A FRAMEWORK FOR LANGUAGE AND COMMUNICATION IN THE CDIO SYLLABUS

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ABSTRACT

How can the CDIO syllabus for *Communications in Foreign Languages* be translated into progressive and achievable goals that engineering students can aim for? How can teachers of additional languages, often with no technical background, best prepare these students before they leave for exchange semesters abroad and the world of work? This paper responds to these issues by presenting the work of the Global Engineers Language Skills (GELS) project. The aim of the project is to investigate which communication skills are most used by engineers in industry and, ultimately, to prepare a teaching guide for language departments that work with engineering students. This paper presents the results of the investigation and the resultant adaptation of the Common European Framework of Reference for Languages (CEFR) for the specific needs of engineers. By combining this framework with CDIO's syllabus for *Communications* and *Communications in Foreign Languages*, we argue that a more ambitious and effective integration of additional languages, communication, and engineering at our universities could not only be within our reach, but should rather be a priority to ensure that our students can engineer both at home and abroad.

KEYWORDS

CEFR, Communication skills, Language for Specific Purposes (LSP), Standards 2, 3, 7, 10

INTRODUCTION

Engineering and Communication

"You don't really understand something unless you can explain it to your grandmother."

Engineering students need training in effective communication skills. The reason why is often summarized in the rather chauvinist maxim above (e.g. in Grossman, 2014); but this reasoning does little to dispel any notion that such skills are superfluous. To readers who undervalue communication for engineers working on technical subjects and projects, Huckin and Olsen (1983) have this clear retort:

> In a word, if technical people cannot communicate to others what they are doing and why it is important, it is they and their excellent technical skills that will be superfluous. From this perspective, communication skills are not just handy; they are critical tools for success, even survival, in "real-world" environments.

The unambiguous wording of this forewarning should compensate for its age. Indeed, in more recent times, advice from other scientists and writers has only become even more explicit, e.g. *Don't Be Such a Scientist* (Olson, 2009), *Escape from the Ivory Tower* (Baron, 2010).

For many engineers, effective communication skills presume proficiency in one or more additional language:

> Communiquer, comprendre, écouter, négocier, argumenter et écrire dans une langue autre que le français et s'adapter aux autres us et coutumes pour fonctionner sur place ou à distance dans un contexte multiculturel, voilà le quotidien du jeune ingénieur commençant une carrière à l'international. (CDEFI, 2011)

> *Communicating, understanding, listening, negotiating, arguing, and writing in a language other than French and adapting to other customs and habits in order to work on-site or remotely in a multicultural context… This is the daily reality for a young engineer starting an international career.* (My translation.)

Indeed, in many parts of the world, there is simply no option to avoid the *à l'international* appendage, because all engineering is a multinational, multicultural, or multilingual enterprise. "Real-world environments" (Huckin & Olsen, 1983) and "modern team-based environments" (Crawley et al., 2011) can be presumed to transcend national, cultural, and linguistic borders.

The purpose of this paper is not to campaign for language provision in university engineering curriculums. Rather, we aim to offer a rationale and a user-friendly method for language teachers working with engineers at CDIO-affiliated universities to ensure that their students learn and practice the most useful communication skills as required by engineers working in industry.

The plan of this paper is as follows. The background section outlines the problematic situation for language teachers currently working with engineering students – especially at universities which follow the CDIO syllabus. This is followed by two descriptions: the first of the GELS project, the second of the Common European Framework of Reference for Languages (CEFR). In the methods section, the process of surveying engineers about their communication skills and needs is described. The results section presents the basic findings from the surveys and the resultant framework of skills. This is followed by a presentation of the framework's relationship to the CEFR and the CDIO syllabus. The conclusion section describes the limitations of the project so far and outlines plans for future work.

BACKGROUND

Communication and the CDIO Syllabus

"To work in a modern team-based environment, students must have developed the interpersonal skills of teamwork and communications." (Crawley et al., 2011)

The ten topics of the CDIO syllabus' *Communications* element can provide a useful stimulus for language specialists and engineering professionals alike. For example, a Spanish teacher may well be motivated to rethink a debating exercise that requires students to negotiate "without compromising fundamental principles". Similarly, a hydraulics teacher

could be inspired by the requirement for students to take "rhetorical factors (e.g. audience bias)" into account for a report writing assignment.

