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SERVICE QUALITY IN THE MANAGEMENT OF SIMULATION PROJECTS

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ABSTRACT

The purpose of this paper is to discuss how the concepts of service quality can be applied to simulation projects. The aim being to find a means for improving the quality of simulation studies and so increase the chance of reaching a successful outcome.

The terms validity, credibility and acceptability are often used in the context of simulation project success. However, there is some disagreement about the meaning of these terms and only a limited understanding of how they are achieved. This paper sets simulation projects in the context of a service provided to a customer. The service provider's aim is to maximise the quality of the work. A short review of service quality concepts is given.

A series of interviews have been performed to establish the factors involved in a customer's assessment of the success of a simulation study. These factors have been summarised in 19 groups, or dimensions. The aim is to create a survey instrument which can be used to assess the quality of a project as it progresses and once it is complete.

1 INTRODUCTION

The past fifteen years has seen the onset of the Total Quality culture in most sectors of Western industry largely as a response to Japanese competition. More recently attention has turned to the service sector and the need to provide total customer satisfaction if companies are to succeed. The key concept within this culture is that quality is 'conformance to requirements' (Crosby 1979) or 'fitness for purpose or use' (Juran 1988). Both these definitions focus primarily on the customer and what the customer requires. Quality is achieved by a variety of means which could be summarised under three headings (Tenner and DeToro 1992):

- Customer Focus: identifying the customers and understanding their expectations
- Process Improvement: measuring processes, identifying areas for improvement and implementing change in an effort to develop a culture of never ending improvement (Kaizen)
- Total Involvement: initiated by management and involving the whole workforce and supplier network. Important aspects are communication, education, reward and recognition

The proponents of Total Quality Management each discuss how such a culture can be engendered in an organisation, for example Deming (1986), Crosby (1979) and Juran (1988).

It is not the purpose of this paper to give a detailed review of Total Quality Management and its implementation, however, the aim is to discuss how these concepts can be applied to the management of simulation projects. It is the view of the authors that although the benefits of simulation are numerous, many simulation studies fail to achieve their potential. Empirical evidence on the proportion of simulation successes and failures is not readily available, but there is much anecdotal evidence that supports this view. McLeod (1982) states that 'many costly models are unused, or ineffectively used, and - in some cases - dangerously misused'. Tilanus et al. (1986) performed a study of operational research applications in the Netherlands and Belgium. Respondents were asked to write two concise case studies, one that demonstrated a project failure and the other a project success; eleven out of 36 respondents described simulation work. This demonstrates that simulation projects have failed, although no conclusions can be drawn about the proportion of failures.

It would seem that there is a need to improve the performance of simulation providers in order to reduce

the risk of simulation project failure. This paper explores how this might be achieved through a quality approach, with particular emphasis on service quality and its measurement. The paper starts with a brief review of the terms validity, credibility and acceptability in relation to simulation. This is followed by an overview of service quality and its measurement. In order to develop an instrument for measuring simulation project quality a series of interviews with simulation providers and their customers have been performed. The results of these are outlined. The paper concludes by discussing the future direction of this research.

2 SIMULATION PROJECTS: VALIDITY, CREDIBILITY AND ACCEPTABILITY

Three concepts are discussed in the context of providing a successful simulation project: validity, credibility and acceptability. These have been defined as follows:

- Validity: Law and Kelton (1991) define a valid model as one that is an accurate representation of the actual system being modelled. Zeigler (1976) points out that it is not possible to speak in terms of universal validity, but that a model is only valid for the purpose for which it was built. In general validity only refers to the simulation model although in some instances the validity of the data is also discussed (Sargent 1992).
- Credibility: this is reflected in the willingness of persons to base decisions on the information obtained from the model (Schruben 1980). Carson (1986) considers a model to be credible when it is accepted by the client as being valid and is used as an aid to decision making. McLeod (1982) relies upon the dictionary definition 'the quality or power of inspiring belief'. In some cases the term is applied to the simulation model while in others it is applied to the overall simulation study.
- Acceptability: there appears to be no common definition for acceptability. Sargent (1992) considers acceptability and credibility to be equivalent. Ören (1981) believes that acceptability involves credibility, cost-effectiveness, timeliness and comprehensibility of the simulation study. McLeod (1982) argues that acceptability is a function of the validity of the model, the credibility of the overall study and the decision-making process. In general acceptability is used with reference to the overall simulation study. Acceptability appears to be in some way derived from the validity of the model and the credibility of the study.

