Beyond specialists and generalists.
A case study of new competencies for engineers in the consulting business

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Keywords: Complexity, competence, production of knowledge, transdisciplinary.

Abstract

Some implications of current changes in society for the competences of engineers working in the consulting business have been investigated.

The authors argue that the increasing dispersion of information sources, escalating globalisation, and rapidly decreasing life span of new products does not exclusively lead to a growing specialisation and complication of the engineering disciplines – but rather accentuates the need for engineers with the ability to embrace complex, transdisciplinary solutions.

The position illustrated by two cases drawn from projects undertaken by the Carl Bro Group, an international engineering consultant company.

The required competences for the engineers working in this new conceptual framework have been investigated, and the findings are compared to the competences derived from the theory. Among the key competences are: communication, dialogue, social intelligence, reflection and creativity.

Prologue

A human being should be able to change a diaper, plan an invasion, butcher a hog, design a building, write a sonnet, set a bone, comfort the dying, take orders, give orders, solve equations, pitch manure, program a computer, cook a tasty meal, fight efficiently, die gallantly.

Specialization is for insects.

-- Robert A. Heinlein
Changes

It is often stated that the accelerating pace of technical progress and the following decrease in life span of any single solution or product, force us deeper and deeper into specialisation and hence a narrowminded outlook of the world. There is little doubt, that the profound specialisation, we face today, is one of the key success factors to the vast technical progress, we have seen.

On the other hand we face an growing dispersion of informations sources and means of communication and an overall escalating globalisation, which demands us to take a much more general or “holistic” view on technical solutions.

Three major trends seems to be prevalent (Gibbons, M. 1994):
1. Multiple interests, and awareness about the benefits and consequences of a solution (financial, technological, environmental etc.), including increased number of stakeholders participating in the knowledge production process.
2. Rapid development of communication technologies that allows for global sharing of knowledge
3. Increasing number of sciences and overlaps.

The traditional boundaries between disciplines are changing and consulting engineers therefore face the challenge of delivering qualified professional advice faster and cheaper in an increasingly fierce competition, and at the same time address the growing overlaps and multiple interest involved in technical solutions (Munch, B 2000).

Complexity

Building a space rocket is a complicated project. There are caskets, circuits, displays, gauges, modules, tubes, wiring, valves etc. - details upon details; but each and every one of them can be accounted for and documented - the rocket can be assembled and taken apart according to a manual. Putting a man on the moon is on the other hand a very complex operation. The consequences of extraterrestrial experience, the impact on society, the technological trade-offs, the politics involved are all aspects of the operation which have to be considered and taken into account.

Engineers are traditionally trained in dealing with problems that are complicated,
meaning rich in detail. Whether they are trying to provide solutions for a suspension bridge, a power plant, an IT system (or a space rocket), engineers know how to get the task done - break the problem down into its constituent parts, use their specialised expertise and that of their colleagues to solve each part, and stitch the whole together.

This approach breaks down when applied to problems that are complex, meaning rich in structure (e.g. health care or moon landing). For these problems, a solution for one part of the problem affects the behaviour of another part of the problem and the problem must be considered as a whole (figure 1). No single discipline or conceptual perspective can therefore claim predominance.

Challenges

The concept of complexity seems to be a valuable point of departure for a description of the challenges that we face as engineers. The majority of technical problems are characterized by being both complicated and complex – acquiring profound technical and analytical insight as well as an ability to sustain an overview and embrace other interest and approaches besides the strictly technical based on true/false (Qvortrup, L. 1998)

The challenge for engineers is how to make the step from a reality with relatively isolated disciplines and just one “bottom-line”, to a more complex and sometimes ambiguous reality, where no single discipline prevails.

Through participation and interviews, we have investigated two cases taken from projects conducted by The Carl Bro Group (see box 1). The aim was to obtain some insight into the implications of working with complex solution and derive some indications to competences needed:

Case 1. SKUB – Primary School Development

The ambition of SKUB is to develop a “paragon education system” for the Gentofte municipality, north of Copenhagen. This is done through a combination of new pedagogical practice, new organisational systems and rebuilding of the physical framework (Gentofte Kommunes Skoleudviklings og –udbygningsprojekt 2001).

Box 1: The Carl Bro Group

The Carl Bro Group is an international consulting engineering company. Carl Bro employs more than 2100 people spread across more than 80 offices in Europe, Asia, Africa and South America. Carl Bro delivers solutions covering a broad variety of expertises: Transportation, energy, building, industry, marine, environment, management and ICT.

“Intelligent Solutions” has been selected as the conceptual framework for addressing the challenge of consultancy in the new economy encompassing four dimensions: Ethics, value, customer focus and multidisciplinarity (The Carl Bro Group 2001)
The project is organised as a partnership, connecting the consultant engineers, the architects and the contractors very close to the client (the municipal authorities).

The participating Carl Bro engineers’ role were initially to deliver project planning and construction management expertise; but because of the close collaboration with the building owner the engineers were working in a compound project team partaking in vision workshops, discussions on pedagogical means, application of ICT etc. The engineers expressed some ambiguity concerning their role, feeling unprepared for the requirement outside their professional expertise.

