COGAN

COMPETENCY IN GEOTECHNICAL ANALYSIS

INDUSTRY NEEDS SURVEY REPORT

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EXECUTIVE SUMMARY

This report presents the results of a survey of users of geotechnical numerical analysis tools to determine their views on the application of such tools in industry, particularly related to competency and training. The results of this survey will be used to shape the development of the COGAN project deliverables so that they match the needs of industry as closely as possible. This work was carried out as part of the COGAN project (Competency in Geotechnical Analysis), funded under the European Commission's Leonardo da Vinci Programme.

A major goal of the COGAN project is to contribute to the competitiveness and quality of geotechnical engineering design in Europe through identifying the competences that users of geotechnical numerical analysis software must possess. A competence framework will be developed to include a comprehensive educational base, a web-based interface to look-up and record achievement of competences, with links to associated resource material that engineers can use to help gain competences. The project will also deliver two exemplar e-learning modules to cover key areas of the educational base.

The survey itself comprised an online questionnaire of 31 questions taking about 15 minutes to complete. It was completed by 619 respondents from 37 different countries / continents. A lot of invitations were sent out across a broad range of industry sectors in Europe and beyond, using the partners contact databases as well as local associations and companies. The high number of responses indicates that the subject is of high interest. All the metrics in terms of overall response rate, company size and seniority, set at the start of the survey were achieved. The margin of error for the survey results was estimated to be ±4.5%.

The majority of respondents were engineers/analysts and senior engineers, although project managers and directors were also well represented. The educational level of about half the respondents was to master's degree level, with about a third reaching doctorate level. Respondents were well distributed across all age groups and were generally well experienced in geotechnical numerical analysis.

Most responses were from design offices and consultancies, but contractors, universities and other research and development organisations were also well represented, as well as organisations of different sizes, over half of which were SMEs.

Responses to some of the questions confirmed that there exists a significant need in industry for the deliverables of the COGAN project. For instance, only 34% of respondents educated even to doctorate level considered that their formal education related fully with their geotechnical numerical analysis activity.

Many organisations have a low number of engineers engaged in geotechnical numerical analysis and many of these are part-time users of such tools. This suggests that many organisations have not accumulated a significant body of expertise in this field and, with a lack of in-house expertise, many engineers will be in need of accessible, external training resources.

73% responded that there is no system to look-up and record achievement in competences in their organisations and a large majority (85%) thought such a system would be useful.

The four highest ranking issues concerning the application of numerical analysis in geotechnical engineering were “validation of analysis results”, “obtaining soil/rock parameters”, “lack of money/time for training” and “poor access to in-house experts or no mentoring system”, all of which can be addressed by the COGAN project deliverables.

The preferred media for a competence framework were a secure website and company intranet, while the preferred number of skill levels was 3.

Respondents also expressed their preferences for areas of geotechnical numerical analysis in most need of competency definition and to be covered by the COGAN e-learning modules. These results, together with the others, will be used to guide the development of the COGAN deliverables for the remainder of the project.

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1. INTRODUCTION

The purpose of this report is to present the results of a survey of the geotechnical engineering analysis and simulation industry to determine its views on the application of numerical analysis tools in industry, particularly related to competency and training. This work was carried out as part of the COGAN project (COmpetency in Geotechnical numerical ANalysis), funded under the European Commission's Leonardo da Vinci Programme.

1.1 COGAN Project as a Part of the Leonardo da Vinci Programme

COGAN follows the general objectives of the Leonardo da Vinci programme and focuses in particular on two of its main general objectives, namely:

- to support geotechnical engineers in training and further training activities in the acquisition and the use of knowledge, skills and qualifications to facilitate personal development, employability and participation in the European labour market;
- to support improvements in quality and innovation in vocational education and training systems, institutions and practices.

Within the programme, under the lead of NAFEMS (UK) and the consortium partners Geofem (Cyprus), Terrasolum (Spain), Mott MacDonald (UK), TU Graz (Austria), Skanska (Sweden), EnginSoft (Italy) and WESI Geotecnica (Italy), the COGAN project has been undertaken with the goal to stimulate innovation and enhance the competitiveness of the European geotechnical engineering industry (through the development of skills in the workforce).

The main aim of this Leonardo da Vinci Transfer of Innovation project is to set out the knowledge and skills that a competent simulation engineer in geotechnical engineering should possess. The goal is to transfer, modify and extend the output from the EASIT^2 project (http://www.easit2.eu), which developed a competence framework and an educational database for generic engineering analysis and simulation to the specific field of geotechnical engineering.

There will be 3 main deliverables from the COGAN project:

- An "Educational Base". This is a set of detailed statements explaining what competences a good simulation engineer should have. This will be broken down into modules, covering different areas of technology (e.g. fundamentals of finite element analysis, obtaining soil/rock parameters, constitutive models for geomaterials, etc). Links will be provided to appropriate books and training courses which will help individual self-learners to gain the appropriate competence and training providers to design focussed courses.
- A "Competency Tracker". This will be a computerised system which will allow the skills that are developed by individuals to be tracked and logged. This can then be used by individuals to plan and monitor their career development as a geotechnical simulation engineer, or by companies to do the same for their staff and to keep a database of the combined simulation skills of their workforce.
- Two "Exemplar E-Learning Modules" for work-based learning, to achieve in depth the learning outcomes in two selected core competencies, and to promote the development of further modules by training providers.

1.2 Study of Industry Needs (WP1)

It is crucial that subsequent development of a geotechnical (non-product-specific) Educational Base, Competency Tracker and the two E-Learning Modules, covering the education and competence of users of engineering analysis and simulation tools in the geotechnical industry, is informed by an accurate understanding of real industry needs. The aim of this initial work package was therefore to study the competency and training requirements across the geotechnical engineering industry. This in turn will directly influence the development of the Educational Base in WP2. The use of formal staff development structures was also examined, to ensure that the design of the COGAN Competency Tracker in WP3 can provide input to such systems. Input was also sought on the development of the two E-Learning Modules in WP4, see Figure 1.

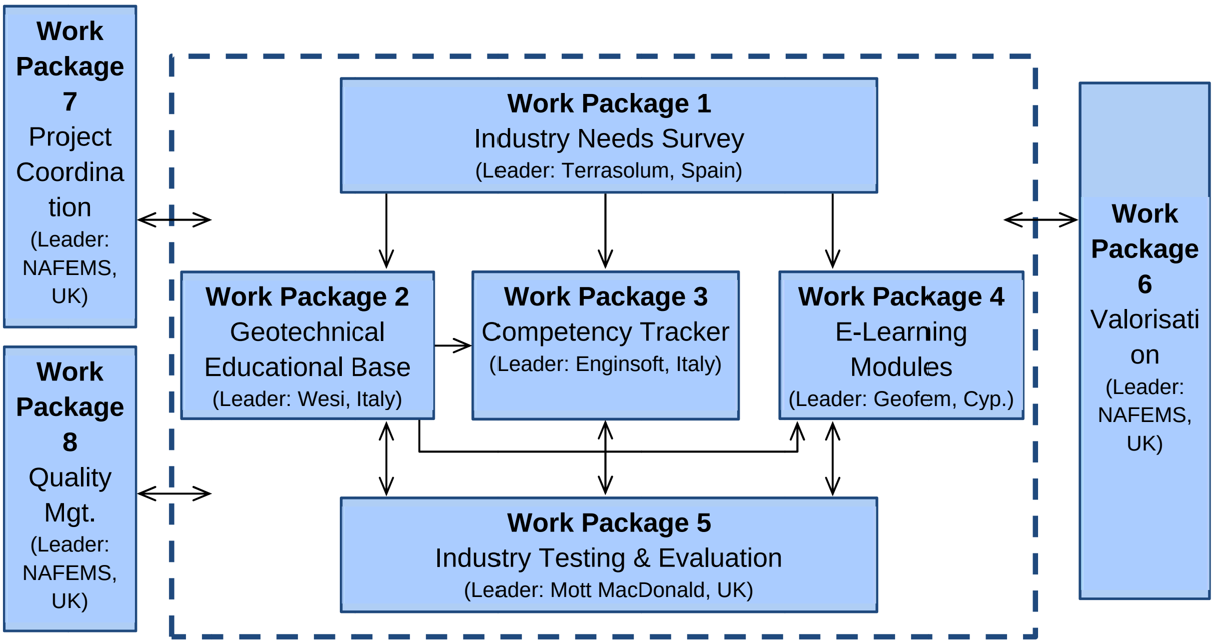

Figure 1 COGAN work package overview

2. THE SURVEY

2.1 The Questionnaire

The questionnaire used in the survey comprised 31 questions divided into 5 sections in addition to a welcome page as well as a concluding page, allowing respondents to add comments and to provide an email address on which to be contacted later in the project for evaluation of some of the project deliverables and to be kept informed about developments on the project. The sections were as follows:

2.2 Start

Introductory page

2.3 Your Details

Respondent's location, age, position, education and experience are sought. The frequency of use of numerical modelling tools as well as the relation of the respondent's academic education to current numerical analysis activity were also provided here.

2.4 Organisation Details

Nature, sector and size of organisation, number of people using numerical tools in geotechnical analysis, issues concerning geotechnical analysis and simulation, different numerical methods used, fields where software is employed (soil or rock mechanics) and existence of competence management systems.

2.5 Existing System to Record Analyst Skills at Your Organisation

Only if respondents indicated in the previous section that such a system existed at their organisation were they invited to complete this section by giving some details on the system's medium, number of skill levels and assessment method (as described in Figure 2). This was to help ensure that the design of the COGAN Competency Tracker can provide input to such systems.

2.6 Ideal System to Define and Record Analyst Competences

Preferred medium, skill levels, topics, focus areas and learning methods for inclusion in the Educational Base and Competency Tracker.

2.7 Training Needs

Respondents were asked their preferred learning methods and asked to select two topics for the E-Learning Modules of WP4.

2.8 Further Comments

Respondents were invited to provide any additional comments and to declare whether they would be willing to evaluate some deliverables later in the project. On completing the questionnaire, respondents were thanked for their contribution to the COGAN Project.

