard definition of the word course in UK higher education … the definition of a course is usually driven by the academic regulations and structures of a provider. • A course [is] a coherent academic engagement with a defined set of learning outcomes. • [A] course [is] something you can apply to. • A course [is] the thing that leads to the student's qualification[26].
Curriculum (also see syllabus, program)	Programme scolaire / de formation	• In formal education, a curriculum is the set of courses, and their content, offered at a school or university. A curriculum is prescriptive, and is based on a more general syllabus which merely specifies what topics must be understood and to what level to achieve a particular grade or standard. • May also refer to a defined and prescribed

[25] Stanford University the Office of the Registrar
[26] Higher Education Statistics Agency (UK)

		course of studies, which students must fulfill in order to pass a certain level of education.
Delivery - Instructor	Enseignement – Instructeur / Formateur	• Individual tasked with teaching apprentices or aspiring workers.
Evaluation	Évaluation	• Evaluation is making a judgement (or set of judgements) on how well a (training) program has reached its stated objectives. Summative evaluation (hereinafter referred to as "evaluation") is the last and concluding step in the DACUM process and the ADDIE training and instructional development models. • The results of evaluation exercises allow us to determine: o The type of contribution the (training) program made to the organization. o Participants' reaction to elements of the (training) program. o Participants' grasp of the (training) program contents. o Participants' success in applying newly learned concepts and behaviors on the job. o The (training) program's cost-effectiveness. o How the (training) program might be improved. o Whether or not the (training) program should be repeated or modified before repeat deliveries.
Exam – Competence evaluation	Évaluation des aptitudes / du savoir-faire	• Competence evaluation is a test of practical competence. Competence is defined as 'the ability to do a particular activity to a prescribed standard'. Competence is based on the belief that what people do rather than what they know is most important in terms of job safety, (training) outcomes, and productivity. Competence is measured against specific job competencies. • A Competence evaluation is trade / occupation-specific. Competence evaluations focus on "core competencies" for the trade / occupation. Those core competencies are identified by subject matter experts (SMEs); core competencies are defined as work activities that are critical to safety and / or extremely common.
Exam - Exam	Examen	• An exam(ination) or test is an assessment intended to measure a candidate's knowledge, skill, aptitude, physical fitness, or ability. An exam or test may be administered orally, on paper, on a computer, or in a confined area that requires a test taker to

		physically perform a set of skills. Formal examinations or tests often yield grades or test scores.
Exam - Quiz	Test	• A quiz is a brief assessment used in education and similar fields to measure growth in knowledge, abilities, and/or skills. • Quizzes are usually scored in points.
Exam – Skills Check	Examen des savoir-faire	• See "Competence Evaluation" above • The results of a Competence evaluation allow us to determine: o The skills level of the candidate against core job competencies. o The training required to fill the skills gaps, if any. o The most appropriate training mode to fill the skills gaps.
KASA - Ability	Capacité	• The power or capacity to perform an activity or task[27]. • An internal / self- (or external) evaluation of an individual's affective, cognitive, and psycho-motor domains' capacities (sometimes partially captured via qualifications) that allow for the placement of that individual on an idiosyncratic ordinal scale.
KASA - Attitude	Attitude	• A state of mind or feeling with regard to some matter. • Affective domain activities such as training or end-of-course-evaluations, and so on, would tap "attitudes".
KASA - Knowledge	Connaissance(s) - Savoir(s)	• An organized body of information, usually factual or procedural in nature. • Cognitive domain activities such as training, end-of-course-evaluations, and so on would tap "knowledge". • As opposed to competencies, knowledge statements do not contain "action" verbs. Rather they state what the content or facts might be.
KASA - Skill	Habileté	• "Skill" is taken to be primarily to be "the ability to carry out [a] particular task" or "the proficient manual, verbal, or mental manipulation of data or things". • Rather than "ability based on some permutation of dexterity, practical knowledge, theoretical knowledge and social ability", or "the ability or potential ability to

[27] http://www.va.gov/jobs/hiring/apply/ksa.asp

		fulfill all the tasks associated with or negotiated for an occupation"[28].
Learning outcome	Aboutissement de l'apprentissage	• A statement of what a learner will be able to do as a consequence of attending a course, studying materials, using a job aid, etc. • Also referred to as "Learning Objective".
Learning task	Attente(s) d'apprentissage	• One of a set of instructional activities which, collectively, are required in order to reach one of a competency's enabling objective, or the competency's learning or performance outcome.
Needs Assessment	Évaluation des besoins	• A needs assessment is a systematic effort to gather data, ideas, and opinions from a variety of sources about performance problems, or new systems/procedures, or new technologies' impact on workers. • A need is a gap between the current situation (actuals) and a more desirable future situation (optimals). A need only exists when there is a discrepancy or gap between actuals and optimals. A training need is training required to fill that gap. • **Note** that training may not be that appropriate response to any given gap.
Performance outcome	Résultat(s) prévus	• A statement describing the learner's observable, measurable behavior resulting from attending a course, studying materials, using a job aid, etc. • Also referred to as "Instructional/Performance Objective".
Qualification	Qualification	• Qualification refers to documentary evidence (in the form of certificates, guild membership, proof of training, on-the-job experience, etc.) that shows the bearer is recognized as a practitioner in the field for which the qualification has been issued. • "Certification" is often used as a synonym.
Qualified	Qualifié	• A bearer of (a) qualification(s) is said to be qualified • Some will argue that one may be certified (i.e. be the bearer of a qualification or certificate) but not qualified. In that instance, "qualified" refers to the (evaluated) ability to "do the job" regardless of documentary evidence in hand.
Qualitative (e.g. assessment, evaluation, research, etc.)	Approche qualitative	• Reported outcomes of investigations in the physical or social realms that eschew any numerical representation (or, at most, report

