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Communication Skills for the 21st Century Engineer

Marc J. Riemer
UNESCO International Centre for Engineering Education (UICEE)
Faculty of Engineering, Monash University, Clayton, Melbourne, VIC 3800, Australia

Communication skills are an essential component in the education of engineering students to facilitate not just students' education but also to prepare them for their future careers. In this article, the author discusses various important communication skills required of modern engineers, such as foreign language skills. Also discussed are various elements of communication skills education, such as oral, listening, written, visual, interdisciplinary and intercultural. The impact of emotional intelligence (EQ) is also presented. Suggestions for communication skills development are made, including the posit that communication skills be integrated across the curriculum, rather than include it as a stand-alone subject in already packed engineering curricula, so as to reinforce student learning. Various potential areas for further research are also made.

INTRODUCTION

Engineering graduates require an ever-increasing range of skills to maintain relevance with the global environment of the new millennium. Communication skills are a vital component of this, recognised by academia and industry alike. It is one of 11 key outcomes required by an undergraduate engineering programme in the ABET Engineering Criteria 2000 [1]. Such skills are essential for an engineer who aspires to carry out his/her professional practice in the global arena. Multilingual skills are considered a salient element in the make-up of the new global engineer.

Yet there is ample evidence that graduate engineers lack the required standard of communication skills, particularly when compared to the needs of industry internationally [2][3]. Communication skills are a regular feature of an engineer's job in industry; some graduates employed in industry have identified that education in communication skills needs to be improved given the demands encountered in industry [4]. Indeed, communication skills are considered to be a valuable *career enhancer* [5].

Inadequate and ineffective communication skills reflect badly on the individual and the profession. An insufficient level of communication skills instruction in engineering education generally only serves to undermine the whole profile of the professional engineer. This in turn affects recruitment and retention in engineering studies [6].

It has been stated that communication skills *should be fostered in engineering education ... becuase they are qualities that employers look for ...* [and] *should be part of any tertiary education* [7].

Communication is multifaceted and incorporates various elements, such as oral, written, listening, visual, intercultural, interdisciplinary, etc. These need to be considered when examining communication engineering education.

ENGLISH GLOBALISATION AND ENGINEERING

In this age of globalisation, international projects are increasing, and cross-cultural communication and collaboration is rising; especially in the now international practice of engineering. English is accepted as *the most widespread language in the world* (cf the *most widely spoken*) [8]. However, the number of people who speak English with at least some degree of proficiency exceeds any other language [9]. This is important for engineering students as this indicates that English may be more useful internationally than almost any other language due to its spread. English is cited as the *… major language of international business, diplomacy, and science and the professions* [8]. English is the prime means for communication, and can often serve as the *global language* between two people from two different cultures where English is not the native tongue. For example, French engineers communicated with Egyptian engineers in English during the building of the Cairo subway [10].

Some multinational firms with bases in continental Europe use English as the prime form of communication in the office. In this sense, multinational corporations can be seen to indirectly influence the educational policies in foreign lands by their value creation of particular languages through global economic power. This also delivers a strategic advantage to those institutions in non-English speaking countries with effective English language instruction.

European students, when recently surveyed, stated that they felt working in a foreign language was a necessary activity in an international career. The implications of this are apparent; the English language maintains extremely strong relevance now and in the future, particularly as a *secondary* language to facilitate communication between two cultures.

Future engineers need also be aware of the potential for so-called *cultural imperialism*, which involves the *systematic penetration and dominance of other nation's communication and informational systems,* [and] *educational institutions* [11]. This goes beyond language hegemony.

However, the importance of multilingualism for the global engineer is not confined to learning English. Multilingualism in an engineering course is increasingly focusing on regional communication skills, where the main languages from within that country's region are becoming just as important as learning English.

FOREIGN LANGUAGE SKILLS

Jensen states that employers want: … *a number of new competencies, with an emphasis on an increased ability to communicate … and good foreign language skills* [2]. This is reinforced in Grünwald's study of competences required by the *engineer of tomorrow*, which includes hard skills like good foreign language skills. He goes further to claim that cross-disciplinary language skills are not sufficiently taught [3]. This indicates a lack of a direct fit between graduate skills and those required by industry.