"Our international collaborators have added Communications in a Foreign Language to this part of the syllabus." (Crawley, 2002)

As the above quotation attests, however, the *Communications in Foreign Languages* element is seemingly unconnected to the rest of the CDIO syllabus. In stark contrast to the *Communications* element, there are no topics or suggestions for the integration of additional languages in engineering curriculums (see the *Compatibility with the CDIO Syllabus* section below). In the absence of such detail, this element of the CDIO syllabus is incongruous with the realities of engineering in many parts of the world where more than one language is commonly used. Furthermore, it does little to inspire students and teachers to engineer in truly global contexts.

If engineering graduates are expected to possess the skills of extending social and professional networks to include people of different cultures (as suggested in the *Communications* element), it is essential that classes in language skills and learning activities in inter-cultural communication be available for them during their studies. Furthermore, these activities must be geared towards the professional and social situations that engineers work within. However, the CDIO syllabus currently offers little practicable guidance to faculty hoping to include additional language skills in its engineering curriculum. On the one hand, the lack of topics and detail in *Communications in Foreign Languages* offers no support whatsoever; on the other hand, the topics in *Communications* are daunting both in their number and linguistic complexity for language learners.

There is a second practical difficulty. Those who generally plan and deliver language classes for engineers are teachers working in language centers, units or departments whose integration within technical universities and engineering departments can be as superficial or limited as additional languages seem to be in the CDIO syllabus. Furthermore, language teachers working with engineering students typically have limited scope to cooperate with engineers in academia and industry, and they even less commonly have technical backgrounds themselves.

The Global Engineers Language Skills (GELS) project aims to offer solutions to these two problems by producing a framework of language and communication skills for engineers, together with a bank of progressive teaching and learning resources that prepare students for the particular demands of working in the field of engineering. These resources should enable students to fulfil, or work towards fulfilling, the topics listed in CDIO's *Communications* syllabus in additional languages.

The GELS Project

GELS is a collaborative project between three language teachers who work with engineering students at KTH Royal Institute of Technology (Sweden), Institut Mines Télécom (France), and the University of Cambridge (UK). The aims of the project are as follows: 1) to investigate and categorize the necessary and desirable language and communication skills for engineering graduates based on input from industry, the CDIO syllabus, and previous literature; 2) to ensure that these findings actively support the teaching and learning of additional languages in technical universities and engineering departments.

To fulfil this final aim, the GELS team is preparing a teaching guide for language departments that work with engineering students. The preparatory work for this guide begins with the two following tasks. Firstly, the language and communication requirements of engineers are clarified by means of a series of surveys completed by engineers working in industry. Secondly, these requirements are mapped against the skills and proficiency levels (A1 – C2) of the Council of Europe's CEFR and, as a result, the framework is rewritten for the specific needs of engineers. This framework, the GELS framework, will form the basis of the teaching guide.

The Common European Framework of Reference for Languages (CEFR)

The CEFR is not only a policy document, but also a departure point for language-related syllabuses, curriculums, and assessment. Language teachers and learners generally rely on the CEFR's global scale and self-assessment grids for explanations of six stages of language use and learning (A1, A2, B1, B2, C1, and C2). The full text of the CEFR, which includes 34 skill-specific classifications of communicative proficiency, can be retrieved at Council of Europe (2001).

The CEFR is used as a fundamental resource for language teaching and learning in 30 European countries and there is growing evidence to suggest that its influence has increased to Asia, Australasia, and Latin America (Normand-Maconnet & Lo Bianco, 2013). The document has been translated into 39 languages, including Arabic, Chinese, and Russian.

The CEFR is a flexible framework in three fundamental ways. Firstly, it is language-neutral and designed to be applicable to any language learning situation. Secondly, it promotes an "action-oriented" approach to language and communication, as shown in the excerpt below:

> I can understand the main points of clear standard speech on familiar matters regularly encountered in work, school, leisure, etc. I can understand the main point of many radio or TV programs on current affairs or topics of personal or professional interest when the delivery is relatively slow and clear. (B1 listening, CEFR self-assessment grid)

Finally, the CEFR is designed to be multipurpose, flexible, and non-prescriptive, meaning that it absolutely should be "applied, with such adaptations as prove necessary, to particular situations" (Council of Europe, 2001).

