Problem comprehension is the key to client problem solving

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Abstract: *This paper seeks to understand the causes of the poor perception of engineers' service quality in the context of their approach to solving the problems of clients. The present study was restricted to the building and construction industry as it involves a large proportion of multidisciplinary consulting engineers with a distinct and identifiable client base. We draw on architects' perceptions of engineer performance because in a previous study engineers frequently referred to project architects as their clients.*
When interviewing 11 engineers and six architects, we observed disparities between engineers' perception of their roles and what was expected of them by the architects. The engineers described their role as providing engineering design in projects as well as solving problems presented by clients. The architects indicated they felt engineers' role was to provide solutions that met their broad architectural needs. However, all the architects described engineers as not being proactive enough in understanding their problems and unwilling to offer alternative solutions.
These qualitative interviews indicate that service quality issues may arise from engineers' inability to fully comprehend and identify problems. Engineers in our study appeared to be more comfortable when solving clearly defined problems, and less comfortable with the time commitment needed to fully explore client problems. We suggest that engineering educators could improve students' problem comprehension skills, by expanding the current focus on finding solutions to pre-defined problems to better expose students to complex problems that graduates encounter when they enter the workplace.

Keywords*: client service quality, problem comprehension, real problem, engineers, architects*

Introduction

The consistently low perception of client service quality of consulting engineers (Beaton, 2007 - 2010), have motivated us to undertake research on the ways in which engineers interact with their clients. We have applied the Gap Model (SERVQUAL) by Parasuraman (1988) to explore how engineers view service quality and what their clients perceive of their performance. The present study builds on the findings of our earlier work, which revealed that narrow understanding of communication creates difficulties in the workplace. The scope of the study was restricted to the building and construction industry which involves building consultants (multidisciplinary consulting engineers and project architects). This paper seeks to understand the causes of the poor perception of engineers' service quality in the context of their approach to client problem solving. The paper begins by the discussion of various models of problem-solving processes.

Models of Problem Solving Processes

The emergence of a persistent theme on architects' perceptions of engineers' technical problem solving approaches, led us to explore literature on problem solving. Since 1910, numerous models of creative or inventive problem-solving processes have been developed. These thinking or problem-solving models were examined and eight of the models were selected for further analysis (Table 1).

Table 1: Models of Problem-Solving Processes (1910-1996)

Dewey (1910)	**Polya** (1945)	**Parnes** (1967)	**Newell & Simon** (1972)	**Mitroff** (1979)	**Hayes** (1981)	**Bransford & Stein** (1984)	**Amabile** (1996)
Perceiving a difficulty Defining the problem Suggesting possible solutions Elaborating implication of these solutions Testing the validity of the solutions	Understand the problem Devising a plan Carrying out the plan Looking back	Fact finding Problem finding Idea finding Solution finding Acceptance finding	Generate a problem statement Encode stimuli in memory Select a problem solving method Apply the problem solving method	Sensing problems Defining problem Deriving solutions Implementing solutions Evaluating outcomes	Finding the problem Representing the problem Planning the solution Carrying out the plan Evaluating the solution Consolidating gains	I = Identify the problem D= Define & represent the problem E= Explore possible strategy A= Act on the Strategy L= Look back & evaluate effects f your activities	Identifying the problem Preparing (gathering & reactivating relevant & resources) Creating responses (seeking & producing potential responses) Justifying response & communicating (testing the possible response against criteria).

From Table 1, it can be seen that most problem-solving processes begin with perceiving a difficulty, fact-finding, generating a problem statement, sensing problems, finding the problem, or identifying the problem. However, Pólya (1945) recommends that 'understanding the problem' should be the first phase of problem solving. This paper focuses on the importance of understanding the problem from various perspectives before arriving at an appropriate solution.

Research Questions

This paper addresses the following research questions:

1) How do engineers arrive at an understanding of the client's problem, specifically architects' problems?
2) How could engineering educators enhance their students' problem comprehension skills?