Engineers can relate the same theories of mathematics, of mechanics and technology, but the modern engineer must also be able to communicate effectively in a shared tongue. This is especially important given that engineering projects are now planned and implemented across national and cultural borders.

The USA has a resilient monolinguistic culture of instruction in English, which may well impact on that nation's future competitive capacity internationally. There seems to be a similar culture in Australia where multilingual education is somewhat of an advantage, but is not compulsory. This differs to the compulsory education in the English language education established in many mainland European schools. However, monolingual dominance is brought into question at a time when employers are demanding new competences, including communication and foreign language skills, and not just from engineering candidates in European nations [2].

Graddol found that regional languages will become increasingly important in the 21st Century. He identified the *big* languages to be Chinese (Mandarin), Hindu/Urdu, English, Spanish and Arabic, with the regional languages being Arabic, Malay, Chinese, English, Russian and Spanish [12]. The future scenario indicates the reduced prominence of English as an international language in favour of the regionalised language dominance of Chinese, Hindu/Urdu, Arabic and Spanish. Such a future would mean that students' and industry needs in English as a First Language (EFL) countries would be best served by fostering additional language skills so that engineering graduates can operate across borders in an increasingly globalised and multinational industry and society. As such, this is an important issue that must be addressed in engineering curricula.

Possible areas for further research in this area include the following:

- Identifying where and how second language skills can be fused in the already packed engineering curriculum;
- Fostering engineering students' understanding of international linguistic diversity and the need for broader language skills given the increasing level of globalisation;
- Identifying dominant regional second languages and how many engineering projects are developed in these linguistic areas;
- Cataloguing instances of international engineering projects and how communication was facilitated;
- Developing cross-institutional opportunities regarding second language instruction, particularly where one institution has greater strengths in one language instruction than another (eg Mandarin at one institution and Spanish at another);
- Encouraging student exchanges with countries that have the dominant regional language as the main form of communication;
- Facilitating increased opportunities for foreign language immersion for students as a component of the curriculum (eg during semester breaks);
- Recognising that those dominant regional languages identified by Graddol potentially provide the most opportunities for expanded communication skills (an important consideration for students and curriculum designers), but not to the exclusion of less widely spoken languages.

The prime language of Internet sites is becoming increasingly regionalised. Although English remains the dominant language with regard to Web content, it is interesting to note that the proportion of non-native English speaking online population has steadily increased and surpassed that of native English speakers [13]. This has clear implications for engineering education. Language will no longer be the prime determinant for access to engineering education based on traditional European structures because large, previously under-represented communities will gain greater representation. Furthermore, this expanded access to the Internet builds a new dimension in the education process in this era of globalisation: by combining language education with technology education. This also generates a greater element of regionalisation as these large underrepresented groups in Asia and Africa demand the skills required to operate competitively in the world. However, language still remains a strong barrier.

English for Specific Purposes

There is a clear necessity for effective English communication skills for engineers in the current globalised environment. A course in English for Specific Purposes (ESP) will enhance English language training and an engineering student's communication skills. It will also aid in the globalisation of education and the internationalisation of practicing engineers. The concept of ESP achieves more in the education of engineering students by focusing the learner's attention on the particular terminology and communication skills required in the professional field. Various examples in the engineering field can be found, including computer science, maritime engineering's *seaspeak*, aviation's *airspeak* and the railway's *railspeak*.

While English is currently a prime language in facilitating communication between international cultures, particularly intercontinental, the increasing growth of regional languages indicates that native English speakers need to learn additional and communication skills, preferably in at least one of the regional tongues. In this case, monolingualism is likely to be an impediment for future graduate engineers in a world where intraregional connections provide stepping stones to facilitating globalisation.