METHOD

Aims of the GELS surveys

Surveys were chosen as the best method for gathering quantitative data from the widest possible geographical range of engineers about their language and communication needs and skills. In a practical sense, two significant advantages of surveys for the GELS project were the low cost and the availability of efficient methods for data entry and management. There is no shortage of insightful and data-rich literature concerning language teaching and the specific needs of engineers and students (e.g. Björkman (2011)), but GELS surveys had the ulterior aims of 1) generating new and particular data to inform decisions concerning the GELS framework, and 2) creating interest in the GELS project among engineers in industry.

The first survey: How good is your Enginese?

The first survey included seven questions that required very short answers or a choice among three defined frequencies. Respondents shared information about their use of additional languages for professional purposes, their most common communication tasks, and the significance of additional language skills to their firm's recruitment process. The full survey can be viewed at http://goo.gl/forms/afKb8J8mfg

The survey was disseminated via social and professional networking websites, relying mainly on alumni associations at KTH, the Ecoles des mines, and the University of Cambridge. Respondents were encouraged to forward the link to their own contacts within their engineering fields.

The survey was often attached to a post with the title *How good is your Enginese?* and a text that introduced GELS, assured the respondents of their anonymity, and explained that all engineers could complete the survey (i.e. anyone qualified in engineering and/or employed to work on the design, construction or maintenance of engines, machines, ICT or structures).

The follow-up survey: How often do you carry out the following activities?

The follow-up survey focused on the most common communication tasks of engineers in any language. After four questions about the precise nature of the respondents' work, the survey was divided into five sections that reflected the divisions of the CEFR's skills (i.e. listening, reading, spoken interaction, spoken production, and writing).

Each section included questions about specific tasks, to which the respondents could choose a frequency reflecting how often they were expected to carry them out (see Figure 3). The tasks were chosen to reflect not only the communicative competences included in the CEFR, but also findings from previous literature (e.g. Dlaska (1999)), and any further topics featured in the *Communications* element of the CDIO syllabus. The full survey can be viewed at https://goo.gl/MF2lof

RESULTS

Survey results

At the time of writing (January 2016), 180 engineers from 29 countries on all five continents have responded to the surveys. Respondents range from self-employed designers of web-based database applications to regional managers for multinational oil and gas suppliers. What is clear from the results is that engineers claim to communicate a great deal and in a variety of ways. This generalization is clearly supported in figure 1.

As can be seen in Figure 1, engineers regularly use all five communication skills at work and more than half carry out all but two of the tasks more than once per week. According to the bar chart, the most common tasks are *interacting in and understanding information given at meetings, reading short documents* (less than two pages of text), *writing correspondence* (casual more often than formal), and *talking on the telephone*. By far the least common tasks are *writing longer documents* (more than two pages of text) and *delivering oral presentations*. The predominance of concise, dialogic, informative but less formal communication is noteworthy.
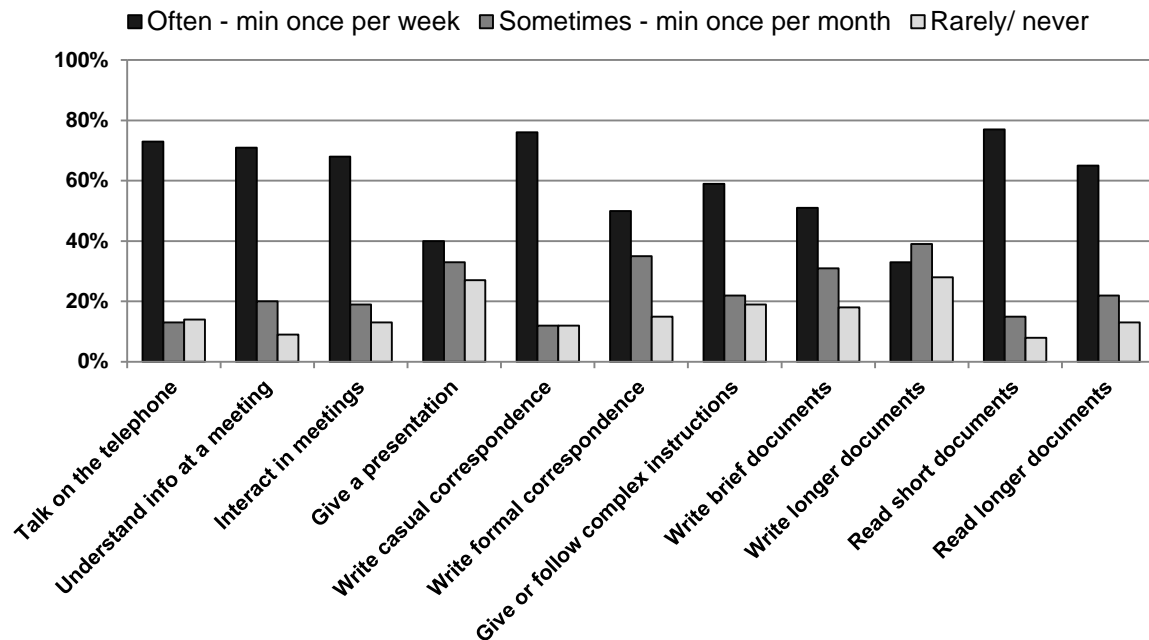
Figure 1. Result from survey 1 question 5: *How often do you do the following in any language?* (N=180)

