Skills, Professional Regulation, and International Mobility in the Engineering Workforce

By Matthew Dixon

MIGRATION POLICY INSTITUTE

THIS PROJECT IS FUNDED
BY THE EUROPEAN UNION

Skills, Professional Regulation, and International Mobility in the Engineering Workforce

Matthew Dixon

July 2013

MIGRATION POLICY INSTITUTE

THIS PROJECT IS FUNDED BY THE EUROPEAN UNION

Acknowledgments

The author would like to thank the Migration Policy Institute (MPI) for the invitation to write this report, which it is hoped may prove a useful reference source for those interested in the international mobility of people working in engineering. The contributions of Madeleine Sumption and Susan Fratzke of MPI in helping sharpen the initial draft are particularly appreciated. Thanks also go to Katy Turff and Jim Birch, the relevant officials of the Engineering Council, for their valuable help in the report's preparation, and to Ken Mayhew, of the Economic and Social Research Council's Center on Skills, Knowledge and Organizational Performance (SKOPE), for feedback on an early draft.

This report was produced for MPI's project on Immigration, Skills, and Mobility in the Transatlantic Labor Market, which was conducted in partnership with Migration Policy Institute Europe. MPI would like to acknowledge Milica Petrovic and Sarah Flamm for their contributions to the research and to organizing the roundtable discussions in Europe and the United States respectively.

The project and this report were funded by the European Union. The report's contents are the sole responsibility of the author and can in no way be taken to reflect the views of the European Union

Cover Design: Danielle Tinker
Typesetting: Erin Perkins, LeafDev

Suggested citation: Dixon, Matthew. 2012. *Skills, Professional Regulation, and International Mobility in the Engineering Workforce*. Washington, DC: Migration Policy Institute.

Table of Contents

Glossary

ABET	(US) Accreditation Board for Engineering and Technology
APEC	Asia-Pacific Economic Cooperation
DBIS	(UK) Department for Business, Innovation and Skills
EMF	Engineers' Mobility Forum
ENAEE	European Network for Accreditation of Engineering Education
EU	European Union
EUR-ACE	EURopean ACcredited Engineer, the European accreditation label for engineering degree programs
FEANI	European Federation of National Engineering Associations (Fédération Européene d'Associations Nationals d'Ingenieurs) (www.feani.org/site/index.php?id=228)
IEA	International Engineering Alliance (www.washingtonaccord.org/)
IPD	Initial professional development
MAC	(UK Home Office) Migration Advisory Committee
MEA	Mutual exemption agreement
MRA	Mutual recognition agreement
MRPQ	Mutual recognition of professional qualifications
NAFTA	North American Free Trade Agreement
NCEES	(US) National Council of Examiners of Engineering and Surveying
NSB	(US) National Science Board
OECD	Organization for Economic Cooperation and Development
SKOPE	(The Economic and Social Research Council's) center on Skills, Knowledge and Organisational Performance, Universities of Oxford and Cardiff
SOC	(UK) Standard Occupational Classification
TEP	Transatlantic Economic Partnership
UK LFS	UK Labour Force Survey (Office for National Statistics)
UNESCO	United Nations Educational, Scientific and Cultural Organization

Executive Summary

Engineers are recognized as a valuable asset for the economies in which they work, in particular because of their contributions to innovation and productivity. Engineering is also an important field for international mobility, in part because of the scale of cross-border working, trade, and cooperation in internationally active industries such as petroleum, engineering services, and information technology (IT).

Because some engineering activities carry potential risks to society — resulting, for example, from poor design, construction, operation, or maintenance — they are often regulated. Engineers may be required to meet certain official competence standards before they can carry out specific activities, use a professional title, or sell their services to the public. Within the whole gamut of engineering activity, a comparatively small number of safety-critical areas exist. In some countries only these areas are regulated directly, while in others engineers who tackle the safety-critical tasks are regulated for all areas of their work.

Current arrangements for international recognition of engineering credentials are very complex.

Such regulation results both in barriers to entering work (which may bring economic disadvantages) and barriers to international mobility. For example, a worker who has been admitted to the profession in one country may not have the formal credentials to be admitted in another. Current arrangements for international recognition of engineering credentials are very complex, involving a wide range of regulation practices between countries and a range of regulating authorities with different powers and relationships with government. The engineering workforce is also highly complex: it involves a range of engineering occupations operating across the economy in various industry sectors, within a number of different engineering disciplines, each of which includes a number of broad work areas. Against this backdrop, efforts to allow foreign-trained engineers to be quickly "recertified" when they move abroad face various obstacles:

- The degree of regulation differs between countries, making it harder for engineers to move from jurisdictions with low levels of occupational regulation to those with higher levels (for example, from Northern to Southern Europe)
- The scope of tasks that different types of engineers are expected to fulfill (and thus the knowledge and competences they are expected to demonstrate) varies by country, and it is often not possible for an individual to be licensed or registered only for the specific activities he or she will actually carry out
- Education and training traditions differ, with some countries ascribing more importance to formal education and others more to practical experience. Significant scrutiny is generally required before authorities can understand and recognize the substantive equivalence of differently structured initial professional development[1] arrangements in other countries.

1 Initial professional development (IPD) is often used within the engineering profession to cover all aspects of preparatory learning and experience that bring a new professional to the stage where s/he can be admitted to the profession or achieve a level of competence necessary in order to operate as an autonomous professional. In some countries this covers the *education base*, *structured training* and *validated experience*, in others just the relevant (tertiary) education. After "admission" to the profession, the professional's competence and commitment are updated through *continuing professional development* (CPD).

Engineers themselves have devoted much time and effort over recent decades to initiatives aimed at reducing international barriers to the recognition of engineering qualifications. This has been done both within Europe, through the European Federation of National Engineering Associations (FEANI), and beyond, under the auspices of the International Engineering Alliance (IEA). Both have proposed common standards for accredited engineering tertiary education programs in participating countries. They have also established international registers such as those for the European engineer (EUR ING) and international professional engineer (IntPE), with the goal of creating internationally transferable professional titles despite national differences in professional education and training requirements. In addition, the European Union's Professional Qualifications Directive has attempted to tackle unreasonable barriers to the movement of engineers — and other professionals — within the European single market.

Progress in much of this work has been slow. Since national engineering bodies have each already "fought" within their own countries to negotiate common standards, their ability to agree to changes in order to accommodate the standards of other jurisdictions is limited. As a result, agreements between professional bodies are often not binding on the authorities that make decisions on foreign professionals' right to practice, and thus do not guarantee the immediate recognition of professionals covered by an agreement. These initiatives may well have more value as an internationally recognizable benchmark rather than as a ticket to immediate recognition by regulatory authorities. Encouragingly, the Washington Accord, which sets out a common standard for engineering education, is now officially recognized as a mark of quality in the admissions process for employment-based immigrants to Australia.

Progress in much of this work has been slow.

Evaluating the direct impact of initiatives in this field is difficult in the absence of data on the international mobility of engineers who have taken advantage of them. The barriers to mobility can seem daunting and unhelpful to the individual, but there are various practical ways around them, particularly for large companies. It would be helpful to have more evidence on the nature of the economic losses that regulatory barriers impose. If the political commitment and the perceived economic gains of reducing barriers to mobility were sufficient, policymakers could put their weight behind the efforts of the engineering profession, and even accelerate the establishment of common international standards for regulating safety-critical activities directly, thus reducing the need for occupational regulation beyond them.

I. Introduction

"The critical roles of engineering in addressing the large-scale pressing challenges facing our societies worldwide are widely recognized... tackling the coupled issues of energy, transportation and climate change; providing more equitable access to information for our populations, clean drinking water; natural and man-made disaster mitigation, environmental protection and natural resource management, among numerous others.

"Engineering is one of the most diverse professions in terms of fields of engineering, types and levels of engineer, where and how they are employed as well as the status of engineers and engineering, and this diversity is reflected around the world; engineering is both global and local. Most political leaders and policy-makers appear to agree that the development and application of knowledge in engineering and technology underpins and drives sustainable social and economic development…"

-- United Nations Educational, Scientific, and Cultural Organization

Engineers are useful: they "make things work." The skills they bring are fundamental for our societies and contribute significantly to innovation, economic growth, national well-being, and prosperity. Many of the innovations of the past 50 years have arisen from the creative application of engineering skills, and the engineering world, influenced by waves of new discoveries from within the science world and creative tackling of practical problems, is one of almost constant change.

Many of the innovations of the past 50 years have arisen from the creative application of engineering skills.

Forecasts of future growth show that economic activity in Europe and other developed regions continues to shift away from the primary sector and toward knowledge-based industries, many of which rely on engineering skills.[2] Governments in developing economies, particularly in Asia, are also recognizing the importance of science and technology to growth and have invested heavily in technology and knowledge-based industries. As new leaders in Asia and elsewhere increase their capabilities, traditional industry leaders — such as the United States and some European countries — are losing some of their dominance.

In Europe, the creation of a common market and currency is thought to have helped to support the position of the EU economies in science and technology fields. As a major portion of European technological trade occurs within the borders of the European Union, the ability of people and goods to flow freely across borders has a significant role to play in future economic growth in this area.[3] The shift to a knowledge-based economy has not only influenced the domestic labor market, but also has implications for the movement of labor across international borders.

This report attempts to explain the basic structure of the engineering workforce, as well as the key elements that influence the realities of constraints on international migration of those with engineering qualifications and expertise. It examines efforts made over recent decades to address and cope with differences in national arrangements for both tertiary education and the requirements for admission to the profession, and considers how serious barriers to international migration are in practice.