Method

The present study draws on the architects' perceptions of engineers because our engineer participants frequently referred to project architects as their clients. Altogether six architects and eleven engineers were interviewed. Table 2 in Appendix 1 gives details of the participants. Each interview covered the same general topics as discussed in the engineers' client service quality interviews. To allow for emergent design (Morrow, 2005), concerns brought up by the participants were discussed as and when they arose. All interviews were conducted and analysed by the same researcher who is familiar with the work of building consultants (architects and multidisciplinary engineers) in the building and construction industry. Only the views of the architects are presented as quotations in this paper.

Results

There were disparities between how engineers perceived their roles and what was expected of them by the architects. The engineers in the interviews often described their work as providing engineering design in projects as well as solving whatever problems arise or are presented by their clients.

However, the architects felt the engineers' role was to provide solutions to problems that met their needs. The architects described engineers as not being proactive in understanding their problems and unwilling to offer alternative solutions. For example, architect A1 stated:

> I think the issue is at the moment engineers are not proactive….They won't proactively suggest solutions. They wait for you to come out with an idea then they say yes or no you can do that. They don't even know the problem they are going to solve let alone they have to come out with alternative solution.

It appears the engineers did not question the architects to gather information for their design. Furthermore, Woods, Felder, Rugarcia, and Stice, (2000) have also found that engineering students have little inclination to examine alternatives once they have reached a solution.

Architect A1 further elaborated:

> I need to have a conversation with the engineer and explain the problem I've got in terms that they understand.

Here the architect indicates that dialogue or conversation is needed to drive home his message to the engineers.

Another architect, A3 also stressed the importance of understanding clients' problems and their actual needs:

> Engineering consultants must really thoroughly understand client's brief and client's requirements, a very costly exercise.

A number of other complains about engineers were raised by the architects. For example, architect A5 stated:

> I guess that's another area when thinking about design solution at the end. And quite often we like to make sizes the same, the same size of steel [section]. There might be two beams right next to each other. The engineering solution works for two different sizes and two different profiles and you could actually make them the same size.

In this case, the architect asked the engineer to provide beams of similar size. If this engineer was able to see his work and the building he is helping to construct through the eyes of the project architect A5, the architect would not need to ask him to make changes, thus saving valuable time. Scholars such as Bailey, Johnson, Alonso, and Orzechowski (2007) also highlight the higher education currently is producing graduates with a lack of appreciation of the holistic design process, and the need for proved quality of design and service as demanded by the clients.

The architect indicated he expects the engineer to know his (architect) preference. A5 added:

> But what if we don't have to ask them to change? What if they knew that's what we would want anyway?

Here we see the architects' focus is on appearance. Architects' emphasis on aesthetics was demonstrated in the responses of all the six architects to questions regarding their preferences for building design. A5 further elaborated:

> It is design coordination in the appearance. We are concerned with the appearance of things. But engineers just want the building to stand up and stay up....The visual line is very important. So we don't want the beam that goes down like that. You have two beams together and you want them to be the same [size].

Architects are well disposed towards creativity, because they are in a position to pursue it within projects with comparatively little risk. On the other hand, the structural engineer is accountable for the safety and overall structural integrity and soundness of the building structure. Similarly, mechanical and electrical engineers are responsible for the ventilation and lighting of the buildings. In addition, these engineers are expected to satisfy architects' aesthetic and creative preferences. However, due to the nature of the architectural design process, consulting engineers could not effectively apply requirements engineering (e.g., Kotonya, 1998) which is commonly used in the software domain. Consulting engineers need to have a global view of the nature of the design and construction of building projects,

Findings

The most important first phase of problem solving is the understanding of the problem before an engineer is able to identify and define the real problem, so that appropriate solutions can be proposed. It is important to do this right from the beginning. In this way, valuable time and effort are not unduly wasted. However, understanding the problem and identifying the real problem will not be enough. Technical competency alone will not solve the client's problems. To improve client perceptions of service quality is likely to also require engineers to listen to their clients, to uncover and clarify their extrinsic needs, to determine their intrinsic wants (such as personal preferences) and to obtain a holistic picture of the problem. As observed in other areas of professional practice, understanding the needs and interest of stakeholders and end-users is fundamental in obtaining sustainable outcomes.