COMMUNICATION ISSUES

Three sources of weakness that can significantly impact on an engineer's communication skills education were identified as:

- Students' attitudes to communication;
- Insufficient course content;
- Deficient or inappropriate teaching methods;
- Lack of opportunity for engineering students to practise communication skills [14].

Gender Equality

Gender distribution in the engineering profession continues to be dominated by males. This is evidenced in recent statistics in Australia where Engineers Australia identified the proportion of female engineers to be below 10%, which has been identified as *one of the lowest participation rates of women across all professions* [15].

However, female participation is increasing at a much greater rate when engineering is coupled with another discipline as part of a double degree [16]. The benefits of a double degree is that the student's skills base is augmented in other areas, including communication, as students are introduced to other subjects in tandem with the engineering degree. Further study would need to be undertaken to cover gender participation in double degrees, with the possibility that females may graduate with a greater range skills that would be more in line with industry demands.

Graduate Feedback

A Melbourne report found that most graduates felt that they had gained analytical and problem-solving skills, subject-specific knowledge, research and improved decision-making abilities through their degrees. Yet despite this, much fewer felt that their graduate degree provided:

- Oral communication skills;
- Awareness of the social implications of their discipline's developments;
- Management skills;
- Understanding of other points of view and other cultures;
- Confidence and competence to work in international environments [16].

Notably, oral communication skills were considered very important in the graduates' new work environments, but this was in the face of the low level of oral communication skills imparted during their studies. However, neglecting learning opportunities can engender a shallow level of understanding in the graduate if he/she does not see the broader picture. Communication skills teaching needs to go beyond the standard elements described above and incorporate reasoning

skills in the communication being sent/received. This will contribute to students' life-long learning skills.

ORAL COMMUNICATION SKILLS

The burgeoning importance placed on oral communication skills by employers has been echoed internationally for a decade or more and across disciplines. Knowledge and technical know-how are clearly important, but these must be presented with an excellent standard of communication skills, particularly oral. Indeed, oral communication and presentation skills are considered one of the best *career enhancers* and to be the *single biggest factor in determining a student's career success or failure* [5]. Communication skills development has been demonstrated through the use of various methods, such as class discussions and others.

Experiential methods have generally yielded better results than purely didactic means. Examples include presentations, peer review, role-play, video of student presentations with individual feedback and up-to-date training in key software used in presentations by graduates in industry (eg *PowerPoint*, *Word*, *Excel*, etc) [4].

Engaging learners will help facilitate and stimulate effective and purposeful learning by students. In particular, involving learners directly will engender a stronger sense of responsibility in future graduates that they can take beyond the university and into the work arena. This is especially important when engaging learners of English as a Second Language (ESL) and English for Specific Purposes (ESP) as it involves new vocabulary.

LISTENING SKILLS

Communication involves receiving as well as sending signals. As such, listening skills are just as important and verbal and written communication skills competences. It has been asserted that we spend 70% of our time awake in some mode of communication, which is comprised of the following proportions:

- 10% writing;
- 15% reading;
- 30% talking;
- 45% listening [17].

Kline further affirmed that *listening is crucial in the workplace* [17]. As such, it is vital across the professions, including engineering. Listening is entails the reception and correct understanding of verbal communication and without effective listening skills, the verbal message can be distorted or ignored, thereby causing the communication process to fail.

Work-based activities provide a direct context to an engineer's training. Such listening skills exercises can be integrated into the study environment and aid students in team-based assignments, an increasingly staple task in engineering.

WRITTEN COMMUNICATION SKILLS

Written communication skills involve a more active, rather than passive, learning method. Writing can enhance critical thinking and problem-solving skills, as well as serve to identify and confront personal misconceptions [18]. Graduate engineers have reported an increasing written communication workload over time [4]. Writing in this instance refers to composing material that is to be read and includes typing.

One Polish study found that engineering students displayed greater difficulties in written communication than with oral; this was despite the students having completed various written tasks before (eg laboratory reports, projects, etc) [19]. In this case, students required help in organising and structuring reports and arguments.