II. Engineering Skills and Structure of the Workforce

Generally speaking, national bodies representing the engineering workforce at all levels recognize three major categories of engineering professional: the *theoretical engineer*, the *applied engineer* (in some countries termed *engineering technologist*), and the *engineering technician*. While the terms used for these categories and the requirements for admission to the profession vary considerably across countries, the recognition of these three categories seems fairly universal in developed economies. Although the categories are generally thought of as different *levels* on a hierarchical scale, it is more helpful to think of them in terms of types of work. So, as an example, the UK Engineering Council summarizes the broad remit of the three categories as follows:

- *Engineering technicians* apply proven techniques and procedures to the solution of practical engineering problems. They carry supervisory or technical responsibility, and are competent to exercise creative aptitudes and skills within defined fields of technology. Professional engineering technicians contribute to the design, development, manufacture, commissioning, decommissioning, operation, or maintenance of products, equipment, processes, or services.

2 European Centre for the Development of Vocational Training (CEDEFOP), *Future Skill Needs in Europe: Medium-Term Forecast*, Synthesis report (Luxembourg: CEDEFOP, 2008), www.cedefop.europa.eu/EN/Files/4078_en.pdf.

3 See National Science Board (NSB), *Science and Engineering Indicators 2012* (Arlington, VA: NSB and National Center for Science and Engineering Statistics [NCSES], 2012), www.nsf.gov/statistics/seind12/.

- *Applied engineers*[4] (or *engineering technologists*) maintain and manage applications of current and developing technology, and may undertake engineering design, development, manufacture, construction, and operation. Such engineers are variously engaged in technical and commercial management and must, therefore, possess effective interpersonal skills.

- *Theoretical engineers*[5] must be able to develop appropriate solutions to engineering problems, using new or existing technologies, through innovation, creativity, and change. They might develop and apply new technologies; promote advanced designs and design methods; introduce new and more efficient production techniques, marketing, and construction concepts; or pioneer new engineering services and management methods. Because theoretical engineers are variously engaged in technical and commercial leadership, they must also possess effective interpersonal skills.

In addition to the professional categories described above, a significant number of people also work in other, lower-skill-level, occupational categories, such as skilled trades and engineering operatives. Those in the skilled trades generally experience — because of the less technically sophisticated type of work they do — fewer barriers to mobility than engineering professionals.

Forecasts of employment distributions within the engineering workforce in the coming years consistently anticipate both a growing demand for high-level engineering skills, such as those of engineers and technicians, and a falling — though not disappearing — demand for lower-level engineering skills, such as those used in the skilled trades. Of course, caution should be exercised when relying upon any forecasts of a system as complex as the engineering labor market.

As well as these categories of engineering professionals, engineers and technicians work in a wide range of *disciplines* or *branches of engineering*, for example, civil engineering, mechanical engineering, electrical engineering, and production engineering.[6] Within each discipline, engineering professionals may be employed in a number of different industrial sectors. So, for example, civil engineers work (*inter alia*) both for construction companies and local authority highways and building control departments. Aeronautical engineers may be employed by either aerospace manufacturing companies (a "supplier" sector) or airlines (a "user" sector). Within the course of a career, an engineering professional may well move between a supplier and a user sector. A civil engineer might naturally move from a local authority to an engineering consultancy that has done a lot of work for that authority (or vice versa), for example, while an IT professional might spend half his or her career in a software or IT services company and the second half working for an IT user company that was one of the previous employer's customers.

An analysis of recent Labor Force Survey data from the United Kingdom (see Appendix 2) provides a quantitative example of how the engineering workforce can best be understood, and illustrates the distribution of professional employment across both occupations and industry sectors.[7] The sectors employing the highest numbers of professional engineers and technicians in the United Kingdom are construction and building services and engineering manufacturing; however, the chemical, pharmaceutical, petroleum, energy, and government (including defense) industries also employ significant numbers of engineers and technicians. It is important to note that while some of the sectors with substantial engineering workforces are active internationally (like petroleum and construction), others (like government and defense) are rather less so. This, of course, has implications for the need of engineers and technicians to move across national borders themselves. While the distribution of employment across sectors and engineering occupations will vary between countries, the structure shown in the Appendix 2 is present in all cases.

4 Termed "Incorporated Engineers" by the UK Engineering Council.
5 Termed "Chartered Engineers" by the UK Engineering Council.
6 A more detailed — and illustrative — list of engineering disciplines is provided in Appendix 1.
7 Author's analysis of the UK Labour Force Survey. Note that the Labour Force Survey data reflect only employment within the United Kingdom.

III. The Role of Qualifications in Engineering Careers

How do employers assess the qualifications of prospective recruits? Engineering is, of course, a supremely *practical* activity, but also depends on specialists' underlying knowledge and understanding. Engineering work includes a significant technical element and, at the higher levels, the application of both fundamental scientific principles and often comparatively complex engineering theory. Thus, the technical content of the initial professional development (IPD) for an engineering career can be particularly high in comparison with some other professions. Engineering professionals often need to understand comparatively complex theoretical models and apply them intelligently and sensibly. While much of engineering depends on a sound, basic understanding of science and mathematics, which must be acquired during secondary education, it is the *tertiary education* that provides the knowledge base required in an engineering career. At the skilled trades and technician levels, the tertiary education often consists of vocational engineering courses and apprenticeships, while at professional levels a vocational university degree in a branch of engineering or allied subjects (e.g. materials or applied physics) is both the norm and, usually, a formal requirement for subsequent admission to the profession. It is, therefore, not surprising that when a professional engineer moves from one country to another, the assessment of his or her capabilities can depend — at least in part — on the perceived quality of the engineering degrees awarded in the country of origin. This has led national engineering bodies to take considerable interest in the engineering degrees of other countries, as discussed below.

Although a good engineering degree will often be viewed as essential in the early years of a career, as with most other professions, employers recruiting experienced engineers are generally more interested in past professional achievement than formal qualifications. Of course not all recruiting employers will assess track records identically: as well as the perceived quality of degrees (often through the assumed status of the university from which they were awarded), they will also gauge the "quality" and relevance of previous (or current) employers, in particular when an applicant is staying in the same sector.[8] Of course a recruiting employer will be able to assess and value past experience more meaningfully if that experience was with an employer it (1) knows and (2) respects.

Employers recruiting experienced engineers are generally more interested in past professional achievement than formal qualifications.

For overseas candidates, recruiting employers will often know correspondingly less about previous employers, and of course the question of employer size will play a role. However, the applicant's previous experience, as revealed both in written documentation and in interviews, will — particularly in engineering — generally be given considerably more weight than either academic qualifications or, indeed, anything that the candidate achieved before age 25.[9] In addition, most evidence from the recruiting and hiring process in the United Kingdom suggests that, more generally, qualifications do not weigh particularly heavily among the criteria on which new recruits are selected.[10] This raises questions about the actual career importance of qualifications of any kind. There are likely to be two main underlying reasons for this:

- The focus of qualifications achieved within the formal education system is almost entirely on

8 Note that for career moves between sectors — for example, between supplier and user organizations — *relevance* does not always mean that a candidate must come from the same sector.
9 On the other hand, it is also likely that international moves occur earlier than later in a career.
10 Ewart Keep and Susan James, "Recruitment and Selection — The Great Neglected Topic" (SKOPE Research Paper No. 88, Center on Skills, Knowledge and Organizational Performance, Universities of Oxford and Cardiff, February 2012, www.skope.ox.ac.uk/publications/recruitment-and-selection-%E2%80%93-great-neglected-topic.

knowledge, while a person's overall contribution to his or her employer depends on a number of key capabilities beyond specific knowledge or understanding (e.g., motivation, interpersonal skills, and the ability to apply appropriate theoretical principles in new situations).

- For other sorts of qualifications — e.g., professional qualifications or competence-based vocational qualifications — employers' ability to understand what such assessments actually mean about the individual's likely performance in new situations is generally limited. This is of course even more true for candidates from overseas. (If employers are not 100 percent clear about the relevance and meaning of professional/vocational qualifications within their own countries, how much more uncertain will they be of such qualifications from other jurisdictions?).[11]

After recruitment, the best employers operate training and development schemes for their employees, and engineering professional bodies can help them with the development, refinement, and quality assurance of such programs, although there is considerable variation among employers, as well as among national traditions. In general, larger employers manage to provide more training for their staff than smaller ones. Although employers often pay limited attention to professional engineering qualifications, the inherent value of such titles remains, and engineering professional bodies continue to promote and market them to employers. In some locations, employer awareness of such qualifications and their use in recruitment has grown, albeit slowly.[12]

In sum, employers generally attribute less weight to formal qualifications than might be expected. While, in principle, qualifications are perceived to be a good thing in a candidate, it is simply not clear what they reveal about an individual candidate's likely contribution in a specific working context. (Note that formal qualifications are equally imperfect as an indicator of a person's economic contribution more broadly. While formal qualifications may be the *best available proxy* for someone's "level of skill," policymakers may attribute too much importance to the specific qualification an individual has, including when formulating employment-based immigration policies.)

IV. Safety and the Role of Professional Regulation

The new artifacts engineers create are intended to be beneficial, but sometimes such creations can operate in ways that cause risks, whether as a result of poor design and construction, careless use, or unexpected behavior of some kind. Certain objects (e.g., those involving high-voltage electrical supplies and devices) and processes (involving hazardous chemicals or flammable or explosive substances) contain inherently dangerous elements. It is thus not surprising that ensuring the safety of the user is an important element of the work of engineers.

While, in principle, the public interest seeks confidence that all engineering activities are carried out safely, certain tasks involve considerably greater elements of risk to users and the public than others. In building services engineering, for example, the reliable installation and commissioning of gas-fired appliances is generally accepted as higher risk than the plumbing of cold water systems. In marine engineering, ensuring that a ship's hull is stable and watertight would be viewed as more important to safety than the installation of a public address system on the vessel, useful though the latter is (and potentially crucial in an emergency situation). The dangers of high-voltage electrical systems also necessitate a range of protective measures for working on them.