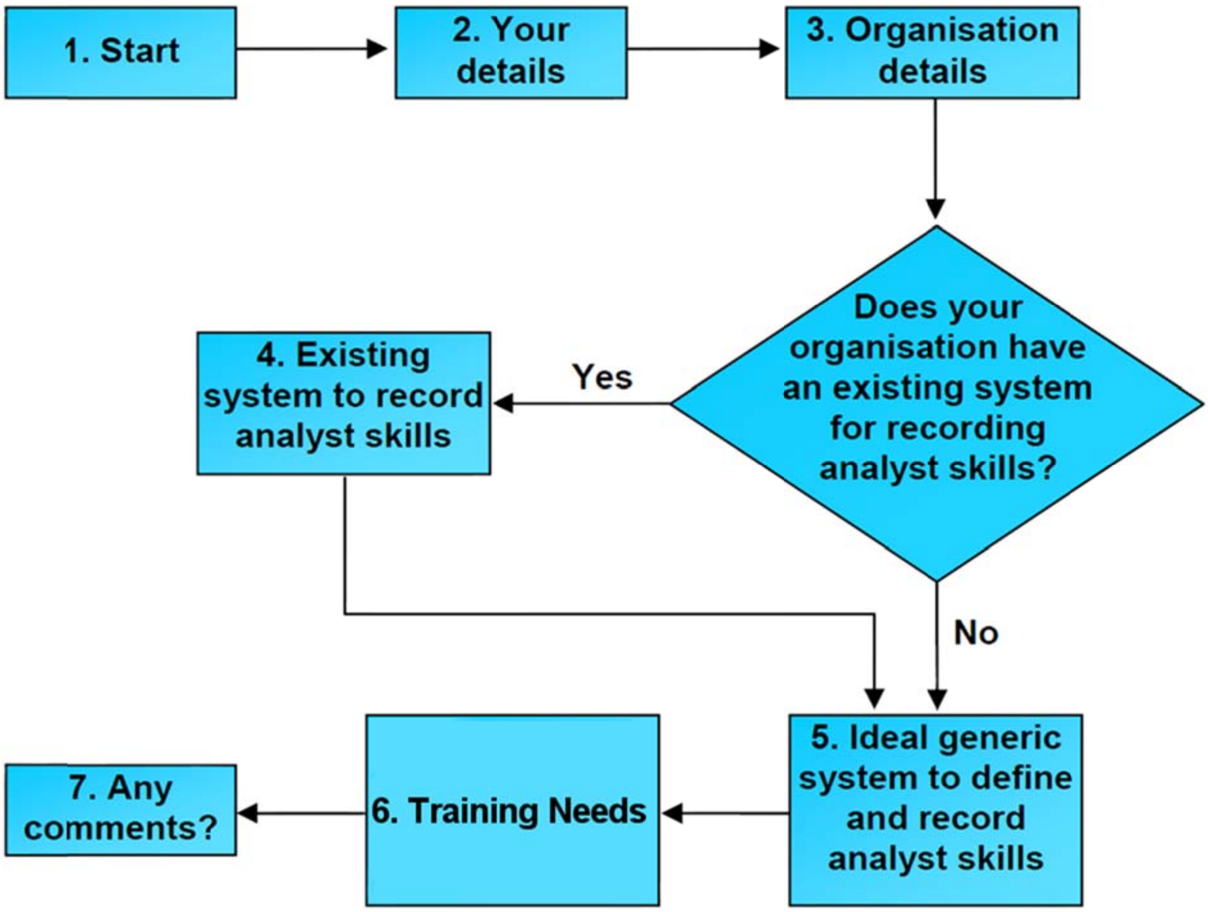

Figure 2 Questionnaire logic

The full set of questions is given in Appendix 1. The survey was conducted online using the website www.surveymonkey.com with which NAFEMS has conducted other successful surveys in the past. The website allows the straightforward setting up of surveys, data collection, data analysis and presentation as well as downloading of response data into spreadsheet programs for complete freedom of data analysis and presentation. The use of a web-based questionnaire made it very accessible both to project partners and potential respondents. The starting page is shown in Figure 3.

Figure 3 Starting page of the survey

The survey was conducted only in English since this is one of the official European languages and is understood by many geotechnical engineers across Europe. It was agreed by all the project partners that this would not significantly deter respondents whose first language was not English and the significant cost of translating both the questionnaire and responses to and from multiple languages could not be justified. However, invitation emails to participate in the survey were translated into the national languages of the partners plus French and distributed in those countries. This was found to be very successful and there was no evidence in the response rates that engineers outside of the UK were discouraged from participating; indeed France, which is not represented on the project partnership, was one of the highest participating countries.

The questionnaire is based on the EASIT[2] questionnaire and was created by Terrasolum. The other project partners provided comments and suggestions during the drafting process.

2.9 Target Group

A challenge was to reach a large number of geotechnical engineers at a European and international level, in particular through the national trade associations. These groups had to be contacted separately using the project partners' contacts distributed across Europe. Furthermore, all partners were encouraged to disseminate the COGAN project and the survey in their country and beyond through national trade magazines, their contact networks, social media networks and membership of committees and societies. Invitation and reminder emails were sent out in English, German, French, Swedish and Italian to the corresponding countries with those national languages.

A valuable route to contact potential survey participants was also provided by software vendors who hold large databases of email addresses of geotechnical engineers for marketing purposes. While COGAN remains strictly software-neutral, five software vendors generously disseminated the COGAN survey through their email channels and this has been recognised on the COGAN website.

Links to the survey were also placed on the COGAN website and links to the COGAN website were placed on some project partner websites.

Due to this multi-channel dissemination process, it is impossible to know exactly how many engineers learned about the COGAN project and its survey, but it is estimated to be well in excess of 10,000 geotechnical engineers worldwide.

2.10 Anticipated Impact

It is anticipated that the results of this survey will impact directly on the subsequent stages of the COGAN project, namely the development of the Educational Base, Competency Tracker and the two E-Learning Modules. This survey will ensure the industry relevance of these project deliverables and help maximise industry take-up.

The survey has also raised awareness of the COGAN project in the geotechnical engineering analysis community, most particularly through the invitation emails which provided a brief explanation of the objectives of the project as well as a link to the project website.

2.11 Survey Metrics

Prior to the survey going live, a number of challenging metrics were agreed between all the project partners by which to judge the success of the survey and to take corrective action if necessary. These are described below where it is shown that all the metrics were achieved successfully:

Metric 1. Achieve the number of respondents (**500**). Result: total number of respondents completing survey by 03/01/2014: **619**. **(✓)**

Metric 2. No more than **30%** of respondents from a single country, to ensure adequate cross-European coverage. Result: greatest participation from North America (**12.1%**), France (**11.6%**), Sweden (**10.8%**), Germany (**10.5%**) and Spain (**10.2%**). **(✓)**

Metric 3. At least **15%** of respondents to be at Project Manager or Director level. Result: 8% Project Manager, 9% Director, total **17%**. **(✓)**

Metric 4. At least **25%** of respondents to be from SMEs to ensure that they are adequately represented and that their training needs are identified. Result: respondents from SMEs **59%**. **(✓)**

2.12 Margin of Error

A key question in surveys of this type is "are the respondents representative of their community?". The margin of error cannot be calculated for this survey from the laws of probability since the true population size (all geotechnical engineers worldwide) is unknown, and because the sample was not randomly selected but rather was self-selecting since recipients of the invitation emails decided themselves whether to participate. The invitation emails could not be sent to all geotechnical engineers in the world, but to contact databases belonging to a number of organisations, which tended to be clustered in certain countries. Additionally, the response data is largely non-parametric (i.e. categorised) which does not lend itself to statistical analysis as readily as parametric data. However, the most important factor in determining the margin of error is the sample size: a sample size of 500 typically produces a margin of error of about 4.5%, a sample size of 1,000 typically about 3%, and a sample size in excess of 4,000 produces a margin of error of about 1.5% (American Statistical Association guide "What is a Survey").

Therefore, in this survey of 619 respondents, notwithstanding the bias that may be expected from a self-selecting sample, a margin of error of approximately ±4.5% would be expected.

3. SURVEY RESULTS – RESPONDENT DETAILS

The full results of the survey are presented in Appendix 2 in numerical form and in Appendices 3 and 4 in the form of charts (overall results and filtered by country respectively). In this and the following chapters, the key findings from the survey are described. In some cases, readers should refer to Appendices 3 and 4 for a display of the results that are discussed below.

3.1 Respondent Location

The respondent locations are shown in Figure 4 and Figure 5 and show a good geographical distribution of respondents across Europe as well as some significant representation from North America and other non-European regions.

The highest number of responses (12%) was received from North America and France, followed by Sweden and Germany with 11% of respondents, which, given Sweden's population of 9.5 million and Germany's 80.5 million, is remarkable and can be attributed to the invitation emails sent out by Skanska to the geotechnical community in Sweden.

Following Spain (10%) and United Kingdom (8%), the remaining countries contributed between 0.2 and 5% each of the total number of responses.

Some responses came from regions outside of Europe, such as North America (12%), Asia (4%), Australasia (4%), South/Central America (2%).

Figure 4 Location of survey respondents (by totals)

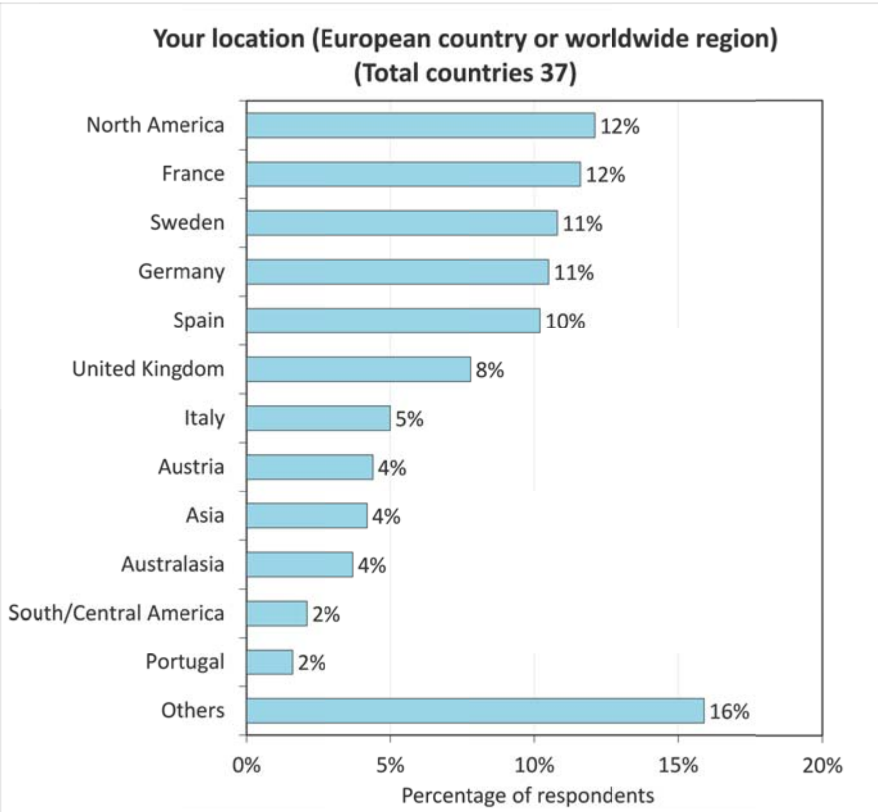

Figure 5: Location of survey respondents (%)

3.2 Respondent Status

Respondents were well distributed across all age groups from 20 to 50+, with the most (35%) coming from the 30-39 age group.

The majority of respondents were engineers/analysts (30%), senior engineers (24%), and academics (20%) while directors (9%) and project managers (8%) were also well represented. Only a small proportion (5%) was at technician/designer level however.

The educational level of about half the respondents was to EQF level 7 (master's degree) (48%), with 38% reaching EQF level 8 (doctorate) and 11% EQF level 6 (bachelor's degree). The high proportion of EQF levels 7 and 8 reflects the highly technical nature of the field of study and the need for specialised postgraduate study before implementing geotechnical numerical analysis tools in practice.

However, significant variation was recorded between countries, as shown in Figure 6. For example, France, Sweden and Spain recorded a high proportion (> 50%) at master's degree level and less (≤ 30%) at doctorate level, while about the opposite occurred in North America and United Kingdom (doctorate level > 50% and master's level ≤ 40%) and Germany had about the same proportion at each level at around 40%. These national differences could be a result of different qualification requirements to practice engineering in those countries as well as different cultures regarding the value of attaining the different levels of academic qualifications, and these differences should be borne in mind during the development of the COGAN deliverables.

Respondents were generally well experienced in geotechnical numerical analysis with 63% indicating over 5 years of experience (Figure 7), which enhances the value of the responses to the survey and reflects the specialised nature of these activities.