Ineffective and poor written communication in engineering workplaces were found to lead to misinterpretation, inefficiency and time wastage, thereby adversely affecting problem resolution. Such miscommunication was then found to contribute to mistrust and aggression, as well as appear unprofessional and be unproductive [4]. This indicates that poor communicators will have trouble in the workplace, potentially contributing to problems rather than solving them.

Written communication needs to be relevant, properly implemented and of a quality standard that can be benchmarked; it should also generate feedback and provide accurate assessment, as well as make a positive and permanent impact on student learning. Examples of written communication include: engineering reports, technical writing, essays, reflective journals, peer review, and mock and student *conference* papers.

A networked digital library of theses and dissertations was recently launched in Lithuania, which serves to enhance graduate education by allowing students to produce electronic documents, utilise digital libraries and understand issues in publishing. This initiative significantly increases the availability of students' research for scholars, preserve it electronically. This also makes it possible for students to convey a richer message through the use of multimedia and hypermedia technologies [20].

VISUAL COMMUNICATION SKILLS

Visual forms, such as drawings, diagrams, real and symbolic pictures, etc, are of tremendous importance in the process of knowledge acquisition in general, especially information processing, storage and retrieval. They may also have important implications for the quality of visual communication within a specific profession. It is clear that every engineering profession relies heavily on the use of visual forms as a means of non-verbal communication [21].

Visual literacy entails being able to perceive visual images, such as icons, and understand them. Comprehending visual images tends to be faster than for the written counterpart. Their pictographic nature facilitates communication between people of different linguistic and cultural (or multidisciplinary) backgrounds, thereby helping to avoid the *cultural and economic hegemony* of text language only [22]. Visual literacy also means being able to generate images that can be used for communication, much like verbal communication entails being able to listen and speak. This impacts on the training of future design engineers in particular, as this increasingly globalised world sees more and more products designed in one country, before being manufactured in another country and distributed around the world.

Visual literacy can be enhanced through cognitive activities, including freehand and grid drawing, and is re-emerging as a valuable tool, particularly with regard to fundamentals in industrial design. Visual literacy has been defined by Anderson as involving the ability to perceive image-based information, processing and understanding it, and having the skill to communicate to others through drawing and modelling [23].

Students, in particular, as future designers, computer professionals and international collaborators, need to consider how to read, write and learn icons, as well as how to design new ones [24]. One pertinent example is electrical engineering. As a rapidly developing profession, this discipline experiences a rapid influx of new ideas and concepts. This demands from modern electrical engineers a variety of intellectual competences and aptitudes that enable them to perceive understand and process complex information through graphical means. The process to develop such capabilities relies heavily on psychological research concerning image formation, cognition and many other symbolic activities.

Leading bodies should act as the caretakers and gatekeepers of new symbols, particularly in engineering, where such a process should lead to more efficient and safer product/service development. The Web offers an excellent opportunity for this to become manifest. However, problems can arise when bureaucrats and designers generate new symbols/icons without proper scientific investigation. Research into the psychological and cognitive nature of symbols and icons, as well as other visual means, used currently appears to be limited, which may lead to confusion or misunderstanding on the part of the person being communicated to. Should miscommunication occur, then the prime objective of communication has failed, and the symbol or icon effectively becomes meaningless or misleading.

INTERDISCIPLINARY COMMUNICATION

Communication between disciplines is an important aspect that also needs to be considered. Increasing globalisation is not confined to engineers only dealing with engineers from other cultures; it also involves effective communication across disciplines, such as engineering and management. Indeed, engineers also need a certain level of basic management and business skills – including entrepreneurship skills – so that they can interact with, and operate, business ventures.

Entrepreneurship skills are being increasingly recognised as important skills for engineering graduates. Communication skills are integral to developing such skills, not least of which because the engineer-entrepreneur has to communicate his/her idea to others from concept to development to implementation and use. An example of the growing importance of this education can be found 7th Framework Programme (FP7) of the European Union [25].