It is natural, therefore, that the authorities responsible for the safety of potential users of engineered products and systems focus on certain engineering tasks and activities to ensure — through regulation of some kind — that these tasks are reliably and safely carried out. However, the threshold between regu-

11 In general, there is much greater diversity (at least within Europe) in the different — mostly vocational — qualifications available at the subdegree level. This makes specifying mutual recognition standards for technologists, and (particularly) technicians, even more challenging than for professional engineers.
12 As evidenced, for example, by more mention of such titles in recruitment advertisements.

lated and unregulated activities, and the mode of regulation, can vary between countries or jurisdictions and is determined by a number of factors, such as:

- Public attitudes following specific serious incidents, such as a rail or marine transport disaster, which may result in calls for stronger regulation
- Cultural attitudes to risk arising from the nature and traditions of the society
- The way in which damage liability and insurance are handled in national legal systems (in some cases companies' operating systems and services are responsible by law for accidents, in others liability can be pinned on to individual designers or operators)

While governments are often the arbiters of regulation, only those with the deep technical understanding of the products and systems involved can adequately assess risk and specify the measures required to reduce it to reasonable levels for society. This fact has led the engineering profession to develop and refine its own view about the requirements for the competence and commitment of individual professionals whose work involves safety-critical activities.

Types of Regulation

The range and breadth of engineering disciplines is such that no single individual professional engineer can be expected to have competence (or even significant knowledge) in all areas.[13] Even within a particular engineering discipline (e.g. civil engineering, marine engineering) there are a number of distinct *broad technical areas* of work specialization. Most individual engineers spend the majority of their careers within one (or at most two or three) of these areas. The tasks and activities with the greatest risk to society generally constitute only a very small part of any one area (see Table 1).[14] In addition, high-risk engineering activities are generally handled directly by a particular category of engineering occupation — typically, the design and development elements by professional engineers and technologists, and implementation and maintenance aspects by engineering technicians or even skilled engineering tradespeople. The reality of this hierarchical structure raises fundamental questions about how safety-critical (s-c) tasks should be regulated and *how precise* the regulation of s-c activity should be.

13 Twelve disciplines, including eight for professional engineers and four for technicians, are indicated in the occupational categories in Appendix 2; the European Federation of National Engineering Associations (FEANI) focuses on 15, and 28 are listed in Appendix 1.

14 Table 1 is intended to be only illustrative — not definitive or comprehensive — and it should be noted that there are often crossover points among the different disciplines (for example, rail signalling work is directly relevant to the rail engineering element in transport, but it would generally be carried out by a telecommunications engineer or technician). In practice, effective management of large engineering projects generally involves expertise in a wide range of engineering disciplines.

Table 1. Examples of Safety-Critical/Regulated Activities within the Broad Work Areas of Selected Engineering Disciplines

Civil Engineering

	Construction	Earthquake Engineering	Environmental Engineering	Geophysics	Geotechnical Engineering	Water Resources	Structural Engineering	Transport Engineering	Surveying
Professional Engineer (theoretical)		(sign-off on new structure safety in earthquake-prone areas)				(Dam/ reservoir design)	(Tall building/ bridge design sign-off)		
Professional Engineer (applied)/ Engineering Technologist						(reservoir inspection)		(Rail signaling)	
Professional Engineering Technician								(Rail signaling)	
"Skilled Trades"									

Mechanical Engineering

	Fluids	Product Design	Hydraulics & Pneumatics	Manufacturing Engineering	Combustion, Engines, Fuels	Strength of Materials	Computer-Aided Design/ Computer-Aided Manufacturing	Energy Conversion	Mecha-tronics/Control
Professional Engineer (theoretical)		(Gaining regulatory approval for aircraft safety)			(Pressure vessel design)				
Professional Engineer (applied)/ Engineering Technologist		(Compliance with product regulatory requirements)			(Pressure vessel design/ manu-facture)				
Professional Engineering Technician				(Aircraft maintenance)	(Pressure vessel welding)				
"Skilled Trades"				(Aircraft maintenance)					

Electrical/Electronic Engineering

	Power	Control	Electronics	Micro-electronics	Signal Processing	Telecommunications	Instrumentation	Computers	Network Analysis
Professional Engineer (theoretical)									
Professional Engineer (applied)/ Engineering Technologist						(Rail signaling)			
Professional Engineering Technician						(Air traffic control system monitoring/ maintenance)			
"Skilled Trades"									

It is, in principle, possible to regulate:

- (just) specific safety-critical activities; or
- the specialized broad work area within the discipline; or
- the engineering disciplines that include each such activity; or
- the practice of professional engineers or technicians in all disciplines.

For example, in some countries rail signaling work is specifically regulated, while in others the overarching regulation of all telecommunications work would ensure the safety of rail signals. In yet other countries *all* electrical/electronics engineers might be regulated (in the process covering any work on rail signals) and — ultimately — in countries with the strongest regulation traditions, *access* to all engineering work is regulated. In reality, regulation often combines elements of all four approaches.

The precision with which regulation is applied to ensure satisfactory work in s-c areas is key to questions of job access and mobility. Regulating an activity that doesn't really need it is in principle undesirable: the broader the scope of occupational regulation around essential areas, the greater the unnecessary barriers to accessing jobs. Table 1 confirms that few areas of engineering work as a whole are s-c; most engineering activity does not require formal regulation.

Additional complexities exist. A study by the European Federation of National Engineering Associations (FEANI) on the regulation of engineering in Europe tentatively classifies national approaches into four categories:[15]

- Those that were not regulated
- Those that protected only professional titles (without any associated reserved tasks)[16]
- Those that both protected professional titles and reserved tasks in select areas

15 European Federation of National Engineering Associations (FEANI), "Survey on the Regulation of the Engineering Profession in Europe," *Special FEANI News 10/2005*, www.feani.org/site/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/PDF_Documents/FEANI_News/FEANI_NEWS_Special_October_2005_in_PDF_format.pdf&t=1349192364&hash=ecc6ccc55c19e0e5d08e4e7a1ae19c1b4704bc10.

16 Reserved tasks are those that, within a particular jurisdiction, can be carried out by only those with specified training and — most often — relevant professional qualifications, acquired through membership in a national professional association.

- Those that were totally regulated, reserving tasks in all areas (with protected titles and full licensure).

While there have been certain adjustments since the FEANI survey was carried out in 2005, all four types of regulation still exist across Europe. In a number of countries, the tertiary education qualification — even if academic and thus including little practical activity — *is* the professional qualification.

While a certain amount of regulation is needed to mitigate engineering risk, it can have an economic downside, especially for workers moving across jurisdictions with different regulatory regimes. In principle, regulation can:

- Restrict the supply of labor to a profession, and keep remuneration at higher levels than might be necessary
- Provide a pretext for justifying restrictive practices, including unnecessary barriers to entry into an occupation or profession (often to benefit "those already in the club").

V. When Engineers Move Across Jurisdictions

Occupational regulation has historically developed within particular spatial jurisdictions — often those of the nation-state and in some cases smaller geographical units, such as US states. This regulation can inhibit mobility where the scope of the labor market is not the same as the scope of a particular regulatory authority. (For example, consider a single country with multiple subnational regulatory bodies, or a region where workers frequently move between countries with different regulations.) In general, the greater the mobility within a labor market, the more efficiently the corresponding economies are thought to perform.

People inevitably find ways around regulatory barriers. The most obvious is the last-minute use — often on the basis of a short consultancy assignment — of a professional, local engineer to carry out the formalities required to comply with prevailing local regulations. So, an engineering company might employ engineers and technicians recruited from abroad to perform all tasks right up to the formal sign-off (for example, certifying the safety of a large structure), and then buy a day or two of a local structural engineer's time for the sign-off itself. In general, when the engineer is an employee — whether moving within an international company or switching to a new one in a different country — there is no pressing need to become registered or licensed in the new country.

Overall, therefore, it is not clear to what extent laws and regulations might impede the mobility of engineers across borders. They may impact the individual, however. Negotiating the recognition of a professional qualification can drag on for years in some countries, but during that time the "unrecognized" foreign engineer can nevertheless be in engineering employment. In this situation, the concern is that the engineer receive the formal recognition he or she deserves; without it, employment might not be as desirable or lucrative as the engineer might wish.

It is not clear to what extent laws and regulations might impede the mobility of engineers across borders.

Economists have argued that reducing barriers within regional groupings, such as the European Union or the signatories of the North American Free Trade Agreement (NAFTA), could ultimately "level the playing field" in the global labor market and capture the economic benefits of greater international trade. It is no coincidence that current arguments for action to stimulate growth at the European level include pressure to reduce barriers to mobility. In fact, this argument is playing a role in the current finalization of the Review of the Professional Qualifications Directive (PQD)[17] (2005/36/EC) and its implementation.[18] Engineers themselves have also devoted substantial energy to initiatives designed to reduce barriers, as described in the next section.