Case 2. Copenhagen Travel Card Project

The purpose of the project is to introduce a travel card in the Greater Copenhagen area. It is to replace the existing multi journey cards and season passes. The card contains an electronic purse - a stored value card - used to pay for journeys (REJSEKORT 1998).

The project has an obvious transdisciplinary nature involving engineers specialising in transportation, ICT, design and environmental issues. A project team including specialist from all of the involved disciplines were assembled, and weekly coordination meeting were conducted. Several cross-disciplinary aspects of the project were identified (e.g. financial, political, legal) and teams for each of them were established.

Some of the complex issues involved were addressed by creating a number of travel scenarios (“the daily pendler”, “the occasional long-distance traveller”, “the frequent cheater” etc.). These scenarios was applied as a starting point for discussions, and solutions were projected along different axes of interest (e.g. environmental, technical, legislative and design) in order to explore their limitations and consequences

Competencies

The case study indicates a list of new competences that engineers and engineering education need to address. The competences are listed in Table 1 and elaborated in the following.

From the two cases the communication competence was an underlying theme. In the SKUB case engineers were challenge on their competence to understand other professions and to make their own knowledge useful for others. In the Travel Card case this was articulated as the challenge of communicating across cultural and professional barriers. As Gibbons points out, “solutions are always produced under an aspect of continuous negotiations” (Gibbons, M. 1994) and as a consequence the communication competence has become crucial.

Both consulting cases were characterised by what Gibbons refers to as dependency on knowledge embodied in people and the ways they are interacting in socially organised forms (Gibbons, M 1994). In the SKUB case this had led to an increased focus on interaction and dialogue. A dialogue which often did not have a specific goal or
direction but rather sought to clarify the underlying assumptions and values of the participants leading to a greater understanding of individual experiences and expertise (Bohm, D. 1996)

The SKUB cases was characterised by its multiple dimensions (construction, pedagogy, ICT and politics) and a starting point in which the solution in its very nature was not to be found in scientific and technological terms alone. The project manager therefore has chosen to involve the stakeholders as active agents in the process. To develop and sustain a common ground for decision-making, reflection on values and preferences has been a daily reality for the involved engineers.

Teamwork, where engineers are working alongside designers, economists, administrators and lawyers were reality in both cases, because the nature of the projects required it. It was therefore a prerequisite, that the team members were able to handle a diversity of cultures and professions, and could adapt to ambiguous and changing roles, thus expressing a high social intelligence.

Particularly the SKUB case indicated that creativity was more important than ever as the solutions not arise solely, or even mainly, from the application of knowledge that already exists. Although elements of existing knowledge must have entered into it, genuine creativity had become another key competence for the engineers.

The study also indicated that the traditional professional insight was still a prerequisite for the job, and the new competences are therefore more to be seen as an extra dimension of competences that engineers needs in the future.

Table 1: The engineer’s new competences

<table>
<thead>
<tr>
<th>Competence</th>
<th>Description</th>
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<tbody>
<tr>
<td>Communications</td>
<td>Sharing professional experience and knowledge with people having a different background, and continuously negotiating solutions.</td>
</tr>
<tr>
<td>Dialogue</td>
<td>Understanding and changing perspective through dialogue</td>
</tr>
<tr>
<td>Reflection</td>
<td>Inquiring into values and preferences, and evaluating one’s own role.</td>
</tr>
<tr>
<td>Social intelligence</td>
<td>Getting on in teams featuring a diversity of professions and cultural backgrounds. Handling ambiguous roles</td>
</tr>
<tr>
<td>Creativity</td>
<td>Finding new solutions which are not merely extrapolation of the existing solutions</td>
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Conclusion

The dilemma between “knowing just about everything about nothing” (the specialist) and “knowing nothing about almost everything” (the generalist) can only be solved through a focus on transdisciplinarity – a third position embracing both deep professional insight, and the ability to cooperate with and venture into the periphery of other professional domains and the people representing these domains. Both in practical project management and in engineering educations importance should be attached to communications skills, social intelligence and genuine creativity. Process reflection and clarifying dialogue should be as natural as solving a quadratic equation.
References

In English:


REJSEKORT. The Copenhagen Travel Card 1998. Travel Card Project c/o HT, Copenhagen

...further readings at: http://www.alone.dk/complex

In Danish:


Gentofte Kommunes Skoleudviklings og –udbygningsprojekt 2001: http://www.skub.dk

Curriculum vitae

Niels Christian Alstrup, Ph.D., M. Sc. has a background in solid-state physics conducting research ranging from super-conducting components to metal-ceramic interfaces. In conjunction with his scientific work, he has worked on organisational and management issues such as value based management, leadership training and storytelling in organisations. Niels Alstrup is currently in charge of the knowledge management programme in the Carl Bro Group.

Carsten Ohm Andersen, M. Sc. Soc. has worked with innovation processes, entrepreneurship, corporate social responsibility, virtual communities, evaluation, research and arts since 1995. His experience covers interdisciplinary and intercultural coaching and facilitation, building of virtual communities, integration of arts and business as well as project development and implementation in self-organised teams. Carsten Ohm Andersen is currently developing a research model for “Group Leaning” based on contemporary systems theory.