Figure 2 presents respondents' communication in an additional language with employees within and outside their company. The bar graph shows that communication with colleagues is the main reason for using additional languages. These colleagues are presumably the interlocutors and recipients for the previously mentioned dialogic, informal communication.
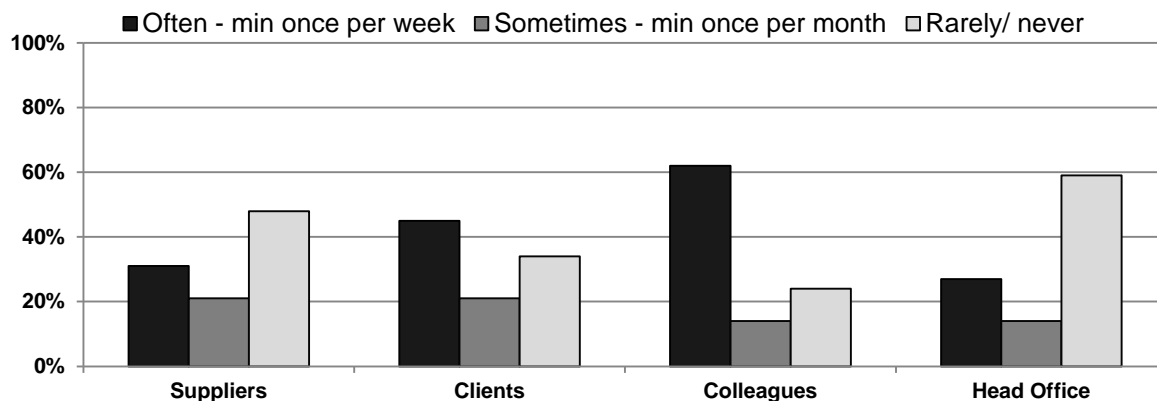

Figure 2. Result from survey 1 question 4: *Who do you need to communicate most with in an additional language?* (N=180)

That engineers should be prepared to communicate with clients in additional languages is no surprise, but the above result suggests that a globalized workforce and an increase in multinational engineering have presented new and different challenges for graduate engineers' language and communication skills.

The results from the follow-up survey confirm that engineers can be expected to communicate frequently and in diverse ways. Out of the 37 discrete tasks listed in the survey, 35 are apparently carried out at least once per month by at least half the respondents. Figure 3 presents 11 of the most common features of how respondents claim to communicate in industry, and with what frequency. As the bar graph shows, writing correspondence and communicating by telephone rank highly once again, but a range of new skills emerges for consideration in the GELS framework. Reading and listening for gist or specific detail is clearly a necessary passive skill, as are understanding and following instructions.