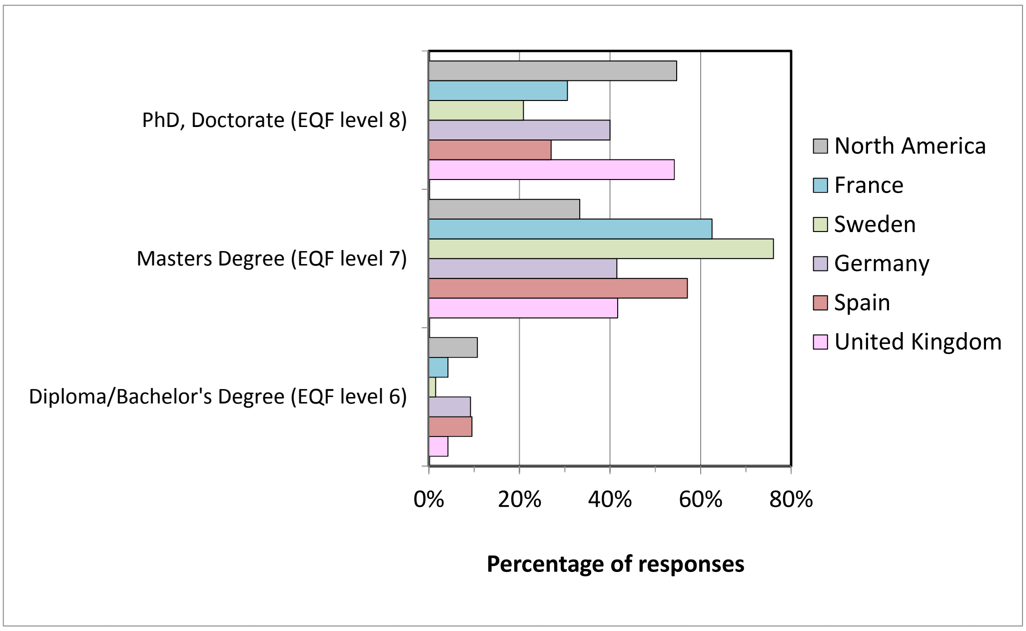

Figure 6: Education level of respondents (by countries)

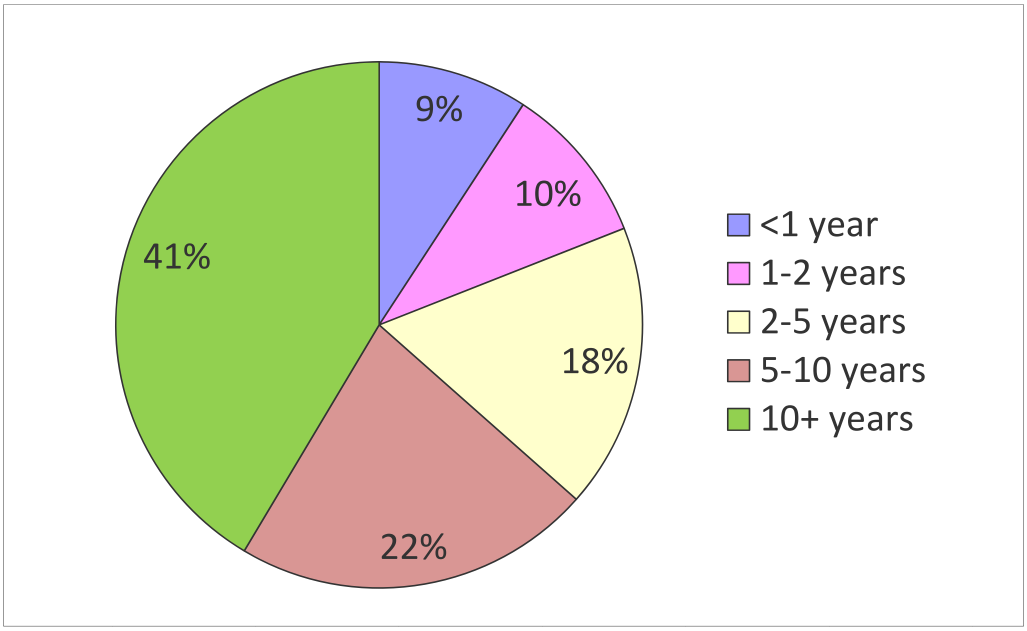

Figure 7: Experience in geotechnical numerical analysis

3.3 Respondents' Engineering Analysis Activity

Figure 8 shows that about 70% of respondents spent less than 40% of their work time in the preceding 6 months involved in geotechnical numerical analysis. This suggests that the majority of users of numerical analysis software are part-time users, sharing their time between analysis work and, presumably, other geotechnical activities. In some respects this is good because of the importance of gaining all-round geotechnical knowledge and experience when performing numerical analysis, but in other respects the occasional usage of numerical analysis by many engineers presents a particular challenge in raising competency levels. It will be vitally important for the work-based training tools developed by the COGAN project to be flexible in order to fit around busy workloads and to be available on-demand when engineers undertake periods of activity in numerical analysis.

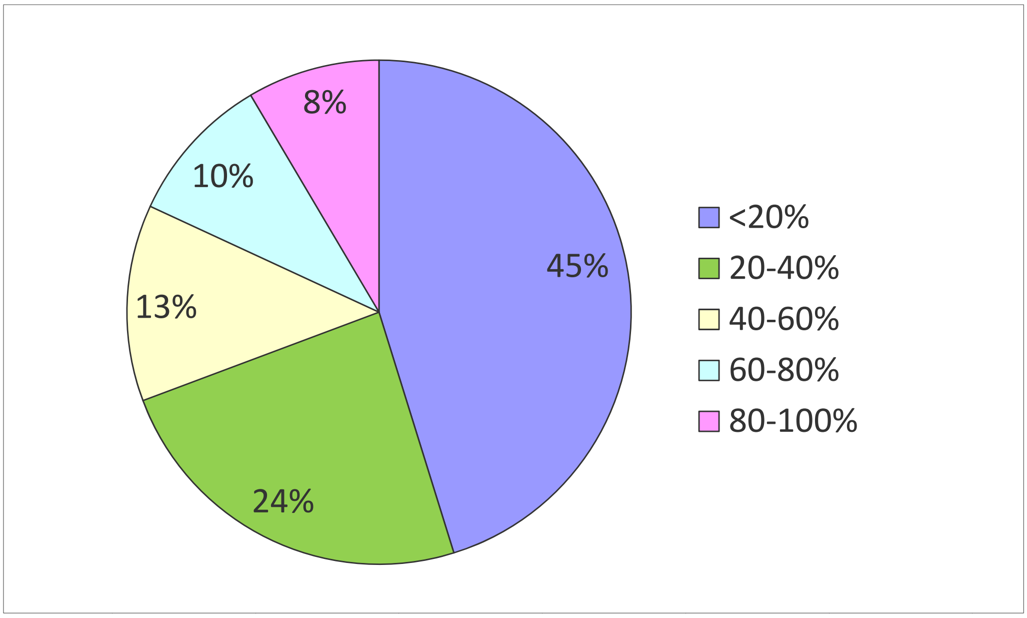

Figure 8: Proportion of work time spent in geotechnical numerical analysis in past 6 months

Respondents were asked how they felt their formal education related to their engineering analysis activity on a scale of 0 to 3 (Figure 9). About equal proportions responded with the intermediate levels of 1 and 2 (35% each), while 20% responded with 3 ("fully") and 11% responded "not related".

When analysed by education level, naturally those at a higher level felt that their formal education related more to their engineering analysis activity. Nevertheless, even among those holding a doctorate, only 34% felt that their formal education related fully to their engineering analysis activity, so there is clearly a need for further work-based learning in geotechnical numerical analysis following academic studies before it is put into practice.

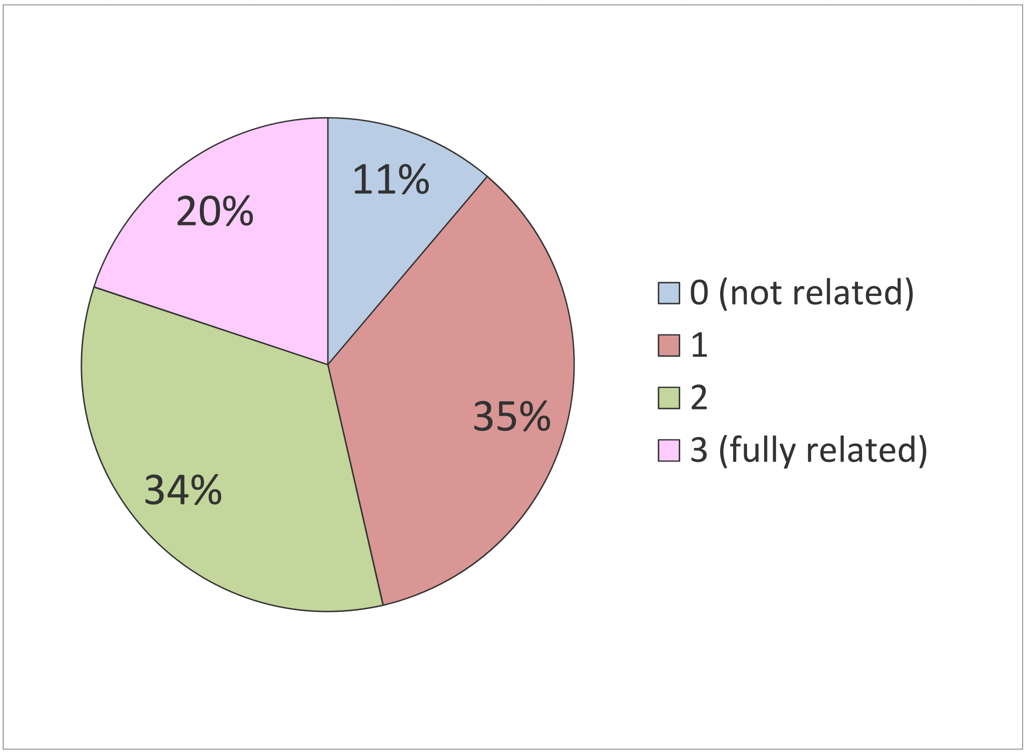

Figure 9: How formal education is related with current numerical analysis activity

4. SURVEY RESULTS – ORGANISATION DETAILS

4.1 Organisation Activities

Figure 10 shows that the majority of respondents were employed in design offices/consultancies (61%) which is where one would expect the majority of numerical analysis use to occur in industry. This was followed by universities (24%), research and development (18%) and contracting (14%). Survey responses from universities were not excluded from this industry survey because many universities undertake a significant amount of consultancy work in addition to their academic activities and, in this respect, are likely to have similar training needs to industry.

Figure 11 shows four main geotechnical sectors, with:

i. 84% of all responses for Civil and Construction
ii. 25% of all responses for Mining
iii. 15% of all responses for each of Marine & Offshore and Oil & Gas.

As for the previous question, multiple selections were allowed so the percentages shown are based on the total sum of selections rather than the total number of respondents and the totals come to over a hundred.

Some interesting variations in geotechnical sector data occurred between location countries, as shown in Figure 12. Clearly, a huge majority (95%) of the responses in France, Sweden and Spain were for the Civil and Construction sector, while less so in the United Kingdom, Germany and North America. In these countries a greater share was taken by the Mining and Oil and Gas sectors and, in the UK, Marine and Offshore.