Interdisciplinary projects at the university level promote the development of teamworking skills in students. The integration of such projects are partly due to industry needs for engineers who have more expanded skills. This includes effective written communication skills for technical reports and oral communication skills for presentations. It has been recently asserted and recognised that team and project-based methodologies facilitate the reinforcement and expansion of key skills, including communication [26]. As such, incorporating these type of tasks and their appropriate assessment are a vital component for current and future engineering curricula around the world.

The social sciences and humanities also have much to offer in the education of future engineers. However, Sjursen stated that this risks overburdening an already packed engineering curriculum and requires mutual multicultural norms to negate any imperialist mentality. Sjursen goes on to recommend increased discursive alliances based on mutual respect between engineering

and humanities educators so as to *enrich understanding* and that *engineers must be humanists to exercise their vocation responsibility* [27]. His example of a multidisciplinary class at the Brooklyn Polytechnic revealed that diverse student teams were assigned, encouraging discourse between team members that provided them with new perspectives through collaboration; he also comments on how engineers need to be able take into consideration the target audience when delivering presentations and communicating information [27].

Further research into interdisciplinary collaboration that facilitate communication include the following:

- Identifying opportunities between engineering and other disciplines, as well as between departments;
- Devising teamed projects once collaborations have been identified;
- Obtaining student feedback;
- Identifying how to reinforce the skills learned;
- Fostering opportunities for staff from different disciplines (potentially including other campuses or institutions) to communicate with each other.

ALTERNATIVE TEXTS IN ENGINEERING EDUCATION

Alternative texts can help in foster communication skills in engineering, as well as broaden students' imagination and understanding of concepts and disciplines beyond the current engineering domain. Such alternative texts include science fiction and so-called techno-thrillers, which can present topics and ideas outside the current scope of science and engineering. Such texts do not undermine the core knowledge required of practicing engineers, as students can question the viability of technological aspects within the recognised framework of fiction [28][29]. Ward has utilised various non-traditional texts to impart to students knowledge of engineering management and safety, among other subjects [30][31].

Indeed, literature can help in the formation of language literacy, whether it be EFL or ESL. Spanos has stated that *literary texts are … at the heart of language* [32]. Educators need to keep up-to-date with such current and past popular texts, and treat them as credible opportunities for the further exploration of engineering and science topics.

INTERCULTURAL COMMUNICATION SKILLS

New communication technologies (such as the Internet, e-mail, cable TV, satellites, etc), the increasing speed and reduced costs of international transport, migration flows and the internationalisation of business have resulted in an ever-increasing number of people – including engineers – engaged in intercultural communication. Representatives of politics, universities and private industry emphasise that internationalising curricula is not only important to remain competitive in a global world economy, but even indispensable in a world that can only survive through global cooperation. A prerequisite for successful global cooperation is the development of intercultural competence. In addition to linguistic skills, intercultural competence integrates a wide range of human relations skills [33]. It is also a key determinant influencing intercultural negotiations [34]. It includes aspects such as implicit language and cross-cultural idiosyncrasies.

The personal culture of a receiver of communication acts as a filter through which he/she interprets the message. This filter may colour the message so much so that the message received may not match the message sent. The source of the communication will most often be within the context of the sender. Indeed, culture has been identified as influencing every facet of the communication experience [35]. The communication actually received is ultimately more important than what the communicator thought was sent [34]. Notably, verbal skill acquisition with regard to language must be accompanied with non-verbal language skills within key cultural context(s) of the language studied. Indeed, learning the non-verbal *signals* of certain cultures will serve to make the individual a more powerful communicator [36].

Senge's concept of personal mastery offers important lessons on enhancing intercultural communication skills [37]. Senge comments that people, who are engaged in personal mastery, which is a life-long learning process, seek to perceive reality accurately and are inquisitive, as well as feel connected to others and to life itself [38]. Such a process will contribute to learning about intercultural communication and the dissonance that may initially be generated. Furthermore, Senge affirms that organisations learn through individuals; as such, individual learning concerning intercultural communication will ultimately contribute to organisational learning as well.