In terms of active communication skills, and with a nod to the CDIO syllabus and Dlaska (1999) respectively, the skills of negotiating using facts and data and verbalizing numerical data are considered everyday necessities by the respondents. Less obvious, though almost as frequent in an average working month as writing formal correspondence, is collaborative writing.
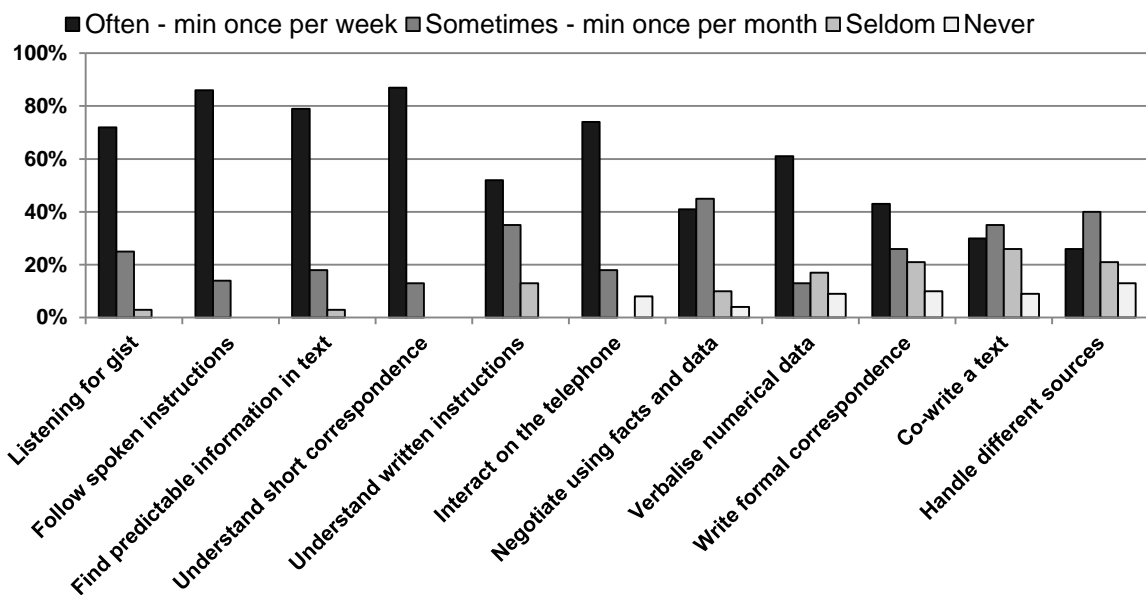

Figure 3. Combined results from survey 2: *How often are you required to carry out the following activities?* (N=24)

The follow-up survey confirms a result from the first survey: engineers deliver fewer prepared oral presentations than universities, and especially language courses, prepare them for. Almost half the respondents seldom or never deliver a rehearsed oral presentation.

The GELS framework: an adaptation of the CEFR for engineers

Compatibility with the CEFR

As shown in Figures 4 and 5, the GELS framework is intentionally similar to CEFR's self-assessment grid in terms of its arrangement: there are six levels of proficiency (A1 – C2) and five skills. This similarity facilitates an effective combination of general and engineering-specific work in language classes.

	A1	**A2**	**B1**
Listening face-to-face & distant communication	I can recognize frequently encountered lexis* from my engineering field. I can understand a message that includes this lexis. * e.g. numbers & equations, terminology, vocabulary of the workplace.	I can listen out for important information and understand enough of a speech to answer simple questions. I can understand simple instructions that use a wider range of frequently encountered lexis.	I can follow instructions from other engineers. I understand enough from radio/ TV/ lectures to summarize the main facts and figures, provided the speech is designed for non-experts and the topic is familiar to me.
Reading short → longer texts	I can recognize frequently encountered lexis* from my engineering field. I can understand short, simple sentences that include this lexis.	I can read simple paragraphs and can infer meaning where necessary in more complex text. I can follow instructions given in simple everyday correspondence.	I can understand short correspondence and recognize distinctive differences in register. I can scan texts for information and can learn from longer, instructive texts on familiar engineering topics.
Spoken interaction networking face-to-face and distant communication	I can meet new people and respond to basic questions about myself and my studies/ work. I can ask basic, corresponding questions.	I can exchange more detailed personal and professional information and can cope in brief, routine situations with my peers. I can inform others about common difficulties with e.g. language or technology.	I can use a range of simple language to deal with formal and informal situations and suggest solutions. I can interact in a conversation about my work and ask questions to develop the topic of conversation.
Spoken production pre-learnt → spontaneous speeches	I can present myself, my background, my field of engineering and my future plans. I can read out numbers and frequently encountered equations from my field of engineering.	I can use simple/ pre-learnt and frequently encountered lexis from my engineering field to describe experiences, observations and plans, verbalize formulae and communicate data in simple language.	I can recount my current work and previous experiences in connected phrases. I can present data, describe specific processes, and deliver a presentation that informs non-experts about topics within my field of engineering.
Writing individual & collaborative texts	I can fill in documents with basic information. I can compose texts with simple sentences about myself, my background, my field of engineering and my future plans.	I can compose short texts for my peers about routine occurrences and to make requests at school/ work. I can describe technical objects in text and use reference materials to enhance the quality of my written work.	I can compose succinct definitions and produce simple, cohesive text to inform non-expert readers about familiar topics in my engineering field. I can use the conventions of formal correspondence.