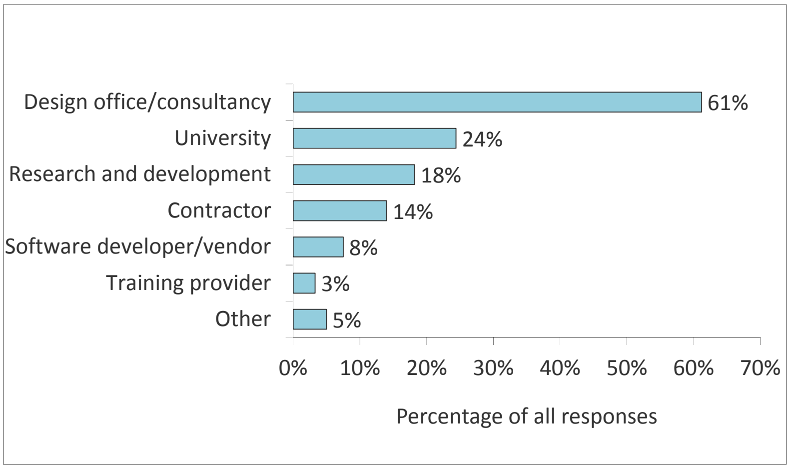

Figure 10: Nature of organisation

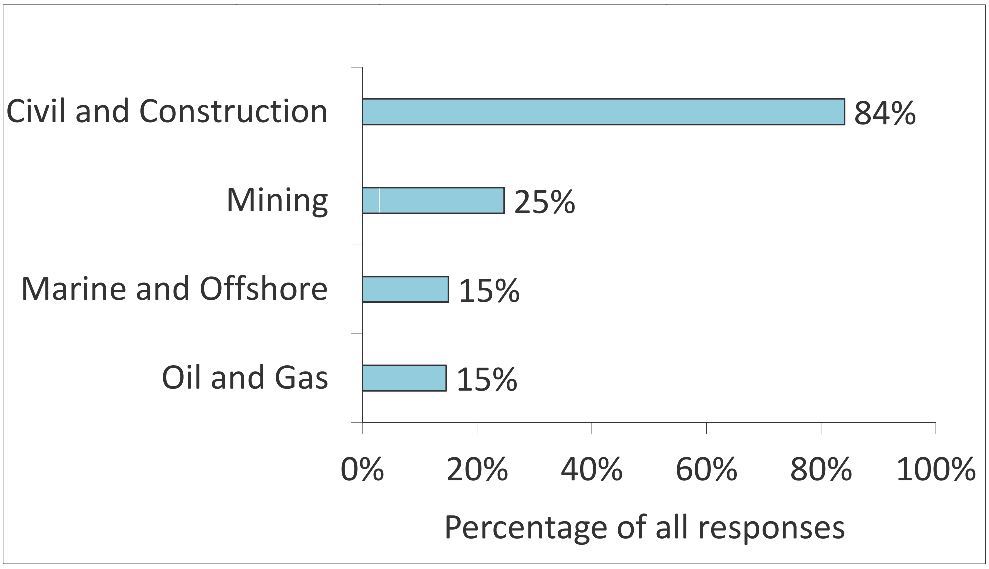

Figure 11: Industry sector of organisations

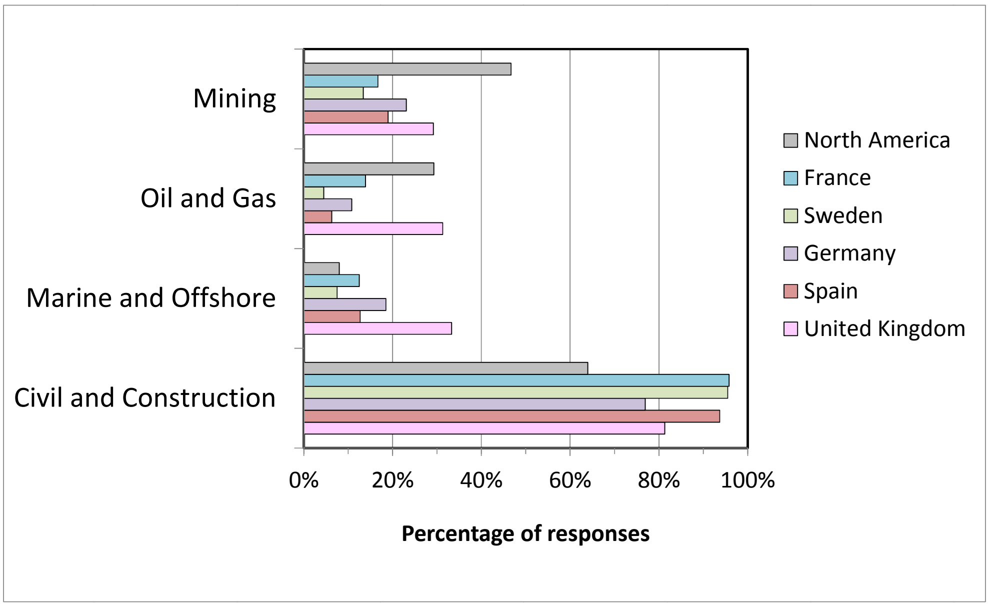

Figure 12: Industry sector of organisations (by country)

4.2 Size of Organisations and Engineering Analysis

A third of the respondents to the survey worked in large organisations (500+ employees) whilst a significant proportion (24%) worked in very small organisations of 1-20 employees. The proportion of respondents working in organisations falling into the SME category (up to 250 employees) was 59%, so both large organisations and SMEs were well represented in the survey.

Respondents were also asked to state the number of engineering analysts working in the organisation. The data shows that 45% responded with 1-5 analysts, 25% responded with 6-10 analysts, 27% had 11-100 analysts and only 4% had 100+ analysts. The significant proportion of respondents working in groups as small as 1-5 users of numerical analysis software, together with the high likelihood that even they might be part-time users (as suggested by responses to an earlier question) illustrates the challenge in raising the competency level of engineers in organisations that have not accumulated a significant body of expertise in this field. With a lack of in-house expertise, many engineers will be in need of accessible, external day-to-day training resources.

4.3 Organisation Engineering Analysis Activity

Respondents were asked to indicate the type of numerical analysis software employed in their organisations and were free to select multiple categories (Figure 13). The most selections (82%) were for “commercially available with standard material models provided with software”, then “commercially available with user-defined material models” (53%), “wholly developed in-house" and “commercially available with in-house modifications” software accounted for 29% and 19% of selections respectively. “Open source” accounted for 12% of selections and “external development/tailoring” for 5%. No particular trends in the data were observed between countries.

Therefore, it can be summarised that 80% of respondents use commercially available software and, understandably, the proportion was higher among commercial organisations (design offices and contractors) at 87%, while universities had a higher proportion of in-house software usage (38%). These figures provide useful insights into the nature of numerical analysis software use in practice.

Respondents were asked to state the proportion of their analysis time spent using different numerical methods. The data shows, on average, 49% use of the finite element method (FEM), 18% on finite difference method (FDM), 13% on discrete element method (DEM), and 20% on “other numerical methods”.

Respondents were also asked how their organisation’s geotechnical activities were shared between “Soil Mechanics” and “Rock Mechanics”. On average, 66% of activities were in soil mechanics and 34% in rock mechanics fields. That is in line with the previous question because the majority of respondents use FEM and FDM which are more associated with soil mechanics problems.

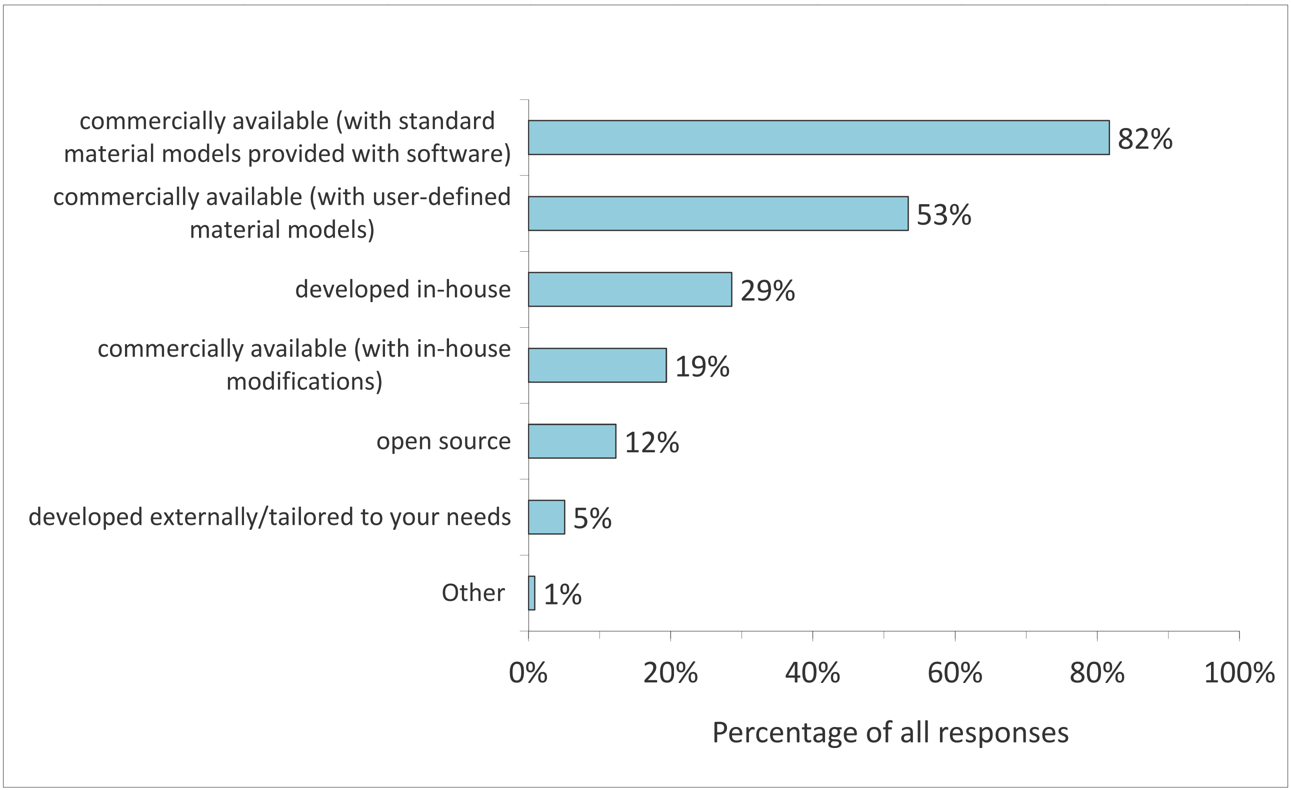

Figure 13: Software types used by organisations

4.4 Issues Concerning the use of Geotechnical Numerical Analysis

Respondents were asked to rate a number of issues concerning the use of geotechnical numerical analysis software in industry, on a scale of 0 (not an issue) to 3 (serious issue), and the average ratings are shown in Figure 14. The four highest ranking issues were "validation of analysis results", "obtaining soil/rock parameters", "lack of money/time for training", and "poor access to in-house experts or no mentoring system". The first two relate to the need for geotechnical engineers engaged in numerical analysis to have a good all-round knowledge of geotechnical engineering in order to bridge the gap between reality and the computer model by obtaining parameters from real-world tests for idealised soil models and by checking that analysis results are a sufficiently accurate representation of reality. These issues place perhaps the heaviest demands on the competency of engineers because they need to understand both the computer model and the background geotechnical engineering. Therefore, it will be necessary for the COGAN Educational Base to include modules on the background geotechnical knowledge needed to perform numerical analysis, as well as to cover the specific areas of validation and obtaining parameters. The third is an issue for many organisations and can be addressed by more high-quality and engaging e-learning courses that can fit around people's workload rather than add to it – a need that should be met by the COGAN Exemplar E-Learning Modules and which can then be developed into more courses by training providers beyond the life of the COGAN project. The fourth ranked issue is particularly concerning and probably arises from the earlier observation of the small number of users of numerical analysis software leaving some organisations unable to establish a critical mass of expertise to provide in-house mentoring. This again shows a clear need for the COGAN deliverables which should help to raise the competency level of these small groups of engineering analysts by providing affordable, accessible training resources.