A. *Assessing and Addressing Regulatory Differences Across Borders*

One of the most far-reaching attempts to reduce regulatory barriers to mobility for engineers has taken place within the European Union. Movement among EU Member States, whose professional regulation varies considerably in type and strength, is governed (in principle) by the European Commission's Directive on Mutual Recognition of Professional Qualifications, known as the Professional Qualifications Directive, or PQD.[19] Under the directive, regulatory bodies must recognize an EU citizen's application for professional registration or licensure in engineering if the course of education and training he or she has undertaken is of a similar length to the required standard in the destination country. In some circumstances, the destination country may require the applicant to take an aptitude test *or* undergo a period of supervised work experience ("adaptation period"). However, there are differences in how Member States define a "regulated profession" and there continue to be inconsistencies in the implementation of the directive. A major review exercise took place over the course of 2011, following which the EU Commission put forward proposals for certain significant revisions to the PQD.[20]

Experience over a number of years with the PQD and its predecessors is of particular value in considering issues of engineering skills and credentials. The challenge of facilitating mobility across a group of countries — in this case, the European Union — that exhibit a remarkable amount of variation in their regulation of the profession raises questions about the mutual equivalence of engineering practice, skills, and qualifications.[21]

Of the 31 European countries surveyed in the 2005 FEANI study, five had no regulation of engineering practice, 14 operated only some activities in one or more engineering disciplines, eight protected professional titles (and seven of these regulated some activities in one or more disciplines), and four regulated all modes of practice in most engineering disciplines.[22] A clear geographical pattern emerged: overall, regulation was *least* in the northern countries and *most* in the southern countries. The major differences have had an asymmetric effect on workers moving within Europe. In very broad terms, engineers trained in the south moving to the north would be expected to encounter fewer barriers to practice, while those moving in the opposite direction might not be eligible for employment as engineers for quite a while. As a result, the European Commission has, in a number of cases, proceeded against governments and competent authorities in (particularly) southern European countries for noncompliance with the directive, and in some cases has pursued Member States vigorously.

---

17 And indeed the review of the related Services Directive, and "Single Market" policy more generally.

18 For example, the UK response to the European Commission's consultation on the review stated that, "recent evidence suggests that there is significant untapped potential in EU services, both in terms of productivity and employment… Reforming the process for mutual recognition of professional qualifications in the EU is a key achievable priority in improving the single market in services, and creating growth." See Department for Business, Innovation and Skills (DBIS), "UK Government Response to European Commission Public Consultation on the Mutual Recognition of Professional Qualifications Directive," March 2011, www.bis.gov.uk/assets/biscore/europe/docs/u/11-794-uk-government-response-mutual-recognition-professional-qualifications.

19 The current directive (2005/36/EC) was designed in the light of considerable previous experience with "general systems" directives, which cover all professional occupations.

20 At the time of writing these are with the European Parliament and the Council of Ministers for consideration.

21 The first "general systems" directive, going beyond arrangements agreed for individual professions, and covering engineering for the first time, dates back to 1989.

22 At least one southern European country regulated "subdisciplines" as well. Note that certain changes are to be expected arising from adjustments since the survey.

B. Engineering Activity and Scope of Competence

A key way in which European regulations on professions can differ by country relates to the *scope* of the technical professional activity being regulated. Because engineering practice in the various fields developed differently in different countries, "adjacent" professions (both within engineering and beyond) often carry out different elements of related work. For example, the split of legal responsibilities between architects and civil or structural engineers in different countries may vary. In some cases, formal sign-off on s-c elements might lie with the architect, in some it might lie with the engineer. Such variations in competence coverage have led to arrangements that have sometimes presented real challenges to individual engineers. To illustrate its concerns about PQD implementation in aeronautical engineering, the UK government used a much-cited example:

A UK aeronautical engineer working on jet engines in another (EU) Member State was required to have training in building runways in order to be registered, so he could sign off his repairs. The UK Competent Authority intervened on his behalf, and the Member State allowed him to register on the condition that he did not work on runways.[23]

EU Member States are, in theory, obliged to allow applicants access to the activities for which they are qualified — without requiring them to qualify for activities they do *not* intend to practice — so long as there is no public safety hazard involved. According to a recent EU evaluation, however, regulatory bodies are often reluctant to do this.[24]

The formal tertiary education systems, and in particular the engineering degrees, of different countries naturally form the starting point for the assessment.

The challenge faced by the host nation's competent authority (which may be a government department, a nongovernmental body specified by the national government, an entity handling individual professions, or an organization with representatives from a wide range of professions) is to establish whether the applicant's professional background is adequate to allow him or her to practice safely in the host country straight away, or whether any additional competence or expertise must be acquired before he or she can be allowed to start work or offer services unsupervised. In principle, this judgment is influenced both by the regulation arrangements in the desired host (or destination) EU Member State and the general interest of protecting public safety. In some cases, the desire to protect the resident labor market from competition with immigrants may intrude upon such decisions. In policy terms, EU Member States' pressure to "reasonably protect" the national labor market[25] clash with employers' needs for skilled labor (where it might not be available from the resident labor market) and the desire to conform with both the PQD and broader economic principles. In practice, with a small number of exceptions, EU Member States can only limit admission of economic migrants from countries beyond the European Economic Area (EEA)[26] and Switzerland.

Individual judgments are made by comparing relevant credentials — including education and initial training arrangements — of similarly skilled engineers in the sending and receiving countries. Since there is a very wide range of training approaches (often designed by individual employers), comparisons of provision must generally be made on an individual basis (rather than by comparing national norms). The formal tertiary education systems, and in particular the engineering degrees, of different countries naturally form the starting point for the assessment. It is not surprising that education systems, which

23 DBIS, "UK Government Response to European Commission Public Consultation."
24 European Commission, "Evaluation of the Professional Qualifications Directive," 2011, http://ec.europa.eu/internal_market/qualifications/docs/news/20110706-evaluation-directive-200536ec_en.pdf.
25 For example, where there might be significant numbers of people with such skills unemployed.
26 The European Union countries, plus Norway, Iceland, and Liechtenstein.

reflect a major element of national culture, are also richly diverse within Europe; in particular, differences exist between the Anglo-Saxon higher education traditions and those of continental universities.[27] In short, while post-graduation learning and assessment requirements within the Anglo-Saxon system are significant — and much more so than on the continent — continental university programs are traditionally longer, by one or more years, than those in the United Kingdom and Ireland. Since the duration of tertiary education courses is often used as a proxy for the level — or quality — of training, this difference has posed real challenges for perceptions and comparisons.[28]

C. Mobility of Engineers in the United States

Although the cultural traditions and economic realities of the US states (and Canadian provinces) are considerably less heterogeneous than those in European countries, there are, nevertheless, labor market barriers between them, not least in relation to professional engineering practice. A valuable overview of professional credential recognition in the United States is provided by Linda Rabben.[29] Regulations and the licensing of professional practice in engineering and some other professions are determined by state and provincial bodies, and mutual recognition between these jurisdictions is by no means automatic.

Within the United States, a federal-level authority, the Accreditation Board for Engineering and Technology (ABET), develops, refines, and applies the engineering tertiary education standards — in particular by accrediting engineering and technology degree programs — while professional licensing in each state is controlled by state (professional licensing) boards. A federal body, the National Council of Examiners for Engineering and Surveying (NCEES), develops, administers, and scores the examinations used for engineering and surveying licensure in the United States. It also works to facilitate professional mobility and promotes uniformity of the US licensure processes through services for its member licensing boards and licensees. In practice, however, the NCEES is essentially a grouping of state boards and is only able to initiate universal changes to labor market access arrangements where all state boards agree.

Arrangements in Canada are rather similar, in that provincial and territorial engineering bodies handle licensing, while a federal level organization, Engineers Canada, handles tertiary course accreditation. While Engineers Canada (by analogy with NCEES) also works on "moderating" the discussion among the different provincial or territorial licensing associations (particularly over recent years with federal government support), it does not run its own examinations or have direct authority to facilitate individual engineer movement between provincial or territorial jurisdictions.

VI. Engineers' Own Approaches: Mutual Recognition Agreements

Engineers themselves, desirous perhaps of seeking solutions to perceived mobility problems before others (in particular, governments) enforce their solutions on the engineering community, have explored the challenges and developed a number of practical approaches to the issue of mutual recognition of engineering qualifications. These include, most notably, arrangements developed by two collaborative groupings of national engineering bodies — one in Europe and one beyond. Such national bodies generally regulate engineering-related activity within a given country, and are of two kinds: (1) those that regulate standards of tertiary education courses (these are often called accrediting bodies; they "assure" the quality of a country's engineering degrees from the perspective of the profession); and (2) those that regulate

27 On the continent, some degree courses leading to professional practice are enshrined in law.
28 The 1999 Bologna Declaration of Ministers of EU Member States, establishing governmental commitment to the creation of a European Higher Education Area (EHEA) has addressed some of the differences between Member States, but has brought additional comparison complexities in its wake.
29 Linda Rabben, *Credential Recognition in the United States for Foreign Professionals* (Washington, DC: Migration Policy Institute, 2013), www.migrationpolicy.org/pubs/UScredentialrecognition.pdf.

admission to the profession, whether in terms of professional engineering *title* or professional engineering *practice*.

A. Arrangements among European Countries

The European Federation of National Engineering Associations (FEANI)[30] was founded in 1951, a few years after the end of World War II, by a group of French and German engineers who believed that through technology, their common field of activity, it would be possible to create constructive links between former adversaries, and thus facilitate the prosperous and peaceful development of European society. Associations from seven European countries immediately joined the initiative. Today associations from 32 European countries are represented in FEANI[31] (bringing together more than 350 national-level engineering bodies of different kinds), all of which are recognized in their countries as the representatives of the engineering profession at the national level (although their roles vary by nation). Through these national associations, FEANI represents the interests of approximately 3.5 million professional engineers in Europe.[32]

At the beginning of the 1960s, FEANI was convinced that the engineering profession in Europe could not be strengthened without mutual recognition of the professional qualifications provided by the numerous and diversified national systems. FEANI has, therefore, worked to set up structures to facilitate such recognition. Two main registers have been established to advance this goal: the FEANI Index (which lists the engineering degrees that are recognized in each member country by the national association), and the European Engineer (EUR ING) Register. All professional engineers who have submitted their credentials for admission to the profession via their national monitoring committees (NMCs), and whose credentials are approved by the FEANI European Monitoring Committee (EMC), are registered with the EUR ING title, which they may then use in their work.