It would seem that each of these needs to be present in some manner if a project is to be considered successful. Many authors have gone on to discuss what is required to achieve validity, credibility and acceptability, for example, Carson (1986), Law and Kelton (1991), Gogg and Mott (1992), Dietz (1992), Musselman (1992) and Robinson (1994). One major failing of all these approaches is that they look at a simulation project primarily from the viewpoint of the simulation provider and not the customer. A key aspect of quality management is to focus on the customer and therefore by applying these concepts to simulation projects this shortcoming should be addressed.

3 SERVICE QUALITY

A simulation project is normally carried out in the context of a customer-provider relationship (in this paper the small number of projects performed by customers themselves are not considered). The provider may be an external consultant, an internal consultant or a colleague working in the same department. Further to this the delivery of the project constitutes a service. This can be shown by considering the three characteristics that set a service apart from the delivery of a product (Parasuraman et al. 1985):

- Intangibility: most services cannot be measured which makes it difficult to know how a customer perceives and evaluates a service
- Heterogeneity: performance varies from producer to producer, customer to customer and day to day, consequently it is difficult to assure consistency
- Inseparability: the production and consumption of the service are often inseparable, therefore the customers input is critical

Since simulation projects fit these characteristics and so constitute a service it is necessary to apply service quality concepts rather than the more general principles of quality management that have been applied to manufacturing organisations. What now follows is a brief review of service quality which particularly focuses on the work of Parasuraman, Zeithaml and Berry.

Service quality is a global judgement, or attitude, relating to the superiority of a service. It is defined as the discrepancy between the consumers' perceptions of the performance of the service firm and their expectations of what they feel the service firm should offer (Parasuraman et al. 1988). This gap between performance and expectations is referred to as disconfirmation (Bolton and Drew 1991).

Parasuraman et al. (1985) go on to develop a conceptual model of service quality for which a concise

version is shown in Figure 1. The customer's expectations are formed as a result of word of mouth communications, personal needs, past experiences and communications from the service provider (for example, advertising). The customer's perception of performance is dependent upon the delivery process and upon what is communicated about the service being delivered. Service quality is the gap between expected service and perceived service.

Parasuraman et al. (1991) argue that the customer's service expectations have two levels: desired and adequate. The desired level is the service the customer hopes to receive, while the adequate level is that which the customer finds acceptable. A zone of tolerance separates adequate service from desired service. If the perceived performance of the service provider falls within this zone of tolerance, this implies competitive advantage. If the performance falls below the adequate service level, and so outside the zone of tolerance, then competitive disadvantage will occur. If performance exceeds the desired service level then it is possible that customer loyalty could intensify to the exclusion of competitors, customer franchise. These concepts are summarised in Figure 2. The position and size of the tolerance zone is affected by a number of factors such as, customer experience, the presence of alternative suppliers, and the urgency of the customer's need.

From their empirical research Parasuraman et al. (1988) show that there are five principle dimensions of service quality:

- Tangibles: the appearance of physical facilities, equipment, personnel and communications materials
- Reliability: the ability to perform the promised service dependably and accurately
- Responsiveness: the willingness to help customers and to provide prompt service
- Assurance: the knowledge and courtesy of employees and their ability to convey trust and confidence
- Empathy: the provision of caring, individualised attention to customers

Reliability is the most important dimension in meeting customer expectations (falling within the zone of tolerance) while assurance, responsiveness and empathy are most important in exceeding expectations (Parasuraman et al. 1991).

Using these five dimensions Parasuraman et al. (1988) have developed an instrument for measuring service quality, SERVQUAL. This consists of two sets of 22 questions. The first set aim to measure the customers' expectations with respect to the five service quality dimensions, while the second set measure their perception of the service delivered. For each question a score of between 1 and 7 is assigned. The gap between expectation and perception (service quality) is measured by the difference between the two sets of scores.

4 MEASURING THE QUALITY OF SIMULATION PROJECTS

Since a simulation project is a service then it should be possible to apply these service quality concepts to obtain a greater understanding of how well a project has been performed. What would be particularly useful would be the ability to measure the discrepancy between customer expectations and perceptions and so develop some measure of quality for a simulation project. However, the SERVQUAL instrument is not suitable for this purpose for two reasons. First, despite Parasuraman, Zeithaml and Berry's (1988) claim to general applicability of the SERVQUAL instrument, others have shown this not to be the case, for example, Brown et al. (1993) who argue that SERVQUAL needs to be adapted for different circumstances. Second, it is based on transient services where service interactions are only brief, for example, banks and telephone companies, while simulation entails a more protracted service encounter. However, a similar approach can be used with more protracted service encounters, as shown by Thompson (1983) who performed a study with hospital in-patients. Therefore, it is necessary to adapt the approach if a useful instrument is to be developed for simulation projects.