Across the different countries (see Appendix 4), the trends were similar to those shown in Figure 14 for all responses.

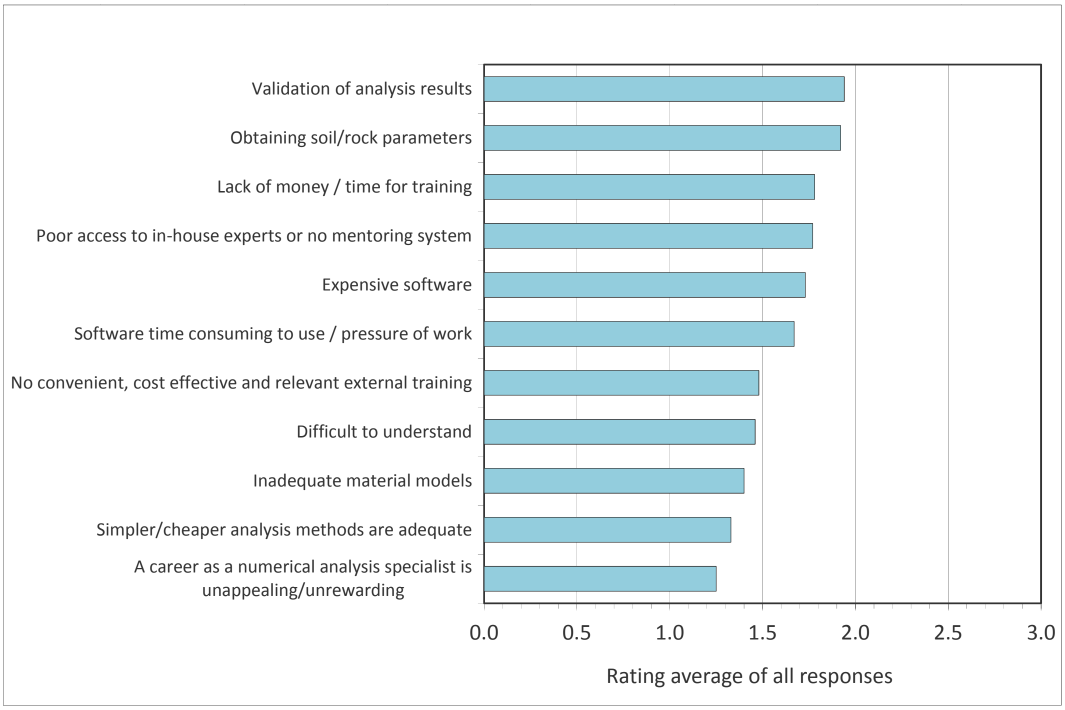

Figure 14: Issues concerning the use of geotechnical numerical analysis in industry

4.5 Any Existing Definition or Recording of Analyst Competences?

Respondents were asked two simple "Yes/No" questions on current practices in their organisations regarding analyst competences. The first asked whether the competences needed to perform different geotechnical numerical analysis tasks are formally defined and the response overall was 62% "No". This shows that there is a significant need for the educational base being developed in this project.

The second question asked whether there is a system for looking-up and recording staff competences in geotechnical analysis and simulation. A significant majority (73%) responded "No", which demonstrates the need for the COGAN competence framework.

Interestingly, the responses to these two questions were not particularly dependent on organisation size or number of analysts, so the lack of definition of competency is perhaps not resource-driven but an industry-wide issue. However, there was some variation by country, as shown in Figure 15, with a higher proportion of organisations with existing systems in both France and UK.

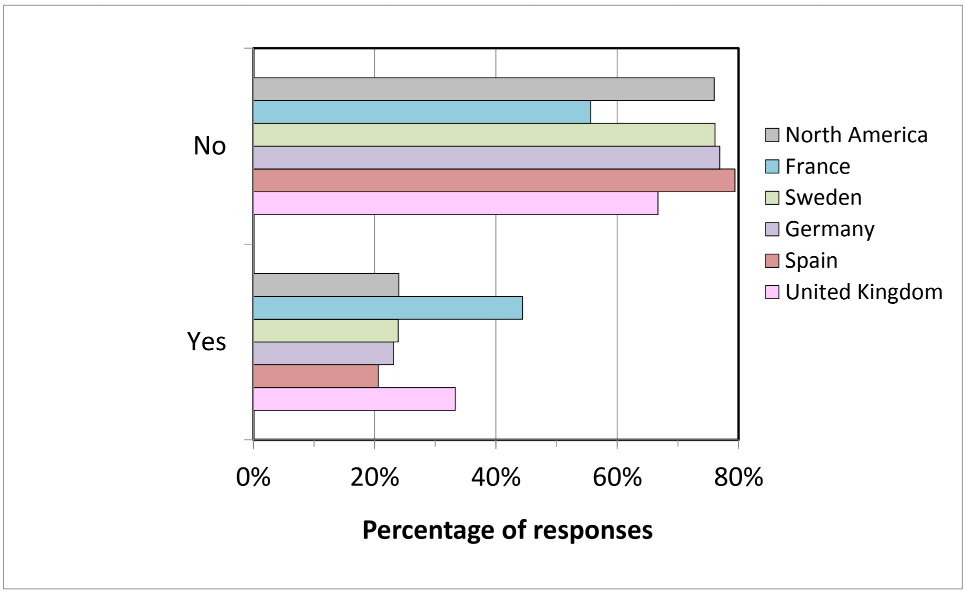

Figure 15: Does a system to record analyst competences exist in your organisation?

5. SURVEY RESULTS – EXISTING SYSTEMS TO RECORD ANALYST COMPETENCES

The 168 (~30%) respondents who selected "Yes" in the question asking whether a system to record analyst competences existed in their organisation were asked three additional questions about their systems in order to help ensure that the COGAN Competency Tracker can interface with existing systems more easily.

The media employed by companies for such systems are shown in Figure 16. Paper based and company intranet are clearly the most common (53% and 51%, respectively) followed by commercially available software systems (24%) (multiple selections were possible in this question).

The number of skill levels used in existing systems is shown in Figure 17. It appears that 33% of existing systems have no definition of skill levels, whilst among those systems with skill level definition, three levels is the most common at 27%.

Finally, respondents were asked to select the method of assessment employed to assess whether engineers have achieved the competences defined in the system (multiple selections were allowed). By far the two most common assessment methods were "internal assessment by manager/mentor" and "self-assessment", both at 62%.

Figure 19 shows the assessment methods by country where there are interesting differences in culture. Spain, for example, rated self-assessment much lower at 36% and external assessment higher at 43%, whilst Germany and UK appear to use more self-assessment. It will be important for the COGAN deliverables to have the flexibility to accommodate these cultural differences.

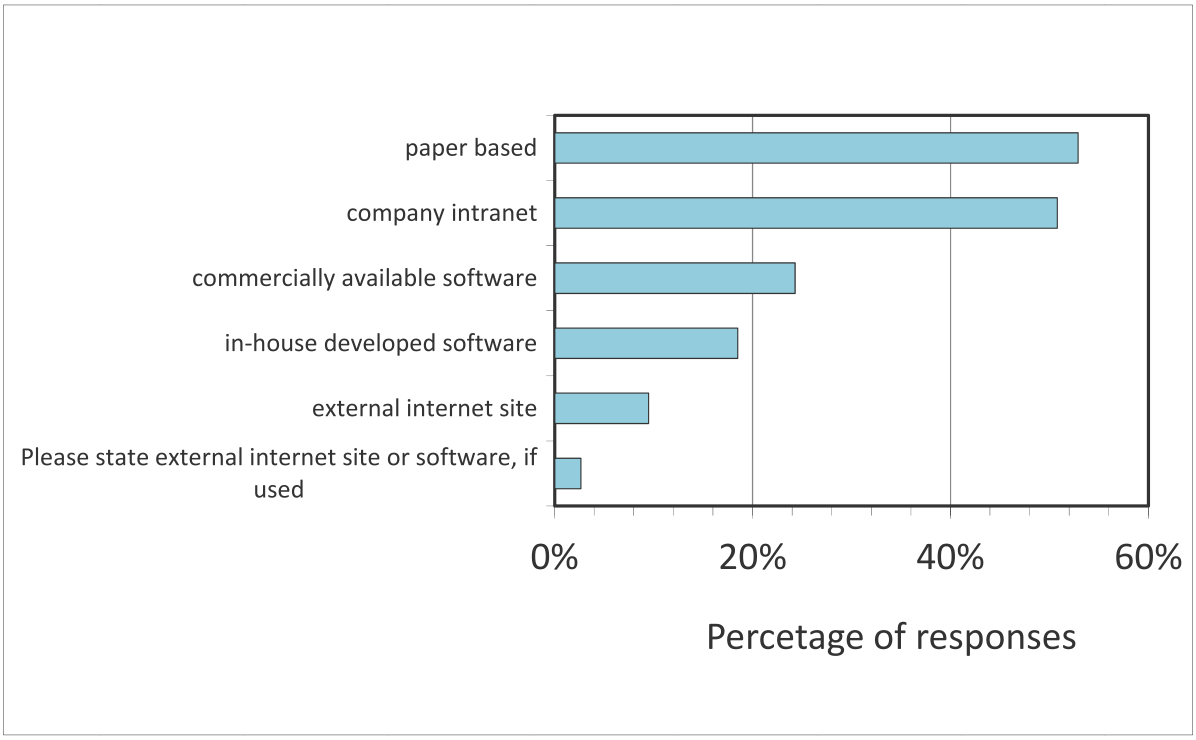

Figure 16: Medium for existing systems of recording analyst competences

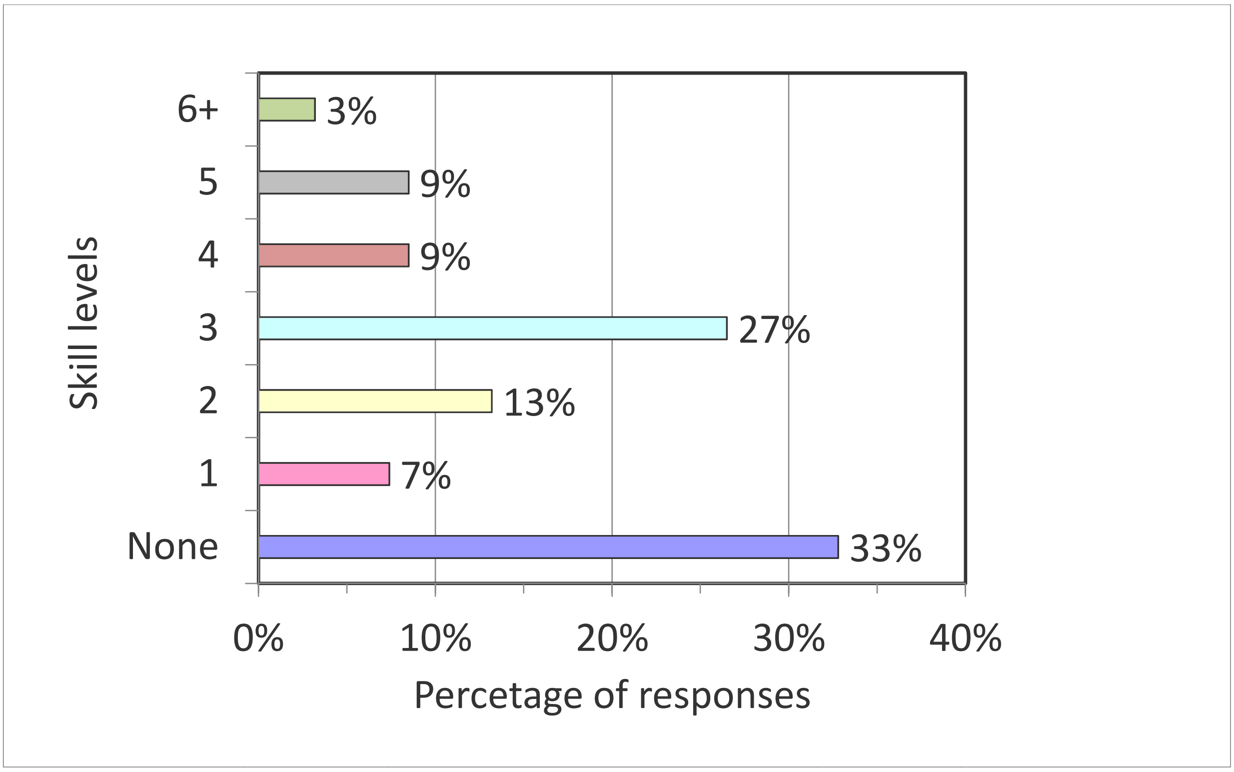

Figure 17: Number of skill levels employed in existing systems for recording analyst competences