In addition, FEANI has been active in the establishment of the European Network for Accreditation of Engineering Education (ENAEE), which has developed the European Accredited Engineer (EUR-ACE®) framework standards. National degree accreditation agencies in the European higher education area that have demonstrated that their criteria and procedures are in line with the EUR-ACE® framework standards and the ENAEE standards and guidelines for accreditation agencies are authorized by ENAEE to award the EUR-ACE® label.[33] Where desired by a university (and on payment of the corresponding fee), programs accredited by authorized agencies can be awarded the label and entered into the EUR-ACE® database, which contains engineering degree programs at the Bologna "first cycle" (bachelor's) and "second cycle" (master's) levels. Some FEANI members are also ENAEE members, but members of ENAEE are, in general, degree-accrediting bodies rather than national associations of engineers.

FEANI continues to work on arrangements to help mutual understanding of national tertiary education arrangements and to support mobility of engineers between member association countries. It is important to recognize that FEANI has focused on supporting mutual recognition of both national engineering tertiary education (and so of national engineering qualifications, in particular engineering degrees) and national requirements for licensing as professional engineers.

30 See European Federation of National Engineering Associations (FEANI), "Welcome to FEANI," www.feani.org/site/.
31 National engineering bodies from all the EU countries except Latvia and Lithuania, plus those from Croatia, Iceland, Macedonia, Norway, Russia, Serbia, and Switzerland.
32 See FEANI, "Welcome to FEANI."
33 There can be more than one European Network for Accreditation of Engineering Education (ENAEE) member from each country, and fewer European countries have ENAEE members than FEANI members.

While a good engineering degree is a key requirement to be able to practice as an engineer, its role in relation to full professional licensing varies across European countries. In some countries, the degree is the only qualification required for practice, while in others it represents the first step — and subsequent structured training and validated experience are required. This difference introduces a significant asymmetry to comparisons of engineering formation among European countries. When the requirements for access to the EUR ING title were negotiated, it became clear that a flexible model was needed for the different national professional formations.

As the result of an agreed-upon compromise, the EUR ING title is awarded on the basis of evidence of seven years of initial professional development (IPD), of which at least three years must be spent in completion of a FEANI-recognized formal education program (or equivalent); two years must be preliminary professional experience; and two additional years must be either (additional) formal education, professional experience, or formal training monitored by an approved engineering institution. This flexibility enabled both Anglo-Saxon three-year programs (with subsequent additional IPD) and the longer programs customary in continental Europe to be accommodated.

B. Beyond Europe

The same two-tier structure for mutual recognition — addressing engineering tertiary education and requirements for admission to the profession — is used by the national engineering bodies working together in the International Engineering Alliance (IEA).[34] An alliance of the national degree-accrediting or practice-regulating bodies of some 19 signatories to the six multilateral agreements it administers, IEA grew from the Washington Accord, which was signed in 1989 by the engineering (accreditation) bodies of six English-speaking countries (see Appendix 3). The accord is an international agreement among bodies responsible for accrediting engineering degree programs. It recognizes the substantial equivalence[35] of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. Of the six agreements administered by the IEA, three relate to the tertiary education base of the professional engineer or technician:

- ***The Washington Accord,*** signed in 1989, recognizes substantial equivalence in the accreditation of qualifications in *professional engineering*, normally for programs of four years' duration
- ***The Sydney Accord*** commenced in 2001 and recognizes substantial equivalence in the accreditation of qualifications in *engineering technology*, normally for programs of three years' duration
- ***The Dublin Accord*** is an agreement for substantial equivalence in the accreditation of tertiary qualifications in *technician engineering*, normally for programs of two years' duration. It commenced in 2002.

The other three agreements cover recognition of individual professional development, rather than tertiary qualifications. In principle, a person recognized in one country as reaching the agreed international standard of competence should only be minimally assessed (primarily for local knowledge) prior to obtaining registration in another country that is party to the agreement.

- ***The Asia-Pacific Economic Cooperation (APEC) engineer agreement*** commenced in 1999 with support from APEC member governments. The agreement functions via national registries, administered by engineering bodies, which list those engineers who wish to have their competence recognized in other member economies at the generic international standard.
- ***The Engineers Mobility Forum (EMF) agreement*** commenced in 2001. It operates the same competence standard as the APEC engineer agreement but allows engineering bodies of any country or economy to join.

34 See www.washingtonaccord.org/.
35 Necessary because exact (100 percent) equivalence is rarely — if ever — possible.

- ***The Engineering Technologist Mobility Forum (ETMF) agreement*** was signed by engineering representatives of participating economies and countries in 2003.

These agreements are possible because of the concept of *substantial equivalence*: While there are detailed differences among both tertiary education systems and national practice requirements, in most cases, such differences will not result in significant limitations on the capabilities of the individuals who have passed through them. Most differences in training will not even be detectable after a number of years of professional experience in an international engineering team (such as that of a large multinational engineering company).

C. Evaluating Mutual Recognition Initiatives in Engineering

Links between national engineering bodies have developed over the years, and more actively than in some other professions. This is perhaps because engineers are often asked to work abroad or because they are used to working in collaborative teams in order to solve common problems. The multilateral mutual recognition arrangements established both within Europe (through FEANI) and beyond (under the auspices of IEA) have now been in place for a number of years. How well do they work?

The first thing to note is that cooperation in both groupings has proved valuable and interesting to the bodies themselves. The processes involved in the multilateral groupings involve a range of peer-review elements that provide those influential in national engineering activity both with new insights into how things can be done differently, and a growing body of evidence about differences between national systems that (1) help clarify understanding of both perceived strengths and weaknesses of various systems, and (2) result in adjustments in national systems that can lead, incrementally, to greater convergence of approaches.

Links between national engineering bodies have developed over the years, and more actively than in some other professions.

Second, there has been progress in some countries toward using agreed-upon international standards to determine immigration eligibility for engineers. The immigration authorities in Australia, for example, use Engineers Australia, the national engineering association, as the authority to determine an applicant's eligibility to work in the country as a professional engineer (or technologist). This process allows fast-track recognition of degrees accredited under the Washington Accord (or Sydney Accord, for technologists). Most IEA members work with their interior ministries to seek recognition of their professional qualifications in assessments for visas, and where such lobbying is successful, benefits to those coming with appropriate credentials from other IEA member countries could accrue over time.

However, the various multilateral arrangements have their limitations, since the national engineering bodies involved do not in all cases directly control all aspects of regulation of engineering practice. It is not yet the case that engineers and technicians from any one country involved in FEANI or IEA can be guaranteed, by virtue of these arrangements, that they can move to another member country and immediately start to practice just as they did in their country of origin. Indeed, constraints on members' abilities to remove all barriers to mobility have limited the value of these agreements for the individual. For example, the EUR ING title is *not* directly recognized by the relevant authorities in FEANI member countries (a serious disappointment, given initial aspirations), and so the Federation continues to work on other approaches to reducing barriers, (e.g., by contributing to ENAEE and exploring the *engineering card* approach).[36]

36 This is of particular importance since the European Commission expressed interest that a *professional card* model be explored in the context of PQD revision.

And while IEA's aspirations in developing professional licensing/registration agreements mirrored FEANI's original barrier-reducing aspirations for EUR ING, the alliance has, in reviewing the EMF/ETMF approach, decided that change is needed for the agreements to make more impact. The constitutions of the EMF, APEC engineer, and ETMF agreements have recently been revised in order to change the emphasis from *mobility facilitation as a result of a schedule of benefits*, to a *standards setting and assessment regime*. The new constitutions for the agreements are designed to increase mobility by achieving — and assessing against — a newly agreed-upon set of graduate attributes, competencies, and experiential requirements, as well as a better understanding of standards on the part of all member jurisdictions.

D. Reasons Behind Slow Progress

Do these developments imply that engineers' own efforts to achieve the barrier-reduction goal have failed? It is probably too early to say, but future success will depend on the building of mutual confidence among authorities in different countries. It is worth reflecting that the bodies engaged in these multilateral relationships are essentially all *regulatory authorities*, whose broad objectives, culture, and natural instincts are those of "gatekeepers." Institutions responsible for maintaining standards are good — within their national jurisdictions — at saying "no" to things that don't meet those standards.

It is therefore inevitable that progress toward full confidence in the tertiary education and registration/licensing practices of other countries, and ultimately full mutual recognition, will be slow. And too much speed could be risky: the desire to cooperate constructively with partners from other countries and the need to (be seen to) succeed in delivering structures and systems may cause some of the more complex and subtle challenges of mutual equivalence to be brushed over, sowing the seeds of later problems.

One example of the complexity that can arise is the use, within each multilateral group, of certain *bilateral* mutual recognition — or mutual exemption — agreements (MRAs and MEAs). These occur between pairs of authorities[37] who have become familiar with others' systems through the multilateral forums, and who, as a result, have realized that their two systems are considerably more similar than many others, and can therefore justify a more substantive agreement — i.e. one that provides *greater exemptions* from assessment requirements for the migrating engineer.[38] In principle, if "bilaterals" steadily increase within a multilateral grouping, then ultimately it could be argued that there is no point in having the multilateral agreement. But the fact that bilateral agreements do arise reflects a reality about the heterogeneity of national standards within the multilateral group that should not be ignored.

The more heterogeneous the individual national standards within a multilateral group, the higher the common bar must be set, and the greater the needed confidence that all other parties will implement any agreed-upon standards in a robust fashion. This underlines the importance and value of the mutual learning process and, perhaps, the acceptance that structures are likely to be more effective when arising from an extended, and particularly careful, familiarization process.

Evidence of the numbers of engineers and technicians who have made use of (or benefited from) multilateral agreements suggests that considerably more use has been made of the tertiary education agreements than the professional licensing agreements. In terms of the direct outcomes of the multilateral agreements, while more than 6,000 engineering programs have been accredited under the Washington Accord (the majority in the United States and the United Kingdom), fewer than 5,000 *individuals* are on the IEA's International Professional Engineer (IntPE) register. FEANI's EUR ING register has been more popular, with just over 30,000 members as of May 2011, but still represents a small share of European engineers (see Appendix 4). Unfortunately, while these are encouraging achievements, their impact on overcoming mobility barriers is less significant.