The purpose of this research is to develop such an instrument for simulation studies. At present it is difficult to measure a simulation provider's performance on a study since no suitable instrument exists. However, if such an instrument could be developed then it would provide the means not only to measure performance but to improve performance by identifying areas for change and so enable a chain of never ending improvement (Kaizen).

Although this instrument has not yet been developed much of the ground work has been done. Here, some of the results of the empirical research are discussed.

4.1 Provider and Customer Interviews

A series of interviews have been carried out with simulation providers as well as customers of simulation projects. A vital part of this empirical research has been to ensure that the customers' views are represented, an aspect which has been missing from previous research in this area. In total, ten provider organisations were interviewed including fee charging consultants (both

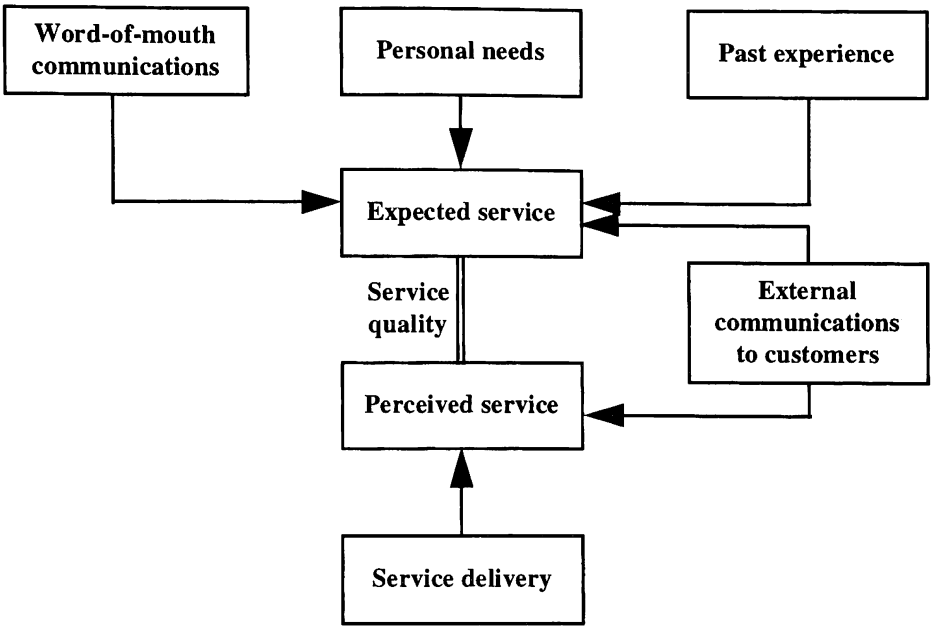

Figure 1: Parasuraman, Zeithaml and Berry Model of Service Quality

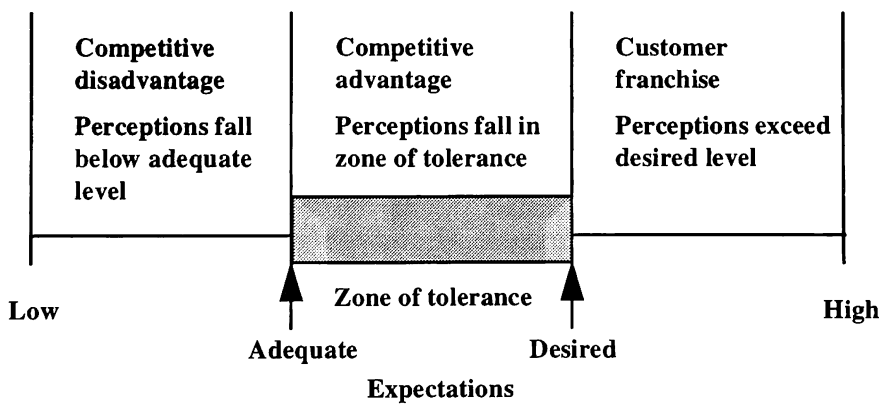

Figure 2: Tolerance Zones for Customer Service (Source: Parasuraman et al. 1991)

internal and external), internal experts and operations staff. Ten customer groups were also interviewed coming from manufacturing and chemical companies, the emergency services and a hospital. The main purpose of these interviews was to establish a set of criteria that are considered when assessing a simulation study. The interviews also aimed to understand what the providers and customers consider to be success in relation to simulation projects.