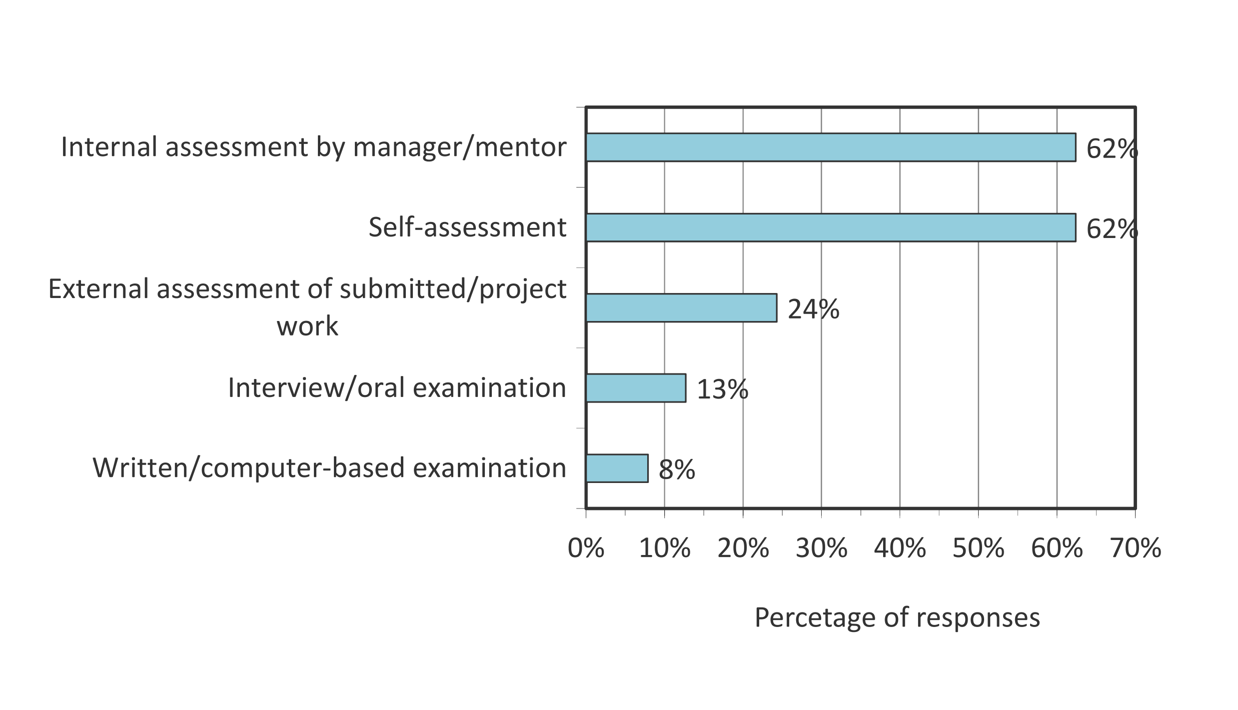

Figure 18: Assessment methods employed in existing systems for recording analyst competences

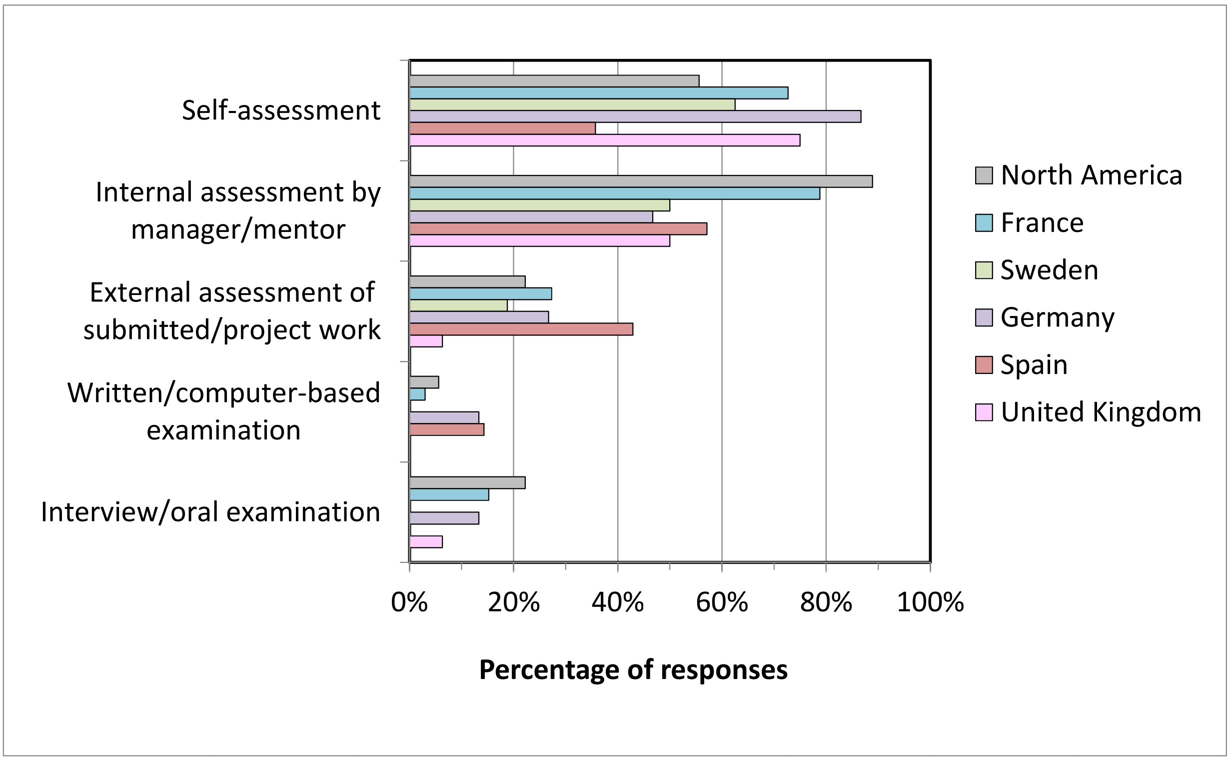

Figure 19: Assessment methods employed in existing systems for recording analyst competences (by country)

6. SURVEY RESULTS – IDEAL SYSTEM TO DEFINE AND RECORD ANALYST COMPETENCES

All respondents were then asked for their preferences for an ideal system to define and record competences. The responses to these questions are described in this section.

6.1 Good Idea?

When asked whether a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development, a large majority (85%) responded "Yes", which shows that there should be enormous interest in the outcomes of the COGAN project.

Respondents were also asked to state any systems they were aware of outside of their organisation for defining and recording analyst competences. The full list of responses is provided in Appendix 2 (Q22), but no existing suitable systems were identified.

6.2 Preferred Medium and Number of Skill Levels

As in the previous section concerning existing systems, respondents were asked for the preferred medium and number of skill levels in their ideal system, and these responses will be used to guide the development of the COGAN competence framework. As shown in Figure 20, the preferred medium is a secure website, followed closely by company intranet.

The preferred number of skills levels, as shown in Figure 21 and Figure 22, are '3' then '4', and '3' was also the most popular selection in existing systems that had skill levels defined, as described in the previous section. It was thought that perhaps director-level survey participants may prefer more levels and junior engineers fewer levels, but the results compared between positions within organisations are shown in Figure 32 and clearly 3 levels is the preferred choice by all.