37 For example, the (UK) Institution of Civil Engineers and Engineers Australia.

38 It should be recognized that some bilateral mutual recognition agreements (MRAs) or mutual exemption agreements (MEAs) (e.g., between UK disciplinary engineering professional bodies and the national authorities in other IEA countries) were initiated *before* the corresponding multilateral agreements.

Overall, a very considerable amount of work has been undertaken, within both European and multilateral groups, including the United States, to facilitate the recognition of engineering credentials. However, challenges remain that limit the practical value of some of the agreements. Substantial equivalence[39] as an approximate — even, in some cases, a "rough-and-ready" — measure brings challenges, and effective implementation of these agreements inevitably varies across countries.

Overall, a very considerable amount of work has been undertaken, to facilitate the recognition of engineering credentials.

As indicated, the numbers involved in the various arrangements developed by the engineering profession are comparatively small (see Appendix 4). However, without data on international flows of engineers who benefit from these arrangements — and indeed given the limited available data on such flows of any kind — it is difficult to know what fraction of those flows are affected by the arrangements (into which considerable effort has been invested). Overall, the conclusion is that any such mutual activity must, over time, lead to greater mutual understanding and (ultimately) convergence, and must therefore be considered beneficial even if significant results are not immediate.

39 In order to make such agreements possible, it is necessary to use substantial — rather than exact — equivalence, which results in tricky judgements about whether differences between perceived "levels of degrees" between any two countries are sufficiently small or not. If substantial equivalence is accepted where the difference is too large, subsequent problems could occur.

Box 1. Case Study: Prospects for Cooperation in the Mobility of Engineers between the European Union and the United States

The United States and the European Union face particular challenges to identifying possible strategies for reducing barriers overall, since both the US federal government and the European Commission have no direct authority over the bodies who control either tertiary engineering education or professional licensing within the labor markets in their economies. This means that change could only come if the two entities were able, and prepared, to enforce reform on the authorities within the individual jurisdictions (i.e., Member States in the case of the European Union and state licensure boards within the United States).

It is worth noting that bilateral EU-US efforts along similar lines in 1999 and 2000, under the auspices of a Transatlantic Economic Partnership (TEP) and involving three professions (architects, accountants, and engineers), made limited progress because of these difficulties. The fact that most constraints exist within the engineering authorities of the different jurisdictions might suggest that public policy could, with enough political will, override such bodies and require them to better align their regulatory and accreditation requirements with those of other countries (as is the approach of the EU PDQ).

While that would, in principle, be an option, the authority of the European Commission to override national authorities is limited and the US federal government is generally careful about trying to intervene in policy areas that have traditionally been the preserve of state governments. Even at the level of individual European Member States such action is not always effective: a recent example of attempted recognition of other countries' professional engineering qualifications in a southern European country found the national engineering body able, constitutionally, to ignore instructions from the national government.

Currently, there is no formal (intergovernmental) bilateral arrangement concerning the movement of engineers or technicians between jurisdictions in any European country and any US state. Variations exist within both sets of jurisdictions in relation to both the nature and degree of regulation of professional engineering practice and the arrangements relating to tertiary education in engineering. As described, there are, however, multilateral agreements for both tertiary education and professional registration or licensing involving engineering (accreditation and regulatory) bodies from the United States and from two European countries (Ireland and the United Kingdom).

If progress is to be achieved at this very high bilateral jurisdictional level, then it will be necessary to distil, and build any strategy on, experience from the arrangements that have been tried thus far, in particular, in this case, that of the European PQD and the IEA agreements. Although progress could not be expected to be fast, the first step might well be to provide governmental support for existing efforts to improve mutual understanding, with the hope that this would, for example, lead to better alignment between the Washington Accord and ENAEE. Were the political will to be sufficient, official attention on implementation issues with professional licensing arrangements, in both the PQD (with respect to engineers) and the EMF and ETMF agreements could almost certainly make a difference. Such a focus would, in practice, probably need to be greatest on issues within jurisdictions where professional regulation is stronger or broader in scope.

Even greater impact could in principle be achieved by a more radical approach: working through national standards bodies (where there is a long tradition of international cooperation) to seek agreement on regulation standards for work in all safety-critical areas (some of which already exists, e.g., for pressure vessel welding). If such agreement could be achieved, the continuation of broader occupational regulation justified on safety grounds would then be difficult to sustain.

However, any significant cooperative policy measures would involve substantial effort, given the great complexity and diversity of current institutional arrangements. In a context of unusually great pressure on public resources in most of the countries involved, such a commitment would probably require more evidence of the scale of the problem (and thus the potential economic benefits of barrier removal) than is currently available, as well as considerable confidence that policy interventions would have a good chance of producing real returns on the public investment involved. Neither point is particularly evident, but that is where the challenge lies for those tasked with implementing top-level agreements in this area.

VII. Conclusion: Assessing Barriers to Mobility

The initiatives presented in this report confirm the considerable variety and complexity of professional engineering careers, as well as the challenges in clarifying any simple, or even single, approach to reducing barriers to international movement. Experience with the design, implementation, and revision of the European PQD, in particular, confirms both (1) the great difficulty in tackling those barriers that exist, and (2) the fact that ways and means to achieve desired mobility have been found in spite of most such barriers.

Initiatives to facilitate the mobility of individuals with engineering skills have some inevitable limitations. As mentioned above, qualifications are not taken as seriously in the recruitment process as is often assumed. This is true within national labor markets, and almost certainly even more true in international labor markets, since the employer is likely to have even less understanding of how a particular title or qualification reveals what a candidate can actually do. Other efforts over recent years to clarify qualification equivalence between countries — in particular within the European Union in relation to the emerging European Qualifications Framework — raise real questions about confidence both in *level* equivalence and in the meaning of such equivalence and its value to employers.[40] Indeed, other practical factors such as language ability, transferability of pensions, a lack of professional contacts in other countries, and recruiting employers' lack of knowledge of applicants' previous employers may ultimately represent more significant hurdles to international mobility than any barriers to professional registration or official recognition of formal qualifications.

Initiatives to facilitate the mobility of individuals with engineering skills have some inevitable limitations.

The Future: Virtual Mobility

As with most other aspects of our lives and work, IT in general and the Internet in particular are bringing significant changes in how things are done and what can be done. In particular, there is inevitable growth in the remote provision of analytical and expert services. While this will not quickly dispense with activity directly associated with work on site, a considerable amount of higher-level expertise can be (and is already) delivered without the need for physical presence. This raises fundamental questions about the delivery of engineering services, and largely bypasses the jurisdictional issues that depend on spatial domains. As this kind of service delivery develops, it may test many of the barriers considered in this report, and raise a number of serious questions. Might some virtual service delivery breach local regulatory requirements, or even break the law in the "receiving country?" On the other hand, might it not "call the bluff" of the regulators — bypassing regulatory constraints that cannot really be justified? What happens when something goes wrong? How would transnational legal frameworks attribute responsibility? Ultimately, such developments may be poised to have an enormous impact on the deployment of skills across jurisdictions in the coming decades, calling into question regulators' ability to impose unnecessary barriers and — perhaps — significantly accelerating efforts to reduce them.

40 Matthew Dixon, "The European Qualifications Framework: Important European Enabler or Questionable Diversion for Bureaucrats?" (SKOPE Issues Paper 23, Center on Skills, Knowledge and Organizational Performance, University of Oxford, July 2010), www.skope.ox.ac.uk/publications/eqf-important-european-enabler-or-questionable-diversion-bureaucrats.

Works Cited

Department for Business, Innovation and Skills (DBIS). 2011. UK Government Response to European Commission Public Consultation on the Mutual Recognition of Professional Qualifications Directive. Department for Business, Innovation and Skills, March 2011. www.bis.gov.uk/assets/biscore/europe/docs/u/11-794-uk-government-response-mutual-recognition-professional-qualifications.

Dixon, Matthew. 2010. The European Qualifications Framework: Important European Enabler or Questionable Diversion for Bureaucrats? SKOPE Issues Paper 23, Center on Skills, Knowledge and Organizational Performance, University of Oxford, July 2010. www.skope.ox.ac.uk/publications/eqf-important-european-enabler-or-questionable-diversion-bureaucrats.

European Center for the Development of Vocational Training (CEDEFOP). 2008. *Future Skill Needs in Europe: Medium-Term Forecast* Synthesis report. Luxembourg: CEDEFOP. www.cedefop.europa.eu/EN/Files/4078_en.pdf.

European Commission. 2011. Evaluation of the Professional Qualifications Directive. http://ec.europa.eu/internal_market/qualifications/docs/news/20110706-evaluation-directive-200536ec_en.pdf.

European Federation of National Engineering Associations (FEANI). 2005. Survey on the Regulation of the Engineering Profession in Europe. *Special FEANI News*, October 10, 2005. www.feani.org/site/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/PDF_Documents/FEANI_News/FEANI_NEWS_Special_October_2005_in_PDF_format.pdf&t=1362854735&hash=ba5919aedb73a4e49f447e158db528f56e290c56.

Keep, Ewart and Susan James. 2010. Recruitment and Selection — The Great Neglected Topic. SKOPE Research Paper No. 88, Center on Skills, Knowledge and Organizational Performance, Universities of Oxford and Cardiff, February 2012. www.skope.ox.ac.uk/publications/recruitment-and-selection-%E2%80%93-great-neglected-topic.

National Science Board (NSB). 2012. *Science and Engineering Indicators 2012*. Arlington, VA: National Science Board (NSB) and National Center for Science and Engineering Statistics (NCSES). www.nsf.gov/statistics/seind12/.