Potential further research areas that could be explored include the following:

- Investigating unsuccessful and successful instances of intercultural communication, notably between speakers of the world's dominant languages, with particular emphasis on engineering;
- Investigating differences between communicators who learn a language as a native tongue to those

who learn the same language as a secondary language;
- Exploring Senge's concept of personal mastery and how it relates to engineering education for both students and educators;
- Facilitating communication between students from different backgrounds and incorporating training so that students provide feedback to each other without conflict;
- Expanding empirical research on non-visual cues for communication (eg common emotional facial reactions are recognised across cultures, including those isolated from the progressively globalised world [39]).

EMOTIONAL INTELLIGENCE AND COMMUNICATION SKILLS

The term *emotional intelligence* (later dubbed EQ) was first defined in 1990 by Salovey and Meyer [40]. Their work has since been considerably expanded by Goleman, who identified that IQ is actually less important for success in life and work than EQ – a set of skills that are not directly related to academic ability [41][42]. Goleman identified five domains of emotional intelligence, namely: self-awareness, self-regulation, motivation, empathy and social skills. These areas can be incorporated into student education and preparation for professional working life.

Given that communication is ranked as one of the prime characteristics required by employers in the engineering industry, EQ has an important role to play in strengthening communication skills when certain EQ elements are enhanced in the student. Similarly, it has been shown that incorporating a greater emphasis on communication activities served to enhance EQ aspects, including more active participation, greater self-control and awareness, heightened motivation and a better understanding of course material [43].

Intellect, measured by IQ, can fall short without EQ. A detailed report from a very smart engineer may be close to undecipherable to the manager who makes the final decisions. EQ contributes to identifying the needs of others and to identifying those projects that are more important to the task at hand. Intellectual accomplishments and social skills can be enhanced through EQ. It has been increasingly reinforced that EQ skills are the key to organisational success, particularly with regard to leadership and the cooperation of staff. Indeed, it has been asserted that those *who can't manage their anger and who blow up at people make those who work for them very anxious*, with aggressive, coercive and overly assertive behaviour potentially providing, at best, only short-term benefits; this directly contrasts with the long-term and profitable returns of leaders with strong EQ skills [39]. Goleman also states that leaders need to be collaborative and make decisions by listening to what others think [39]. This has clear implications for engineering education; engendering a collaborative study environment and advancing communication skills between students, as well as within and across teams, is vital for the advancement of engineering graduates in the workplace. Experiential over didactic means are recognised as providing *continual learning opportunities* in EQ; notably the area of the brain associated with reasoning skills is the same for EQ skills [39].

EQ skills contribute to the learning potential of foreign language acquisition, particularly as it relates to acknowledging the legitimacy of other cultures as being equally valid. Ultimately, this deters ethnocentrism as foreign cultures related to that language become more relevant.

EQ directly impacts on communication competences by targeting particular elements that improve and enhance the process of communication. In America, the biggest complaint of workers is poor communication with management, sometimes even preventing employees doing their best work. Further, the key to empathy is listening well. Being in control of personal emotions also makes the worker more accessible to other people, both inside and outside the workplace [42].

Also, EQ skills improve teamworking skills, especially with regard to communication between team members. Furthermore, the context of the receiver of the communication, whether it be written, non-verbal or oral, is taken into account through empathy and self-awareness, whether the context be cultural, educational, professional, social or otherwise.

Empathy

Various authors have cited empathy as a key skill for effective leadership and management [44]. Managers and leaders who displayed empathy skills were able to communicate honestly and proactively and had very good listening skills; this permitted them to successfully steer their organisations in times of difficult transitions [44]. This provides a lesson for engineers, particularly those in management roles, that empathy skills are required in managing interpersonal relationships in the workplace with colleagues, clients, customers and other stakeholders.

Goleman also highlights the connection between fluency in non-verbal skills and empathy [41]. Non-verbal cues and awareness are an important component

of communication that is not restricted by language. Goleman goes on to state that *mastering this empathic ability smooths the way for classroom effectiveness* [41].

Evidence indicates that listening skills directly contribute to empathic skills [45]. Listening to another person's state helps the listener become more aware of the other person's needs and wants. This is especially important for engineers engaged in the design and construction process.