[28] Winch C, and Clarke, L (2003); "Front-loaded" Vocational Education versus Lifelong Learning. A Critique of Current UK Government Policy, Oxford Review of Education, 29:2, 239-252

		rudimentary frequencies/counts) or mathematical (usually statistical) manipulation. Often used as a counterpoint to "quantitative" (aka "hard"), "qualitative" outcomes report on attributes of interest using the vernacular (although with post-moderns, there has been a marked increase in the use of obscure language). • There is a connection between the qualitative and the quantitative via the theory of measurement: "The objects measured, their properties and the relationships between them are described as *qualitative*, to distinguish them from numbers and numerical relationships, which are described as *quantitative* … Such qualitative structure, however, may be similar (i.e. isomorphic or homomorphic) to quantitative (numerical) structures. It is in virtue of this structural similarity that numerical systems may be used to *represent* qualitative empirical systems.[29]"
Quantitative (e.g. assessment, evaluation, research, etc.)	Approche quantitative	• Commonly thought to be the assignment of numbers (real, rational, and irrational) to a process, product, result, or any outcome of an investigation in physical or social realms. This assignment of numbers to outcomes is taken as a confirmation that some sort of attribute has been measured. While commonly understood to follow Steven's (1946) nominalist-representational formulation: "a measurement is the assignment of numerals to objects or events according to a rule[30]", the concept of measurement as an arbitrary, investigator-based assignment of a scale is erroneous. • "Put as succinctly as possible, *measurement* is **the numerical estimation of the ratio of a magnitude of a quantitative attribute to a unit of the same attribute**." • "*Quantitative attribute*. A quantitative attribute (or quantity) is an attribute the instances of which are related to one another both ordinally and additively. One version of (continuous) quantitative structure is given by Hölder's (1901) axioms[i] … Not all

[29] Michell, J (1993): The Origins of the Representational Theory of Measurement: Helmholtz, Hölder, and Russell, *Studies in History and Philosophy of Science* 24 (2), 185-206 (emphasis in original)

[30] Stevens, S.S. (1946): On the theory of the scales of measurement. *Science*, 103, 667-680

		attributes are quantitative. E.g. length is quantitative, but neither sex nor nationality is.[31]"
Training	Formation	• A planned, systematic set of mediated activities which results in a predicted, (mainly) permanent behavior change in the participants and is (i) a response to a documented knowledge or skill-based performance gap, and (ii) job-specific, location-specific, or firm-specific.

[31] Both quotes from Michell, J (1997): Quantitative science and the definition of *measurement* in psychology. *British Journal of Psychology*, 88, 355-383 (emphasis in original)

APPENDIX 3 – Select Web References

Accessed 19 - 24 March 2016

http://www.collegesa.co.za/what-is-a-tvet-college.html

http://www.tasagauteng.co.za/the-nature-of-artisan-development-in-south-africa-tooling

http://www.sol-tech.co.za/wp-content/uploads/2009/09/Article-26D-trade-certificate.pdf

http://southafricapage.com/learnerships-for-2016/

http://www.ceta.org.za/registered-qualifications/

http://nadsc.dhet.gov.za/site/NAMB.aspx

http://www.fetcolleges.co.za/

http://africaskills.co.za/trade-test-centre/

http://www.qcto.org.za/index.php/registered-qualifications

http://www.labourguide.co.za/health-and-safety

http://www.dhet.gov.za/DHET%20Statistics%20Publication/Statistics%20on%20Post-School%20Education%20and%20Training%20in%20South%20Africa%202012.pdf

http://www.bibc.co.za/news/Collective%20Agreement%201%20November%202010.pdf

http://www.goenterprise.co.za/index.php/q-a-a/what-is-a-seta/29-ceta

Statistics Canada
http://www.statcan.gc.ca/pub/81-004-x/2010002/article/11253-eng.htm
Accessed 26 November 2015

Statistics Canada
http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3154&lang=en&db=imdb&adm=8&dis=2
Accessed 26 November 2015

[i] Hölder's axioms (1901) are as follows (from Michell, J (1993): The Origins of the Representational Theory of Measurement: Helmholtz, Hölder, and Russell, *Studies in History and Philosophy of Science* 24 (2), 185-206:

1. Given any two magnitudes, *a* and *b*, of the same kind, *one* and *only one* of the following is true
   (i) *a* is identical with *b* (i.e. *a=b* and *b=a*).
   (ii) *a* is greater than *b* and *b* is less than *a* (i.e. *a>b* and *b<a*).
   (iii) *b* is greater than *a* and *a* is less than *b* (i.e. *b>a* and *a<b*).
2. For every magnitude there exists one that is less.
3. Any two magnitudes of the same kind, *a* and *b*, when added in a definite order give a well determined sum, *a+b*
4. For any two magnitudes of the same kind, *a* and *b*, *a+b>a* and *a+b>b*.

5. If for any two magnitudes, a and b, of the same kind, $a<b$ then there exists magnitudes x and y also of that kind such that $a+x=b$ and $y+a=b$.
6. For any three magnitudes, a, b, and c, of the same kind $a+(b+c)=(a+b)+c$.
7. If all magnitudes of the same kind are divided into two classes such that
   (i) each magnitude belongs exactly to one class, and
   (ii) each magnitude of the first class is smaller than any magnitude of the second class, then there exists a magnitude, m, such that every magnitude $m'<m$ belongs to the first class and every magnitude $m''>m$ belongs to the second class (m may belong to either, depending upon the case)