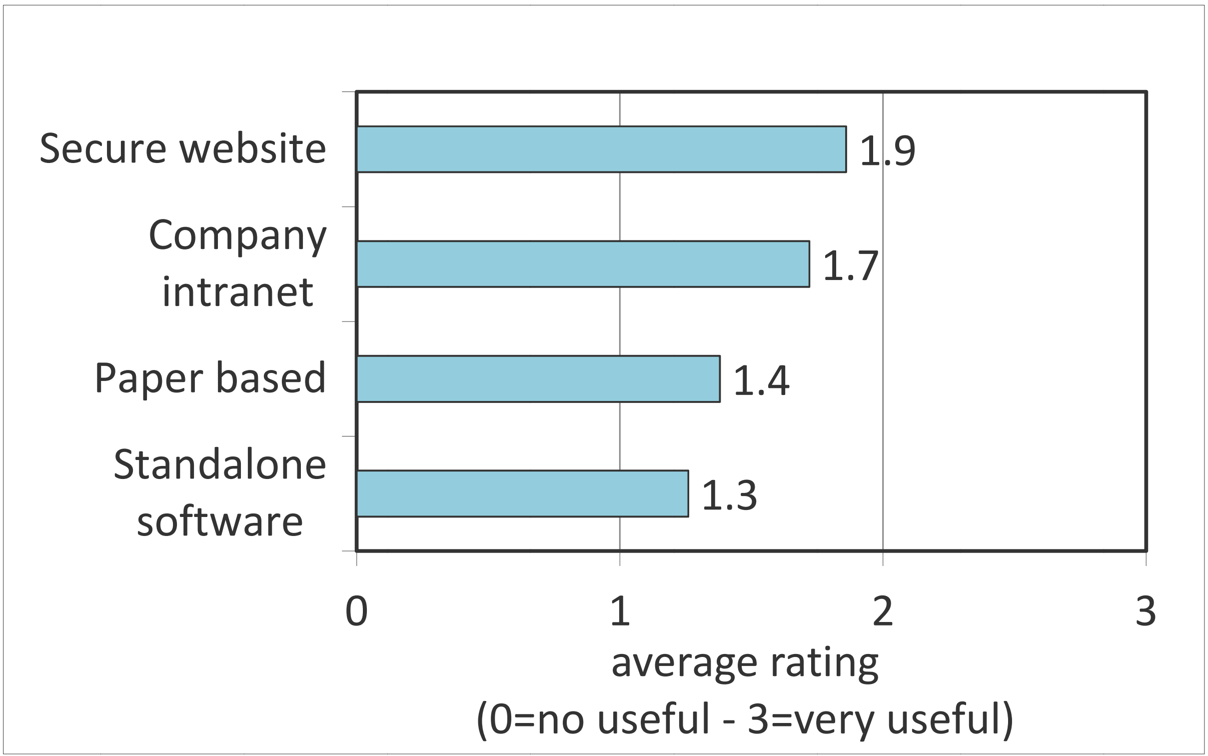

Figure 20: Preferred medium for recording analyst competences

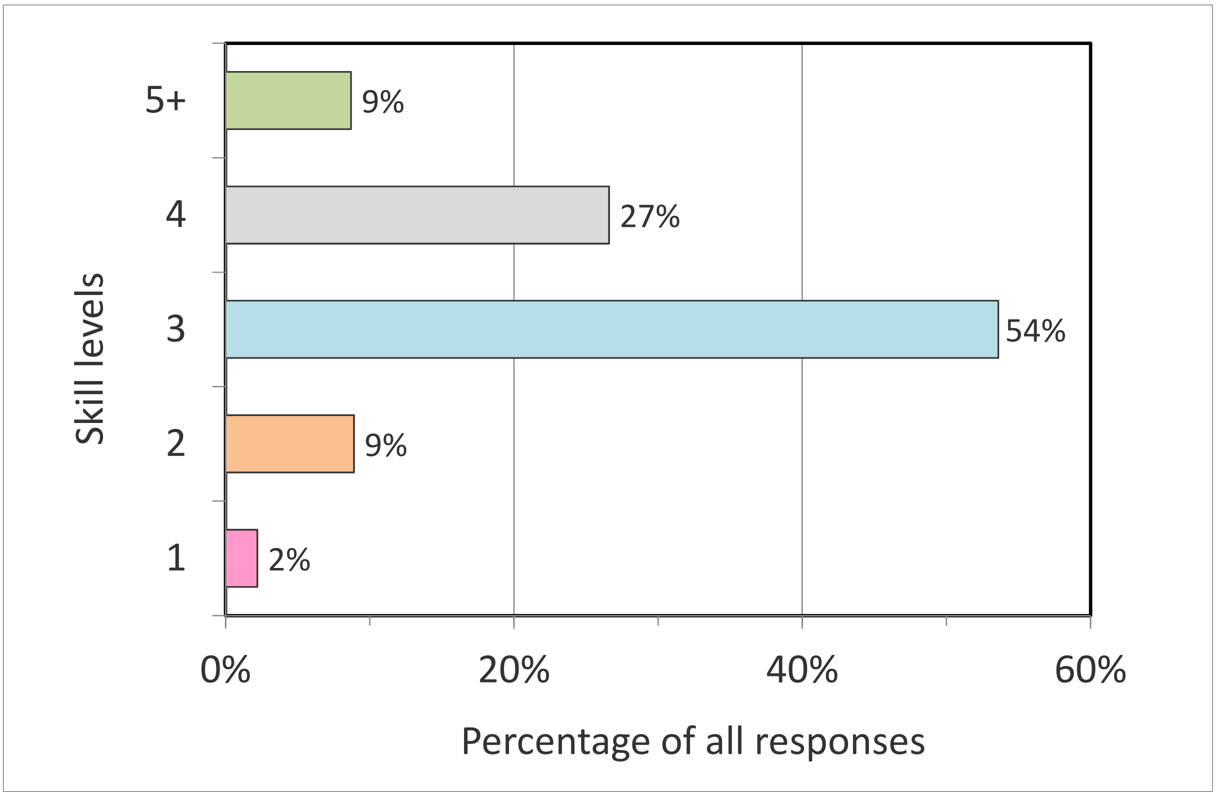

Figure 21: Preferred number of skill levels for recording analyst competences

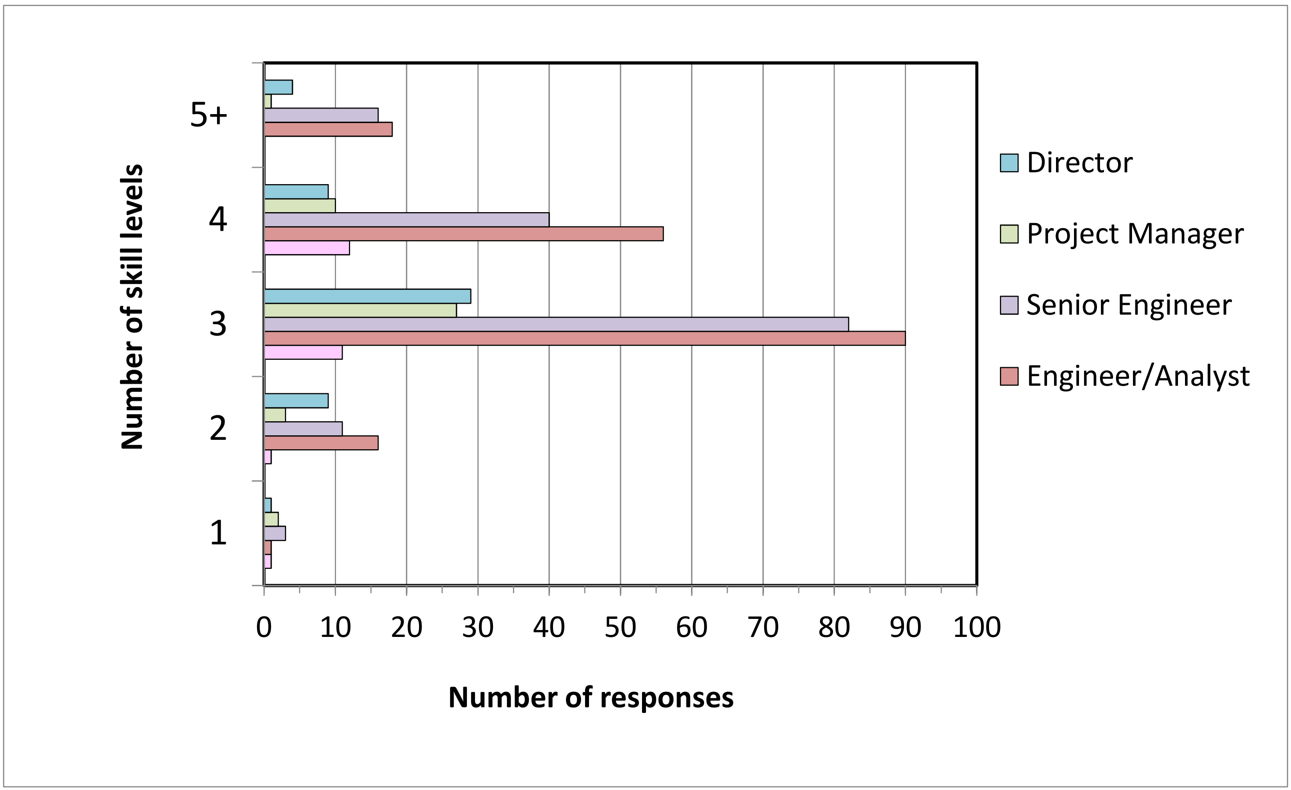

Figure 22: Skill levels filtered by seniority

6.3 Analysis Areas

To help draw up the list of competence modules in the Educational Base, respondents were asked to rate the importance of defining the competency of a list of analysis areas. The average rating of each of these is shown in rank order in Figure 23. The two highest ranked areas were obtaining parameters and validation, which were also flagged up as serious issues in an earlier question, reaffirming the need for improved competency in these areas.

Respondents were also asked whether the competence statements should be focussed on background geotechnical knowledge, or generic, structure-specific or software-specific analyses. Background knowledge was ranked the highest (see Figure 24), reflecting the importance of a broad geotechnical knowledge when performing geotechnical numerical analysis. Consequently, the COGAN Educational Base will include modules on the background geotechnical knowledge required to perform effective numerical analysis. Structure-specific and generic analysis were also ranked highly. Consequently, the Educational Base should contain modules in background geotechnical knowledge and structure-specific applications as well as in the generic areas originally proposed. This might be at the expense of some of the lower-ranked areas shown in Figure 23. A software-specific focus was the lowest ranked but still indicating strong demand for software-specific competence statements, perhaps providing motivation for software vendors to develop their own software-specific competences to add on to the non-software-specific competence statements of COGAN.