Empathy certainly has a key role to play for achieving effective intercultural communication. Former US President Carter once asserted that the dissemination of information between nations will lead to improved understanding between different cultures. However, his view differed markedly from prior and later conservative US governments that promoted the concept of (mostly Soviet) *disinformation* and countering it with what Snow calls US propaganda [11].

Further Research in EQ

It has been commented that despite various publications on EQ, there is still a lack of consistent empirical evidence and clear definition [46]. This shows that further opportunities for research into EQ and its impact on communication skills acquisition, such as:

- Comparing the two main approaches identified by Zweig and Gruman with regard to engineering education;
- Undertaking further research on the impact of EQ on communication skills, especially as they relate to engineers;
- Identifying how EQ skills can be fostered in engineering students and treated as credible by them;
- Identifying how EQ can be incorporated into the engineering curriculum;
- Fostering collaboration between engineering educators and the two disciplines most associated with EQ research, namely management and psychology.

COMMUNICATION SKILLS DEVELOPMENT

A review of literature indicates that oral communication has been identified as a *learnable skill* and that experiential methods have generally yielded better results than purely didactic means [5].

Presentations

The student's knowledge base is augmented by allocating class projects for presentations. However, students will not place any great emphasis on presentation, and with it oral communication skills, if presentation and communication is not allocated a significant share for the exercise's marks. Furthermore, as much as many students dislike giving presentations, it is better that they experience a *dry run* in their education than to be suddenly confronted in the workplace. An Irish study found that 78% of sampled practicing engineering graduates were required to give oral presentations as part of their work, often on a regular basis [4]. Group projects and presentations encourage and enhance the interpersonal skills of the student members and should be emphasised early in the education curricula. This should be considered as teamwork is recognised as a core skill in industry, and communication with team members needs to be effective.

Peer Review

Advantages of peer assessment include getting students to think about the exercise more deeply, recognise others' viewpoints and how to give constructive criticism to peers. Disadvantages include potential bias, reluctance to give low marks for poor work from their peers and the need for clearer guidelines, although these can be countered by utilising group-based marking, rather than individual, increasing marking guideline specificity, and limiting the impact of the peer review exercise on the overall unit grade.

Role-Play

As knowledge of communication theory does not necessarily parallel skills in practice, it is important to immerse students in similar work environments. Context-specific enactments, or role-play, can focus the student's attention on the differing types of communication required with various groups in potential future work situations.

Video

Video/audio grading has been shown to dramatically improve presentation skills in students, with one prime example given where student presentations were filmed and then graded with dubbing from the teacher and a feedback sheet [5]. Importantly, this provides relevant educational feedback to the student that is not transitory as the student's performance can be revisited.

Technology

Current technology should be utilised, or at least

demonstrated to the students, so that they are aware of what is in use beyond the university walls. The Irish study found that practising engineering graduates suggested that greater content for communication courses in undergraduate engineering cover basic MS Office applications (number 3 on the list, directly after oral presentations and keyboard skills), as well as other technical elements including Web page design, e-mail and graphic design [4]. This gives a clear indication of technological elements that need to be incorporated into fundamental communication training for engineering students in preparation for industry.

Active Involvement of the Learner

Littlewood suggested several elements that involve the learner to reinforce learning:

- The classroom must be conducive to communication and learning;
- Learning has to be relevant to learners' interests and needs;
- Processes and products are important in the classroom;
- Learners must engage in active roles in the classroom [47].

Engaging learners facilitates and stimulates effective and purposeful learning by students. Involving learners directly engenders a stronger sense of responsibility in the future graduates that they can take beyond the university and into the work arena. It is especially important to engage learners of English as a Second Language (ESL) and English for Specific Purposes (ESP) as it involves new vocabulary.

Team-Teaching Collaborations

Team-teaching collaboration between a subject expert and an English language teacher can benefit learners. Overseas experience already indicates that the synergy from team-teaching can significantly improve the written and communication skills of most students, particularly oral presentations and report writing.