Rabben, Linda. 2013. *Credential Recognition in the United States for Foreign Professionals*. Washington, DC: Migration Policy Institute. www.migrationpolicy.org/pubs/UScredentialrecognition.pdf.

(UK) Engineering Council. 2010. United Kingdom Standard for Professional Engineering Competence: Engineering Technician, Incorporated Engineer and Chartered Engineer Standard. www.engc.org.uk/ecukdocuments/internet/document%20library/UK-SPEC.pdf.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2010. Engineering: Issues, Challenges and Opportunities for Development. http://unesdoc.unesco.org/images/0018/001897/189753e.pdf.

Appendices

Appendix 1. An Overview of Engineering Disciplines

This list is intended to be illustrative — to give a feel for the *breadth of engineering activity* — rather than exhaustive or definitive. Note that descriptions and definitions differ from country to country, often overlapping and changing over time.[41]

Agricultural engineering

- Engineering theory and applications in agriculture in such fields as farm machinery, power, bioenergy, farm structures, and natural resource materials processing

Chemical engineering

- Analysis, synthesis, and conversion of raw materials into usable commodities
- Biochemical engineering — biotechnological processes on an industrial scale

Civil engineering

- Design and construction of physical structures and infrastructure
- Coastal engineering — design and construction of coastline structures
- Construction engineering — design, creation, and management of constructed structures
- Geo-engineering — proposed earth climate control to address global warming.
- Geotechnical engineering — behavior of earth materials and geological phenomena
- Municipal and public works engineering — for water supply, sanitation, waste management, transportation and communication systems, and hydrology
- Ocean engineering — design and construction of offshore structures
- Structural engineering — design of structures to support or resist loads
- Earthquake engineering — behavior of structures subject to seismic loading
- Transportation engineering — efficient and safe transportation of people and goods
- Traffic engineering — transportation and planning
- Wind engineering — analysis of wind and its effects on the built environment

Computer and systems engineering

- Research, design, and development of computer, computer systems, and devices

41 United Nations Educational, Scientific and Cultural Organization (UNESCO), "Engineering: Issues, Challenges and Opportunities for Development," 2010, http://unesdoc.unesco.org/images/0018/001897/189753e.pdf.

Electrical engineering and electronic engineering

- Research, design, and development of electrical systems and electronic devices
- Power systems engineering — bringing electricity to people and industry
- Signal processing — statistical analysis and production of signals (e.g., for mobile phones)

Environmental engineering

- Engineering for environmental protection and enhancement
- Water engineering — planning and development of water resources and hydrology

Fire protection engineering

- Protecting people and environments from fire and smoke

Genetic engineering

- Engineering at the biomolecular level for genetic manipulation

Industrial engineering

- Analysis, design, development, and maintenance of industrial systems and processes

Instrumentation engineering

- Design and development of instruments used to measure and control systems and processes

Integrated engineering

- Generalist engineering field including civil, mechanical, electrical, and chemical engineering

Maintenance engineering and asset management

- Maintenance of equipment, physical assets, and infrastructure

Manufacturing engineering

- Research, design, and planning of manufacturing systems and processes
- Component engineering — assuring availability of parts in manufacturing processes

Materials engineering

- Research, design, development, and use of materials such as ceramics, composites, and nanoparticles
- Ceramic engineering — theory and processing of oxide and non-oxide ceramics
- Textile engineering — the manufacturing and processing of fabrics

Mechanical engineering

- Research, design, and development of physical or mechanical systems such as engines
- Automotive engineering — design and construction of terrestrial vehicles
- Aerospace engineering — design of aircraft, spacecraft, and air vehicles
- Biomechanical engineering — design of systems and devices such as artificial limbs

Mechatronics

- Combination of mechanical, electrical, and software engineering for automation systems

Medical and biomedical engineering

- Increasing use of engineering and technology in medicine and the biological sciences in such areas as monitoring, artificial limbs, and medical robotics

Military engineering

- Design and development of weapons and defense systems

Mining engineering

- Exploration, extraction, and processing of raw materials from the earth

Naval engineering and architecture

- Research, design, construction, and repair of marine vessels

Nanotechnology and nanoengineering

- New branch of engineering on the nanoscale

Nuclear engineering

- Research, design, and development of nuclear processes and technology

Production engineering

- Research and design of production systems and processes related to manufacturing engineering

Software engineering

- Research, design, and development of computer software systems and programming

Sustainable engineering

- Developing branch of engineering focusing on sustainability and climate change mitigation

Test Engineering

- Engineering validation and verification of design, production, and use of objects under test

Transport Engineering

- Engineering relating to roads, railways, waterways, ports, harbors, airports, gas transmission and distribution, pipelines, and associated works

Tribology

- Study of interacting surfaces in relative motion including friction, lubrication, and wear

Appendix 2. Employment Structure of the Professional Engineering Workforce, United Kingdom

Employment level estimates by broad sector and engineering occupation

Sectors Occupations (with SOC 2000 ref.)	Chemical, Pharmaceutical, Nuclear, Petroleum, Polymers and Life sciences	Construction and Building Services	Gas, Power, Waste Management and Water Industries	Information Technology and Telecommunications	Passenger Transport	Government (inc. Defense)	Food and Drink Manufacturing	Processing and Manu-facturing[42]	Engineering Manufacturing	Media and Creative Industries[43]	Other Sectors	Total All Sectors
Professional Engineers												
2121 Civil Engineers	3,392	63,366	6,473	291	752	2,448	0	265	4,896	0	3,232	85,115
2122 Mechanical Engineers	4,148	15,114	2,833	115	5,330	4,477	1,037	1,849	39,853	0	5,592	80,348
2123 Electrical Engineers	1,780	14,561	4,735	8,630	4,570	479	726	692	13,751	0	4,925	54,849
2124 Electronics Engineers	0	5,113	135	5,135	674	1,047	0	0	13,312	1,843	5,044	32,303
2125 Chemical Engineers	5,878	1,601	1,075	129	0	0	0	0	1,366	0	823	10,872
2126 Design & Development Engineers	2,555	18,378	1,379	2,927	583	1,449	0	813	34,925	707	3,220	66,936
2127 Production & Process Engineers	5,994	3,466	1,443	376	0	845	2,625	1,110	14,627	129	2,840	33,455
2128 Planning & Quality Control Engineers	3,557	2,817	629	1,431	398	533	999	990	15,838	169	6,752	34,113
2129 Engineering Professionals n.e.c.	5,888	27,506	5,964	1,715	1,598	3,115	6,222	1,306	23,860	0	11,531	88,705
Total Professional Engineers	**33,191**	**151,920**	**24,665**	**20,749**	**13,905**	**14,392**	**11,610**	**7,025**	**162,427**	**2,848**	**43,963**	**486,695**
Technicians Working in Engineering												
3112 Electrical & Electronics Technicians	1,055	4,464	2,216	1,843	806	2,827	128	0	11,144	914	5,562	30,959
3113 Engineering Technicians	4,076	5,796	2,135	1,829	3,724	7,442	1,041	270	28,785	286	14,973	70,357
3114 Building & Civil Engineering Technicians	379	17,857	961	386	256	542	0	133	1,291	432	2,771	25,008
3115 Quality Assurance Technicians	3,247	780	793	333	108	845	1,574	1,250	6,040	238	3,283	18,491
3119 Science & Engineering Technicians n.e.c.	4,118	3,090	3,108	624	811	4,104	2,710	344	11,562	132	13,323	43,926
Total Technicians Working in Engineering	**12,876**	**31,986**	**9,212**	**5,014**	**5,704**	**15,760**	**5,453**	**1,997**	**58,822**	**2,001**	**39,916**	**188,741**

Source: UK Labor Force Survey (Q4 2008); estimates below 6,000 not statistically reliable — these are shown for illustration only.

42 Building products and refractories; coatings; ceramics; extractive and mineral processing; furniture, furnishings, and interiors; glass and related industries; paper; printing; wood.

43 TV, film, radio, interactive media, animation, computer games, facilities, photo imaging, publishing, advertising, and fashion and textiles.

Appendix 3. Signatories/Members of IEA Accords and Agreements (as of 2012, with date of joining)

Washington Accord Signatories

- **Australia** – Represented by Engineer Australia (1989)
- **Canada** – Represented by Engineers Canada (1989)
- **Chinese Taipei** – Represented by Institute of Engineering Education Taiwan (2007)
- **Hong Kong China** – Represented by The Hong Kong Institution of Engineers (1995)
- **Ireland** – Represented by Engineers Ireland (1989)
- **Japan** – Represented by Japan Accreditation Board for Engineering Education (2005)
- **South Korea** – Represented by Accreditation Board for Engineering Education of Korea (2007)
- **Malaysia** – Represented by Board of Engineers Malaysia (2009)
- **New Zealand** – Represented by Institution of Professional Engineers NZ (1989)
- **Russia** – Represented by Association for Engineering Education of Russia (2012)
- **Singapore** – Represented by Institution of Engineers Singapore (2006)
- **South Africa** – Represented by Engineering Council of South Africa (1999)
- **Turkey** – Represented by MUDEK (2011)
- **United Kingdom** – Represented by Engineering Council UK (1989)
- **United States** – Represented by Accreditation Board for Engineering and Technology (1989)

Organizations holding provisional status have been identified as having qualification accreditation or recognition procedures that are potentially suitable for the purposes of the accord; those organizations are further developing those procedures with the goal of achieving signatory status in due course; qualifications accredited or recognized by organizations holding provisional status are not recognized by the signatories.