Figure 4. The GELS framework for engineers (levels A1 – B1)

	B2	C1	C2
Listening face-to-face & distant communication	I can understand extended, well-structured speech and can follow potentially complex arguments and counter-arguments. I can form thoughtful questions that show that I have listened carefully.	I can follow a presentation designed for an expert audience on a new topic within my engineering field. I can understand and infer meaning in discussions and unplanned speech about technical topics.	I can understand extended speech on any topic of my engineering field and can simultaneously analyze and evaluate the information provided.
Reading short → longer texts	I can find the answers to specific questions in longer texts on familiar but complex topics. I can read journalistic texts on a range of subjects and follow potentially complex arguments and counter-arguments.	I can skim and read long texts written for experts within my engineering field and infer meaning where necessary. I can follow complex instructions on unfamiliar processes and understand the subtleties of register.	I can understand long texts on any topic of my engineering field and can simultaneously analyze and evaluate the information provided.
Spoken interaction networking face-to-face and distant communication	I can interact effectively on a range of topics within my engineering field and address specific problems. I can substantiate my opinions with evidence, negotiate with colleagues and interact effectively to reach a consensus.	I can express my understanding and motives fluently to an expert audience in all situations. I can interact spontaneously with a high degree of fluency to enhance dialog and resolve problems.	I can participate constructively in discussions on any topic in my engineering field. I can adapt the lexis, register, technical complexity, and arguments of my speech to the situation and the audience.
Spoken production pre-learnt → spontaneous speeches	I can describe and give effective instructions about specific processes and methods within my field of engineering. I can interpret data spontaneously and share my understanding precisely and concisely.	I can apply the structures used in prepared presentations in more spontaneous speech to ensure that both my non-expert and expert audiences pay attention, are convinced, and well-informed.	I can speak fluently about any topic within my engineering field. I can adapt the lexis, register, technical complexity and arguments of my speech to the situation and the audience.
Writing individual & collaborative texts	I can summarize and/or paraphrase complex texts about technical topics. I can compose longer texts which are effectively structured. I can write in both a neutral style to inform, and in a persuasive style to convince.	I can co-write coherent texts with my peers. I can apply the conventions of academic/ technical writing to produce effective, informative text with supporting evidence and an appropriate combination of media.	I can compose fluent, coherent, reader-friendly text on any topic within my engineering field. I can adapt the lexis, register, technical complexity, and arguments of my writing to the situation and the audience.

Figure 5. The GELS framework for engineers (levels B2 – C2)

Where possible, the character of each proficiency level is also maintained. The most obvious examples of this can be found at the intermediate level. In both frameworks, successful completion of B1 level signifies a threshold to independent language use. In the CEFR, learners should be able to "maintain interaction and get across what [they] want to" and "cope flexibly with problems in everyday life" (Council of Europe, 2001). In the GELS framework, successful completion of B1 means that learners can study abroad and use their additional languages to cope at foreign universities and engage in their studies. At B2 level, the GELS adaptation is faithful to the original framework in its emphasis on argumentation.