In order to obtain this information a series of questions were asked in an attempt to obtain ideas without significant prompting by the interviewer. Interviewees were asked to discuss their experiences with simulation projects, what they meant by success, the factors they felt were important in the delivery of a project and the effect of charging/paying for the work on their assessment of the project. Each interview was transcribed and analysed in detail to identify any references to factors that could be a part of a customer's assessment of a simulation project.

4.2 Factors Associated with Successful Simulation Projects

In total 732 references to potential factors were made in 20 interviews; obviously some of these factors were cited more than once. Taking into account multiple citations of the same factor by different interviewees a total of 338 factors were identified in the interviews. Table 1 summarises the frequency distribution of these factors; 197 factors were mentioned only once during the 20 interviews, while 1 factor was mentioned 11 times (the validity of the model). The factors identified ranged from aspects such as the validity of the model to the appearance of the provider.

In order to simplify the data an attempt has been made to group these factors into a set of dimensions; this was performed intuitively by comparing factors with the definition of dimensions. Initially the dimensions identified by Parasuraman et al. (1988) were used, however, it was difficult to classify the data in this fashion with a poor fit between their dimensions and the factors identified during the interviews. Therefore, a new set of 19 dimensions were devised, these were:

- Model: aspects pertaining to the simulation model (ease of use, suitability, flexibility, aesthetics and speed)
- Software: aspects pertaining to the simulation software (ease of use, suitability, flexibility, links to third party software, confidence)
- Involvement: involving everybody (especially the customer) at all stages of the simulation study

Table 1: Frequency of Factor Citations in Provider and Customer Interviews

Number of citations of a factor	Frequency	Percentage
1	197	58.28%
2	39	11.54%
3	43	12.72%
4	20	5.92%
5	17	5.03%
6	6	1.78%
7	7	2.07%
8	5	1.48%
9	3	0.89%
10	0	0.00%
11	1	0.30%
Total	338	100.00%

- Communication and Interaction: frequency, clarity and appropriateness of communication and interaction with those involved in the simulation study
- Credibility: trustworthiness, believability and honesty of the provider and his/her organisation
- Competence: possession of the necessary skills and knowledge by the provider and his/her organisation to perform the simulation study
- Professionalism: provider's commitment (to the project, the customer and quality), interpersonal skills and appearance
- Education: the customer learns about simulation and the model as the study progresses
- Understanding the customer: making the effort to understand the customer's needs and expectations
- Responsiveness: timely and appropriate response to the customer's needs and expectations
- Access: approachability and ease of contact of the provider, accessibility of the model
- Fees: correctly charging for the simulation study
- Recovery: recovering from problem situations
- Confidence: trustworthiness and believability of the model and the results
- Client/Organisation: aspects pertaining to the client/organisation which are largely outside the control of the provider
- Data: aspects pertaining to data collection and analysis (availability and accuracy)
- Reliability: consistency of performance and dependability
- Interpersonal: relationship between customer and provider
- Other

The 'Other' category was included for a small number of factors that did not obviously fit the other 18 dimensions. Table 2 shows the number of factor citations for each dimension. It also splits the frequency distribution between provider and customer citations.

Care must be taken in interpreting these results but some interesting patterns do emerge. Firstly, the providers have made many more citations than customers, 435 versus 297. This is no doubt indicative of the level of knowledge providers have about the service against customer understanding. Secondly, certain dimensions would seem to be of greater importance than others, based on the frequency with which they were cited. Communication receives the highest weighting (11.75%) with competence second (10.79%). Recovery does not seem to be of great significance (0.68%), although this is in the light of general observations about project experience; in a project where significant difficulties are being encountered recovery might become a priority.

A third observation is the weighting customers put on certain dimensions against the weighting for providers. For example, the providers placed much more emphasis on communication than the customers, 14.71% against 7.41%. Perhaps providers are over emphasising the need to communicate, or customers may not identify communication as important when indeed it is. Alternatively, communication may be such an implicit need for a customer that it is simply expected and is not explicitly stated as a requirement. Competence shows the reverse pattern with the customers weighting this at 14.48% and the providers at only 8.28%; the reasons for this could, quite possibly, be due to the converse of the disparity in communication. An interesting observation is that confidence appears to be valued far more by the customer than the provider. This dimension has much to do with the traditional concepts of validity of the model, credibility of the study and acceptance and yet seems to be underestimated in importance by the providers of simulation studies (that is unless it is simply taken for granted and was therefore not mentioned).