COMMUNICATION SKILLS ASSESSMENT

Communication skills have been identified as multidimensional and so it becomes crucial to classify how they will be assessed in the students' work. Furthermore, the particular communication skills required in a profession are usually poorly defined. One study identified that communication skills assessment must:

- Be formal so that it occurs at specific times and contributes to a student's marks;
- Provide feedback to be educational;
- Involve active participation by students in actual communication situations;
- Tackle student insights so that skills are identified and developed [48].

Individual feedback is important but there needs to be prudent identification and clear operational definitions of the rating dimensions so that the same standards are applied to all students: consistency and accuracy [48].

INTEGRATION

Stand-alone subjects need to clearly identify the benefits and relevance of utilising the methods learned so that they can be incorporated in the rest of the student's experience. For example, integrating compulsory communications education, whether represented wholly or in part by one or more units, should be part of an engineering degree. However, this is not enough; those skills need to be utilised *across* the degree to demonstrate application and reinforce behaviour. This may involve a restructuring of certain components of subjects, even the curriculum.

To maintain relevance in today's world, universities need to reflect industry (and social) demands by imparting to graduates the required skills. Integrating these skills within subject modules, especially in the marking structure, can thereby achieve the right skills combination.

Potential future research in this regard includes the following:

- Identifying how communication can be integrated into engineering subjects;
- Identifying which subjects/courses/disciplines will be easier for such integration;
- Discerning the proportion of assessment that should be allocated to communication skills (eg presentations, reports, etc);
- Identifying where initial training in communication should occur (eg at the first year level);
- Ascertaining the number and range of institutions that currently engage in such integration in engineering curricula (and to what extent);
- Collaborating with other faculties (eg management) to identify how communication education is incorporated into the curriculum in different subjects;

- Fostering international communication between academics to facilitate information exchange.

CONCLUSIONS

Language and communication skills are recognised as important elements in the education of the modern engineer. Those institutions that have already implemented multilingual and communication elements will be at the forefront of providing the demands of industry and society.

The already crowded engineering curriculum still needs to incorporate additional competences, notably workplace and international/intercultural skills, especially communication. Fitting in a new subject will, in most cases, be difficult, but also less enduring with regard to the competence being taught. The integration of communication skills, as can be found in various business curricula, will serve to reinforce such skills like communication across different contexts, particularly if students recognise this as an important component if part of the overall grade is attributed to it.

The incorporation of language and communication improvement courses is an important element of continuous learning, and will ultimately contribute to the process of life-long learning. This should facilitate advancements in engineering and, indeed, engineering education through streamlining fundamental communication skills.

Ideally, students' skills in communication and EQ, which reinforces these competences, should be initiated and inculcated at least at the secondary school level. However, if this is lacking in the national school curriculum, then it needs to be fostered at the tertiary level, particularly as such skills can still be acquired as adults and will contribute to the life-long learning process.

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BIOGRAPHY

Marc Jorrit Riemer completed a Bachelor of Arts in 1989 at Chisholm Institute of Technology, Melbourne, Australia, and finished his Honours year in English at Monash University in Melbourne in 1990. He later completed a Bachelor of Business

(Business Administration) in 1995, also at Monash University.

He has worked for several years in the private sector, including as a Sales Administration Manager for an Australasian wholesale electrical cable/wire/insulation distribution firm, and has been the administrative officer at the UNESCO International Centre for Engineering Education (UICEE), based in the Faculty of Engineering at Monash University, since December 1999.

He is also the Assistant Editor of the UICEE's *Global Journal of Engineering Education* and the *World Transactions on Engineering and Technology Education*, plus various other UICEE publications, including numerous conference proceedings.

With his qualifications, he seeks to build a bridge with other disciplines in the development of engineering education, particularly in the field of communication and English skills, and has published various papers in this field. His research interests include English and communication skills development and emotional intelligence (EQ) issues in relation to the education of engineers.

He is currently finalising his Masters, which focuses on English and communication skills for engineering students.