Details aside, the GELS adaptation makes four significant departures from the original CEFR. Firstly, there is an emphasis away from expressing *opinions* and towards presenting *reasoning* (e.g. Spoken interaction C1). Secondly, there is distinct progression from communication with or for a lay audience towards an expert audience, e.g. Writing B1 → C2. Thirdly, the skills connected to problem solving are more prominent in the GELS framework than in the more general CEFR, with a progression from *informing* others about problems (A2 spoken interaction) to *resolving* specific problems (C1 spoken interaction). Finally, there is an intentional focus on the language learner's specific field of engineering. We suggest that an engineering field (for the purposes of e.g. vocabulary learning) be similar to the level of specificity of a Master's degree (level 2 or 3 or in Figure 6).
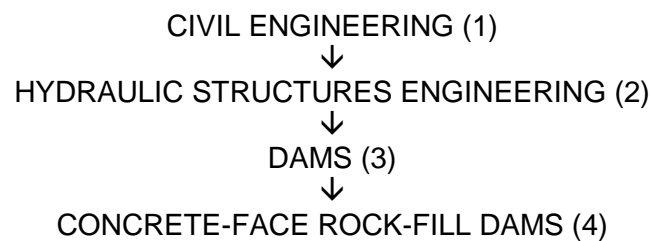
CIVIL ENGINEERING (1)
↓
HYDRAULIC STRUCTURES ENGINEERING (2)
↓
DAMS (3)
↓
CONCRETE-FACE ROCK-FILL DAMS (4)

Figure 6. Example of the levels of specificity in an engineer's education from Bachelor's level to PhD.

Compatibility with the CDIO syllabus

Language classes already contribute indirectly to students' fulfilment of many aspects of the CDIO syllabus. These classes often provide students with the low-stakes setting to (re)consider the societal and enterprise contexts of their work. Practically speaking, language classes are also an ideal opportunity for students to work in multidisciplinary teams. This paper has a more specific focus on language learning, however, and this subsection outlines the GELS framework's compatibility with the CDIO syllabus for *Communications* and *Communications in Foreign Languages*.

The relevant sections of the CDIO syllabus are listed in italics below, followed by a short description of how the GELS framework aims to be compatible with each section:

3.2 Communications

3.2.1 Communications strategy. Strategy refers to considerations such as audience, purpose, context, content, and the organization of the communication. In the GELS framework, audience awareness is explicit in all active skills at C2 level, as are the resultant considerations concerning the appropriate levels of formality, persuasion, and technical

complexity. Attention to technical and semi-technical lexis, and international and local terms, is also an important consideration at this level. A sensitivity to register is ensured in Reading B1, Spoken Interaction B1, and Reading C1, and learners are required to consider the appropriate rhetoric and combination of media in Writing B2 and C1 respectively.

3.2.2 Communications structure. The importance of effective macro-structure (i.e. the arrangement of ideas and supporting evidence) is made explicit in Writing B1 and B2, and can be reinforced in Spoken Production C1 and Writing C1 as part of the conventions of academic communication. The task of communicating succinctly and precisely at the micro-level (e.g. vocabulary choice) is set in Writing B1 and Spoken Production B2. Effective cross-disciplinary communication and appropriate uses of rhetoric emerge in the active skills at B1 level and are developed until they form the basis of all the active skills at C2 level.

3.2.3 Written communication. The important meso-structures for cohesive paragraphs and concise, reader-friendly sentences appear first in Writing B1, but continue in every active skill thereafter. The skills of technical writing are important in Writing C1, and learners are prepared for this in A2 (describing technical objects and using reference materials), B1 (composing succinct definitions and cohesive text), B2 (paraphrasing, structuring, using a neutral style), and C1 (using evidence, ensuring an appropriate combination of media).

3.2.4 Electronic/ Multimedia Communication. Specific methods of communication are avoided in the GELS framework. However, the importance of distance communication is made explicit in Listening and Spoken Interaction skills. The protocols of composing e-correspondence can easily be covered in Writing A1, A2, and B1, and Reading B1 and C1. The skills required for delivering effective presentations with electronic aids can feature in Spoken Production B1.

3.2.5 Graphical Communication. Writing C1 makes explicit the need for an appropriate combination of media in written work. Learners are prepared for the effective inclusion of data, including graphical data, in their work in Spoken Production A2, B1, and B2. This skill can also be developed in Writing B1.

3.2.6 Oral presentation. Oral presentation is synonymous with Spoken Production. It will be important in later work to specify how using the appropriate media, language, style, timing, flow, and body language contribute to delivering informative presentations (Spoken Production B1) and ensuring that audiences pay attention and feel well-informed (Spoken Production C1). Practice in answering questions effectively can be included in Spoken Interaction B1 – C2, where learners are challenged to interact effectively and, at a more advanced level, spontaneously in conversations about their work.