4.3 What is Success?

A variety of definitions for success were given by customers and providers. Some of the most cited examples were:

- The project delivers a (financial) benefit to the customer
- The simulation provides a result that otherwise would not have been obtained
- Meeting the objectives of the project
- The recommendations are implemented
- Simulation is sold to the customer who will then come back for further studies
- The results are accepted
- Identifying problems and solving them

What did emerge was a four stage model of success (Figure 3). The benefits obtained in stage 1 may be financial or simply greater understanding. It is felt that the simulation provider has most control over the first two stages since implementation is dependent on many external factors outside the control of the simulation provider. It was notable that one customer had accepted the results of a study and implemented them since at the time he felt the study had been successful (stage 2). However, following implementation the results of the model were not proved out in practice and consequently his view of the project was something far less than a success (stage 4). It is therefore important to view success as a dynamic assessment by the customer which changes through the course of events and time.

5 FUTURE DIRECTION OF THE RESEARCH

Having established a set of factors associated with the success of a simulation project the next stage is to develop a survey instrument, along the lines of SERVQUAL, which can be used to assess the quality of a simulation study. This instrument needs to measure the customer's expectations regarding each factor and his/her perceptions of what actually happened. The survey also needs some importance measure in order to weight the various factors and obtain an understanding of the customer's priorities. With so many factors involved it is impracticable to develop an instrument that would test all of these, therefore, the aim is to include only the most important factors. Having developed a prototype instrument it will be tested with a number of customers in order to refine it.

It is envisaged that such an instrument could be used in a number of ways. Firstly, to measure the customer's expectations as a project progresses. It must be recognised that a customer's expectations are not static, and even less so when the customer is new to simulation. It may prove useful to record the expectations at the start of the project and then at intervals throughout the duration of the study. In this way the provider can aim to ensure that these expectations are met. A second use would be to continually assess the customer's perceptions of the service he/she is receiving. Any gaps between expectations and perceptions could be identified and addressed. A final use would be an overall measure of project quality. There must be some doubt that this is

Table 2: Factor Citations by Dimension

	Frequency of citations			Percentage of citations		
Dimension	Provider	Customer	Total	Provider	Customer	Total
Model	30	17	47	6.90%	5.72%	6.42%
Software	10	11	21	2.30%	3.70%	2.87%
Involvement	33	28	61	7.59%	9.43%	8.33%
Communication	64	22	86	14.71%	7.41%	11.75%
Credibility	12	16	28	2.76%	5.39%	3.83%
Competence	36	43	79	8.28%	14.48%	10.79%
Professionalism	34	15	49	7.82%	5.05%	6.69%
Education	11	11	22	2.53%	3.70%	3.01%
Understanding	27	8	35	6.21%	2.69%	4.78%
Responsiveness	39	32	71	8.97%	10.77%	9.70%
Access	7	11	18	1.61%	3.70%	2.46%
Fees	10	8	18	2.30%	2.69%	2.46%
Recovery	5	0	5	1.15%	0.00%	0.68%
Confidence	23	28	51	5.29%	9.43%	6.97%
Client	41	18	59	9.43%	6.06%	8.06%
Data	31	14	45	7.13%	4.71%	6.15%
Reliability	14	7	21	3.22%	2.36%	2.87%
Interpersonal	5	6	11	1.15%	2.02%	1.50%
Other	3	2	5	0.69%	0.67%	0.68%
Total	435	297	732	100.00%	100.00%	100.00%

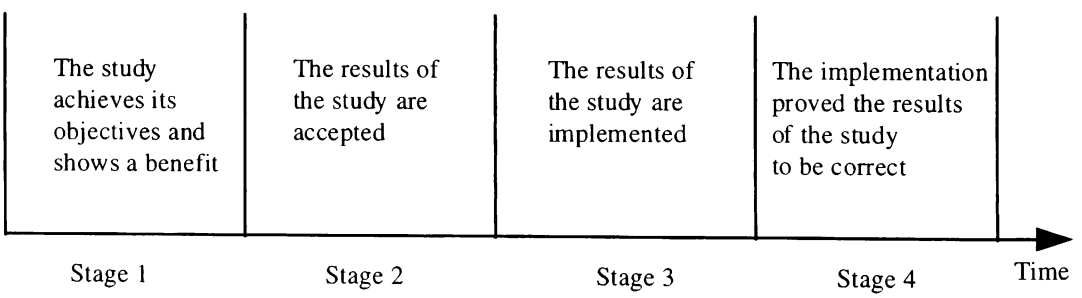

Figure 3: Four Stage Model of Success in Simulation Studies

possible in such a complex service encounter, but the instrument will be tested for its reliability as an overall service quality measure.

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