Discussion & Conclusions

This study provides evidence that the service quality issues may arise from weaknesses in problem understanding skills. That is, knowing the real problem as well as client's perspective. Engineers in our study appeared to be more comfortable when solving clearly defined problems, and less comfortable with the time commitment needed to fully explore client problems. They associate clients' discomfort with the time delays and fee increases necessary to explore problems more extensively. On the other hand, it also reflects architects' discomfort with engineers' level of skills in understanding the nature of the architectural work.

Workplace engineering problems are significantly different from the kinds of problems that engineering students most often solve in the classroom; therefore, learning to solve classroom problems does not necessarily prepare them to solve workplace problems (Jonassen, Strobel & Lee, 2006). In some training systems, one source of knowledge — problem solving, is emphasised to the neglect of the other — problem comprehension. Traditionally, educators teach by providing the students with problems, leaving them to solve the problems themselves. This mentality of "given problems" is carried by graduates into the workplace. Also, clients or employers conventionally dictate problems and expect engineers to provide solutions. Nevertheless, a small number of universities have attempted to overcome this by the use of Problem Based Learning (PBL). When engineering graduates enter the workplace, they are met with high expectations and demands. Thus, skill acquisition in practical domains depends upon purposeful learning experiences where knowledge connects with its uses in the workplace.

Service quality is not what engineers contribute; it is what the client requires and is willing to pay for. Clients pay only for what is of use to them. Unless engineers can contribute what is useful for their clients, their service quality from the client's perspective will be low. Therefore, a strategy of saving time and effort by first fully understanding the problem and various perspectives from clients, stakeholders, and end-users will enable holistic picture and thinking, the engineer is then able to provide appropriate design solutions.

Implications for Educators

Engineering educators could improve students' problem comprehension skills, beyond the current focus on finding solutions to pre-defined problems. They may consider using their creativity in providing engineering students with more exposure to real world problems. There is still a predominant focus among engineering educators on getting the problem statement correctly framed to avoid misunderstanding and misinterpretation by students (e.g. Diefes-Dux & Salim, 2009). We need students to see the wisdom in the following quote from Socrates (Hamilton, 1973):

SOCRATES: Then it-shows great folly...as well as ignorance ... to suppose that one can transmit or acquire clear and certain knowledge of an art through the medium of writing, or that written words can do more than remind the reader of what he already knows on any given subject.

In other words, we need to think about ways to give our students opportunities to go beyond written problem descriptions and explore problem understanding through dialogue and social interactions with clients, stakeholders, and other informed and knowledgeable experts.

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APPENDIX 1

Table 2: Details of Participants

	Discipline	Gender	Years of experience	Years with current firm	Years in Consulting role	Nos. of architects or engineers under their supervision
A1	Architect	Male	25	4	25	6
A2	Architect	Male	25	15	25	30
A3	Architect	Male	25	15	25	4
A4	Architect	Male	30	17	30	8
A5	Architect	Male	16	16	7	9
A6	Architect	Female	4	2	3	0
E1	Civil & Structural	Female	22	22	22	180
E2	Civil	Male	25	18	25	4
E3	Environmental	Female	14	4	14	25
E4	Structural	Male	15	15	15	3
E5	Geotechnical	Male	25	1	20	12
E6	Civil	Male	31	30	16	22
E7	Mechanical	Female	7	4	7	40
E8	Electrical-Regulatory	Male	33	4.5	NA	5
E9	Mechanical-Gov. Rep	Male	35	32	NA	NA
E10	Mechatronics	Male	35	32	32	8
E11	Project Engineer	Male	17	17	17	6