3.2.7 Inquiry, Listening, and Dialog. Listening C2 challenges learners to listen and simultaneously analyze and evaluate the information provided. Learners are prepared for this skill in Listening B2. Listening carefully for detail is an early challenge for learners (Listening A2), and the skill of following spoken instructions from other engineers is made explicit in Listening B1. The skills of ensuring dialog are implied throughout Spoken Interaction and are explicit in Spoken Interaction C2, but the progressive challenges of asking questions to develop the topic of conversation, reaching a consensus, and resolving problems are set in Spoken Interaction B1, B2, and C1 respectively.

3.2.8 Negotiation, Compromise and Conflict Resolution. The skill of following complex arguments and counterarguments in speech and text emerges at B2 level and the challenge

of evaluating the arguments is set at C2 level. To prepare learners for negotiations beyond the classroom, the GELS framework introduces the communicative skills required for dealing with potential problems, reaching a consensus, and resolving problems in Spoken Interaction B1, B2, and C1 respectively.

3.2.9 Advocacy. The communicative skills listed in this topic, such as explaining a rationale and justifying a methodology, are introduced in Spoken Interaction B2. Opportunities for development feature in Writing B2 and Spoken Interaction C1. The importance of audience awareness is central to the active skills at C2 level.

3.2.10 Establishing Diverse Connections and Networking. The requirement of networking is explicit throughout Spoken Interaction. We hope to create opportunities for learners to use additional languages to practice establishing and maintaining social and professional networks at every stage of the framework.

3.3   Communications in Foreign Languages.   The GELS framework, like the original CEFR, is language-neutral.   The intention is that teachers and learners can use these schemes to develop level-specific language and communication activities – in any additional language. The distinctions made below in 3.3.1, 3.3.2, and 3.3.3 are, therefore, irrelevant to the GELS framework.

3.3.1   Communications in English.

3.3.2   Communications in Languages of Regional Commerce and Industry

3.3.3   Communications in Other Languages

CONCLUSION

This paper has presented a framework of progressive communicative competences for the specific needs of engineers in universities and industry. The framework has four aims.

Firstly, it is intended to serve as a counterpart to the CEFR. Language teachers can use the GELS framework with confidence as a support for including more activities and exercises in their courses that are specific to the needs of engineers. Some of the ideas are ambitious, particularly at A2 and B1 level: they require extra effort from learners to create their own glossaries of frequently encountered lexis for their own engineering fields, and to engage with material designed to explain technical subjects before learners have mastered the fundamentals of grammar.

Secondly, it is a scheme of work to render the taxonomy of the CDIO syllabus accessible for language teachers and learners. The framework is broadly compatible with the ten topics of *Communications* and offers a structure for studying additional languages where there currently is none.

Thirdly, it is the first draft of a scheme of work that is intended to inspire discussion among engineers and language and communication specialists around the world.

Ultimately, it will form the basis of a teaching guide that aims to highlight the potential contributions that additional language classes can make to an engineering education.

Limitations of the work so far

180 responses provide only a glimpse of what engineers do and, due to the small number yet broad range of the engineers who responded to our follow-up survey, it is difficult to grasp the differences between employees' communication needs in different branches of engineering.

The geographical distribution of our 180 respondents presents a similar problem. Almost 30 countries are represented in the GELS surveys, but this is not enough to analyze the potentially different language and communication needs of engineers in different parts of the world.

Bias must also be recognized in surveys, and the GELS survey is no exception. It is more likely that engineers with an interest in languages and communication responded to the survey and, therefore, the breadth of needs and skills recorded may be skewed.

Plans for future work

This paper has outlined the first two stages of the GELS project: collection of data and categorization of the language and communication skills of engineers. More data needs to be collected and a consultation period is necessary, where as many stakeholders from academia and industry as possible comment on the GELS framework. Once a consensus is reached, the third stage of the GELS project can begin, which is to research suitable teaching and learning activities for each detail of each skill at each level of proficiency of the GELS framework. The final stage is the dissemination of a comprehensive bank of teaching and learning activities, together with a summary of the project's findings and conclusions.

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