- **Bangladesh** – Represented by Board of Accreditation for Engineering and Technical Education
- **Germany** – Represented by German Accreditation Agency for Study Programs in Engineering and Informatics
- **India** – Represented by National Board of Accreditation of All India Council for Technical Education
- **Pakistan** – Represented by Pakistan Engineering Council
- **Sri Lanka** – Represented by Institution of Engineers Sri Lanka

Dublin Accord Signatories

- **Australia** – Represented by Engineers Australia (2001)
- **Canada** – Represented by Canadian Council of Technicians and Technologists (2001)
- **Hong Kong China** – Represented by The Hong Kong Institution of Engineers (2001)
- **Ireland** – Represented by Engineers Ireland (2001)
- **New Zealand** – Represented by Institution of Professional Engineers NZ (2001)
- **South Africa** – Represented by Engineering Council of South Africa (2001)
- **United Kingdom** – Represented by Engineering Council UK (2001)
- **United States** – Represented by Accreditation Board for Engineering and Technology (2009)

Organizations holding provisional status have been identified as having qualification accreditation or recognition procedures that are potentially suitable for the purposes of the accord; those organizations are further developing those procedures with the goal of achieving signatory status in due course; qualifications accredited or recognized by organizations holding provisional status are not recognized by the signatories.

- **Chinese Taipei** – Represented by Institute of Engineering Education Taiwan
- **Korea** – Represented by Accreditation Board for Engineering Education of Korea

Sydney Accord Signatories

- **Canada** – Represented by Canadian Council of Technicians and Technologists (2002)
- **Ireland** – Represented by Engineers Ireland (2002)
- **South Africa** – Represented by Engineering Council of South Africa (2002)
- **United Kingdom** – Represented by Engineering Council UK (2002)

Organizations holding provisional status have been identified as having qualification accreditation or recognition procedures that are potentially suitable for the purposes of the Accord; those organizations are further developing those procedures with the goal of achieving signatory status in due course; qualifications accredited or recognized by organizations holding provisional status are not recognized by the signatories

- **Australia** – Represented by Engineers Australia (1997)
- **Korea** – Represented by Accreditation Board for Engineering Education of Korea
- **New Zealand** – Represented by Institution of Professional Engineers NZ (2006)
- **United States** – Represented by Accreditation Board for Engineering and Technology (2007)

Engineers Mobility Forum Members

- **Australia** – Represented by Engineers Australia (1997)
- **Canada** – Represented by Engineers Canada (1997)
- **Chinese Taipei** – Represented by Chinese Institute of Engineers (2009)
- **Hong Kong China** – Represented by The Hong Kong Institution of Engineers (1997)
- **India** – Represented by Institution of Engineers India (2009)
- **Ireland** – Represented by Engineers Ireland (1997)
- **Japan** – Represented by Institution of Professional Engineers Japan (1999)
- **South Korea** – Represented by Korean Professional Engineers Association (2000)
- **Malaysia** – Represented by Institution of Engineers Malaysia (1999)
- **New Zealand** – Represented by Institution of Professional Engineers NZ (1997)
- **Singapore** – Represented by Institution of Engineers Singapore (2007)
- **South Africa** – Represented by Engineering Council of South Africa (1997)
- **Sri Lanka** – Represented by Institution of Engineers Sri Lanka (2007)
- **United Kingdom** – Represented by Engineering Council UK (1997)
- **United States** – Represented by National Council of Examiners for Engineering and Surveying (1997)

Provisional members have been identified as having competence assessment systems developing toward equivalence to those of full members; they do not currently operate national sections of the international professional engineer register.

- **Bangladesh** – Represented by Bangladesh Professional Engineers, Registration Board
- **Pakistan** – Represented by Pakistan Engineering Council

Engineering Technologists Mobility Forum Members

- **Canada** – Represented by Canadian Council of Technicians and Technologists (2001)
- **Hong Kong China** – Represented by The Hong Kong Institution of Engineers (2001)
- **Ireland** – Represented by Engineers Ireland (2001)
- **New Zealand** – Represented by Institution of Professional Engineers NZ (2001)
- **South Africa** – Represented by Engineering Council of South Africa (2001)
- **United Kingdom** – Represented by Engineering Council UK (2001)

Provisional members have been identified as having competence assessment systems developing towards equivalence to those of full members; they do not currently operate national sections of the international engineering technologist register.

- **Australia** – Represented by Engineers Australia

Appendix 4. Some Data on Scales of Activity Relating to FEANI and IEA Arrangements

COUNTRY WITH FEANI MEMBERSHIP	Number of European Engineers on the FEANI Register *(in nearly all cases as of May 2011)*
AUSTRIA	349
BELGIUM	313
BULGARIA	36
CROATIA	0
CYPRUS	72
CZECH REPUBLIC	101
DENMARK	333
ESTONIA	34
FINLAND	658
FRANCE	2,631
GERMANY	2,666
GREECE	277
HUNGARY	649
ICELAND	17
IRELAND	1,286
ITALY	0
LUXEMBOURG	32
MACEDONIA (FYROM)	0
MALTA	184
NETHERLANDS	633
NORWAY	188
POLAND	290
PORTUGAL	52
ROMANIA	163
RUSSIA	3
SERBIA	0
SLOVAKIA	89
SLOVENIA	105
SPAIN	3,514
SWEDEN	300
SWITZERLAND	871
UNITED KINGDOM	15,094
TOTAL	**30,940**

Source: National member pages of FEANI website.

		IEA Accord/Agreement					
		Washington Accord	**Dublin Accord**	**Sydney Accord**	**EMF (Register)**	**APEC (Register)**	**ETMF (Register)**
	Units:	*# Accredited Programs*	*# Accredited Programs*	*# Accredited Programs*	*#IntPEs*	*# APEC Engineers*	*# IntETs*
Jurisdiction	**Country**						
ABET	USA	1,930	365				
Engineers C.	Canada	265			17	17	
ECUK	UK	2,311	215	6	185		29
Engineers A.	Australia	248	21		318	318	
IPENZ	New Zealand	35	13		1,629	1,629	15
Engineers I.	Ireland	69	75	48	77		0
HKIE	HK, China	128	70		34	33	18
ECSA	South Africa	51	96	1	18		7
IES	Singapore	28				32	
IEET	Chinese Taipei	401					
ABEEK	Korea	526					
JABEE	Japan	389					
CCTT	Canada		202	42			0
IPEJ	Japan				469	2,004	
KPEA	Korea				1,166	1,166	
NCEES	USA				368	368	
IESL	Sri Lanka				61		
IEM	Malaysia				307	307	
PII	Indonesia					36	
CoET	Thailand					244	
PCT	Phillipines					45	
CIE	China				41	92	
AEER	Russia					62	
Total		**6,381**	**1,057**	**97**	**4,690**	**6,353**	**69**

Notes: As can be seen, representation from some countries is different for the Education-base Accords and the "professional licensing" Agreements. For example, in the United States, the Accreditation Board for Engineering and Technology handles tertiary education program accreditation, while "professional licensing" is handled at individual state levels by licensure boards: NCEES is the federal level grouping of the state boards. The two indicators – numbers of accredited engineering programs and numbers on the relevant international Register – form the basis for the Member Fee contributions. No formal records are yet kept on international flows of people supported by the Accords and Agreements: the numbers of Engineers/Technologists/Technicians who have benefitted from the existence of these arrangements.
Source: International Engineering Alliance Secretariat, as of spring 2012.

About the Author

Matthew Dixon is a Skills Policy Researcher and Consultant specializing in the labor markets for engineering and information technology (IT) skills. He has served in senior positions both in the United Kingdom and internationally, spanning the public policy, research, development, technology transfer, training, and enterprise-support areas. After earning an engineering science degree at Southampton and a PhD in control and systems engineering at Cambridge, Dr. Dixon spent eight years at an international policy research institute, finishing as Scientific Secretary. On returning to the United Kingdom, he worked as Business Development Manager for the knowledge management systems stream of technology transfer business at the National Computing Centre. He was then appointed Chief Executive of the National Association of IT Centres, representing the national interests of over 100 IT technician training centers.

Dr. Dixon later served as International Consultant at the Engineering Council, and supported the negotiating of international multilateral mutual recognition agreements on behalf of UK professional engineers and technicians. He continues to serve on the Council's International Advisory Panel. In 1997 he joined the IT National Training Organisation, of which he was appointed Director of Research and Strategy in 2000. On a freelance basis, he has carried out assignments on IT and skills matters for a range of public-sector entities, professional bodies, and commercial organizations in the United Kingdom, at the European level, and beyond. He coauthored a European (CEN) pre-standard on an EU-level e-skills meta framework, and led — for the Council of European Professional Informatics Societies — a study for the European Commission titled *e-skills Foresight Scenarios for the ICT Industry in Europe*.

Dr. Dixon was active within the British Computer Society (BCS) from 1995, chairing its Training and Career Development Committee for six years, and serving on a number of boards and working groups. He also served on the Institute of Physics Professional Standards Committee from 2003 to 2011. Dr. Dixon represented the BCS on the Home Office agency Information Technology Communications and Electronics sector advisory panel (advising on migration policy) from 2002, and has made significant contributions to two sector panels (ITCE and engineering) and to the subsequent Migration Advisory Committee, in particular around the assessment of serious skill shortages.

Most recently he has worked for the UK Sector Skills Council for Science, Engineering and Manufacturing Technologies (Semta) and remains a Fellow at the Center on Skills, Knowledge and Organizational Performance (SKOPE) at Oxford.

The Migration Policy Institute is a nonprofit, nonpartisan think tank dedicated to the study of the movement of people worldwide. MPI provides analysis, development, and evaluation of migration and refugee policies at the local, national, and international levels. It aims to meet the rising demand for pragmatic and thoughtful responses to the challenges and opportunities that large-scale migration, whether voluntary or forced, presents to communities and institutions in an increasingly integrated world.

www.migrationpolicy.org

1400 16th Street NW
Suite 300
Washington, DC 20036

Tel: 001 202-266-1940
Fax: 001 202-266-1900