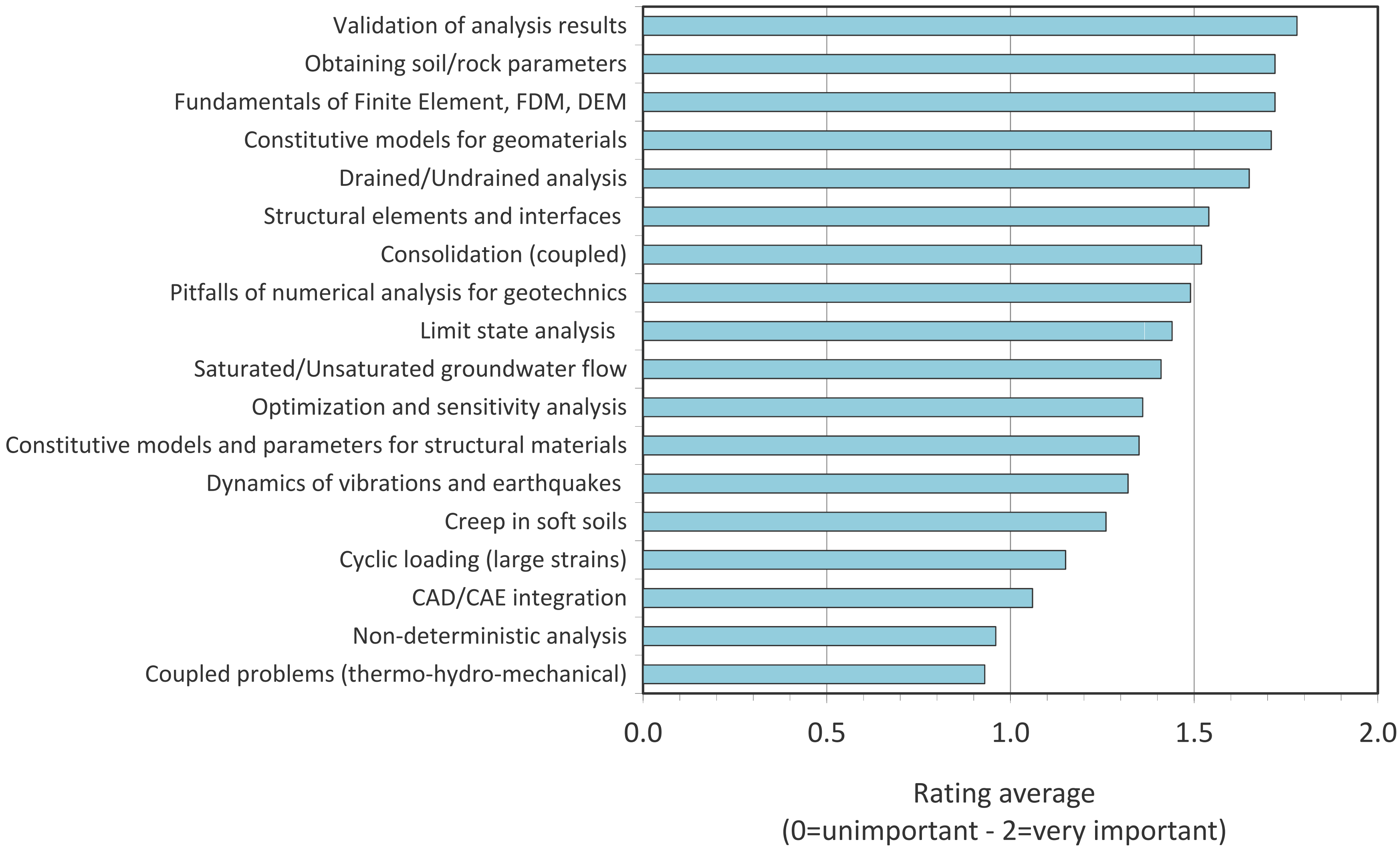

Figure 23: Importance of analysis areas for definition of competency

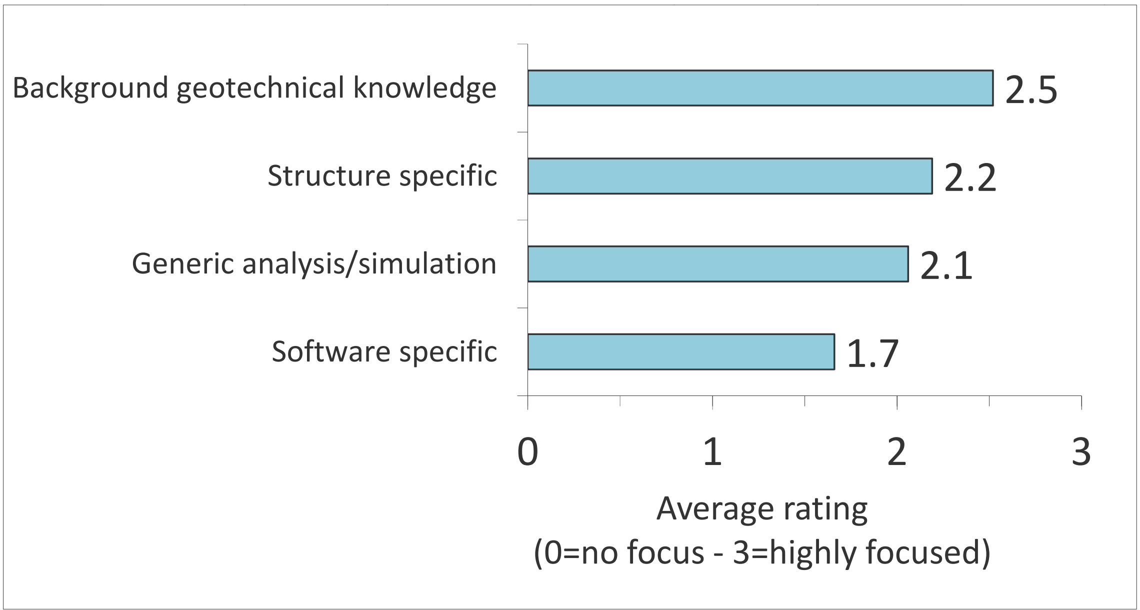

Figure 24: Preferred areas of focus for competency statements

7. SURVEY RESULTS – TRAINING NEEDS

7.1 Learning Methods and e-Learning Modules

Respondents were asked to rate the usefulness of various learning methods on a scale of 0 to 3 where 0 = not useful and 3 = very useful. On-the-job training or mentoring was ranked as the most useful (along with face-to-face courses), which makes it all the more disappointing that access to mentoring was ranked as a major issue in an earlier question. To help address the issue of a lack of mentors and in-house expertise, the COGAN deliverables will give more structure to on-the-job learning and provide a larger pool of competent engineers to provide the mentoring. Similarly, the Educational Base and Competency Tracker should help to give more structure to face-to-face courses so that they complement the other learning methods.

It was interesting to note that a high proportion of respondents (23%) had no experience of e-learning courses in geotechnical numerical analysis (see Figure 25), reflecting the paucity of e-learning material currently available. The average rating of these learning methods (among those who had experience of them) was a little lower at 1.5, but still apparently valued by many who have had experience of them. They are also a requirement in order to address the issue of access to affordable training.

Finally, respondents were asked to vote on the fields of geotechnical numerical analysis that they would like covered by the two COGAN e-learning modules. Following a common thread throughout the survey, the most popular areas were fundamentals of FEA, FDM, etc., constitutive models, obtaining parameters and validating analyses, as shown in Figure 37. These results will assist the project partners in selecting appropriate topics, but the final decision will be deferred until the draft Educational Base has been completed.

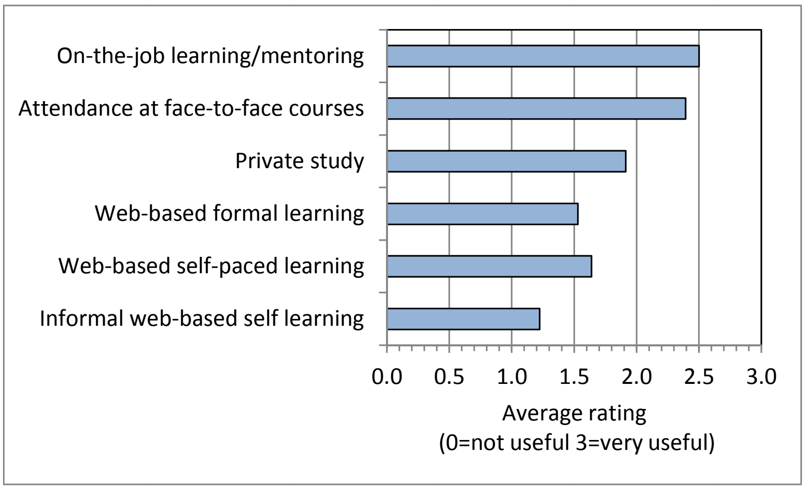

Figure 25: Usefulness of learning methods

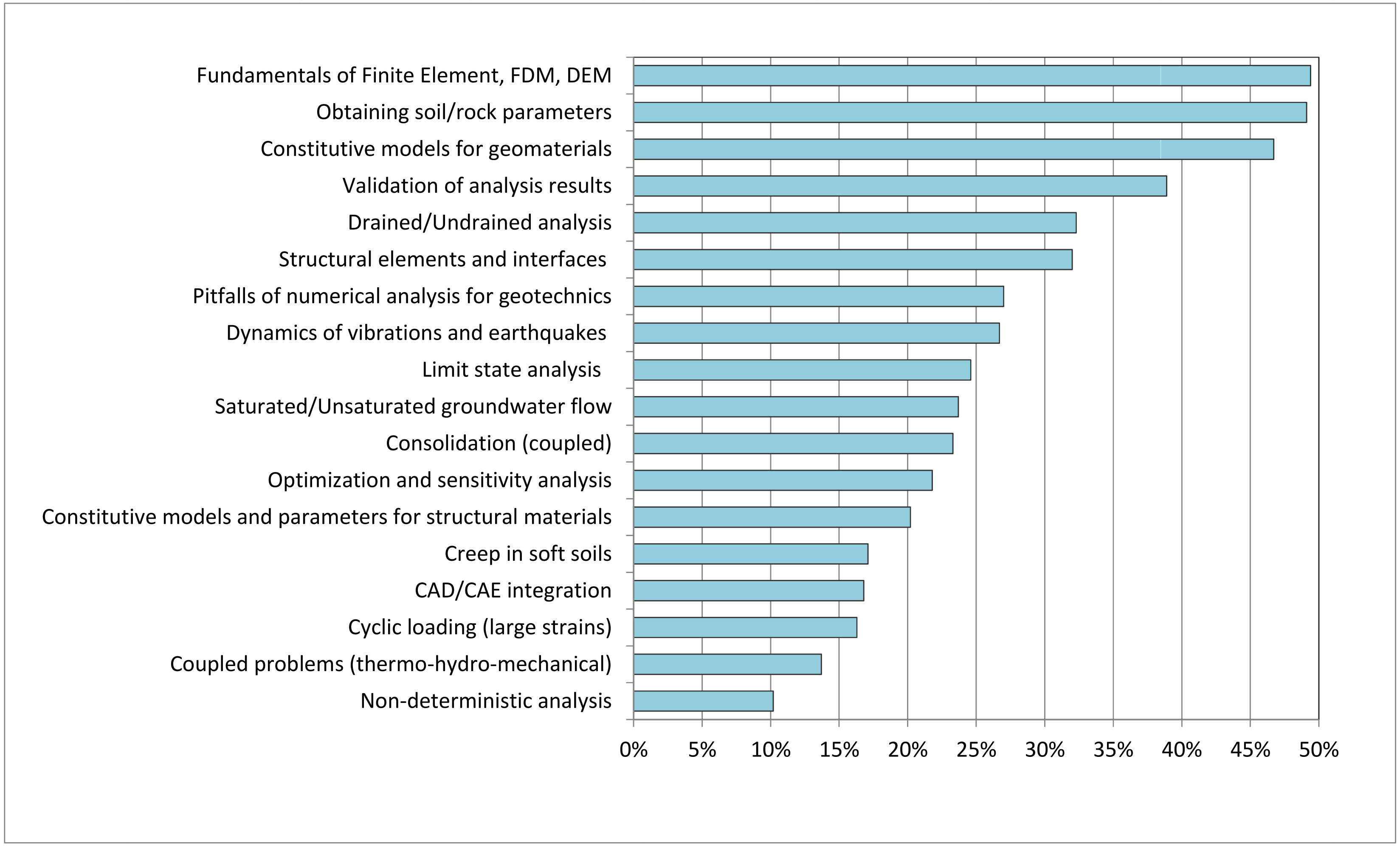

Figure 26: Popularity of potential topics for the COGAN e-learning courses

8. SURVEY RESULTS – ADDITIONAL COMMENTS BY PARTICIPANTS

In the penultimate question, participants were asked whether they would be willing to evaluate some of the COGAN deliverables later in the project. More than half (57%) responded "Yes", illustrating the high level of interest in this project.

At the end of the survey, respondents were invited to provide any additional information concerning the survey that could not be expressed in the preceding questions. 80 respondents did so and their comments are listed in Appendix 2 (Q30). The vast majority of the comments either reinforced the need for the COGAN project through participants' concerns regarding competency in geotechnical numerical analysis, or expressed support for the goals of the COGAN project.

9. CONCLUSIONS

1. The COGAN industry needs survey was completed successfully with all metrics exceeded. A wide geographical distribution of responses was obtained, together with a good cross-section of ages and seniority. Most responses were from design offices and consultancies, but contractors, universities and other research and development organisations were also well represented, as well as SMEs with 60% falling into this category (less than 250 employees).
2. The large number of responses (619) and wide geographical distribution confirmed that there is strong Europe-wide interest among geotechnical numerical analysis users for greater staff development, a competency tracker and new training material.
3. The majority of respondents have high education levels (86% at EQF 7 or 8) and experience levels (63% at 5+ years), confirming the specialised nature of geotechnical numerical analysis and the need for postgraduate formal study before beginning to apply these tools in practice.
4. Responses to some of the questions confirmed that there exists a significant need in industry for the deliverables of the COGAN project. For instance, only 34% of respondents educated even to doctorate level considered that their formal education related fully with their geotechnical numerical analysis activity.
5. Many organisations have small teams of engineers engaged in part-time use of geotechnical numerical analysis tools. This suggests that many organisations have not accumulated a significant body of expertise in this field and with a lack of in-house expertise, many engineers will be in need of accessible, external training resources.
6. 73% responded that there is no system to look-up and record achievement in competences in their organisations and a large majority (85%) thought such a system would be useful.
7. The four highest ranking issues concerning the application of numerical analysis in geotechnical engineering were: “validation of analysis results”, “obtaining soil/rock parameters”, “lack of money/time for training” and “poor access to in-house experts or no mentoring system”, all of which can be addressed by the COGAN project deliverables.
8. The preferred media for a competence framework are a secure website and company intranet, while the preferred number of skill levels is 3.
9. Respondents also expressed their preferences for areas of geotechnical numerical analysis in most need of competency definition and to be covered by the COGAN e-learning modules. These results, together with the others, will be used to guide the development of the COGAN deliverables for the remainder of the project.

10. This survey is also unique in this field and its results will be made freely available for industry and academia alike for improving training and other aspects of geotechnical numerical analysis in response to these findings.

APPENDICES

Appendix 1: ONLINE SURVEY

Appendix 2: SURVEY RESPONSE FULL DATA

Appendix 3: RESULTS OVERALL

Appendix 4: COMPARISON OF RESULTS BY COUNTRY