AN INTERPRETIVE METHODOLOGY FOR INFORMATION SYSTEMS STRATEGY DEVELOPMENT IN PROJECT MANAGEMENT

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ABSTRACT: Computer Integrated Construction can lead to great developments in construction productivity and quality. A key contribution is the adoption and application of consistent computer-based information systems. This paper examines an area of concern deriving from a consideration of the benefits and stages involved in developing a Computer-Based Information Systems Strategy Plan for construction project management: the ICON-Based Methodology. This is situated in context with Total Quality Management, the ISO 9000 family of standards and the ISO/CD 10006 document.

KEYWORDS: ISO 9000, ISO/CD 10006, Soft Systems Methodology, ICON project, Information Systems, Information Systems Strategy, ICON-Based Methodology

1. FROM THE ISO 9000 STANDARDS TO THE ISO/CD 10006 DOCUMENT: A REVIEW OF CONCEPTS, PRINCIPLES AND GUIDELINES

The importance of quality and the management of quality are subjects that have been receiving increasing attention world-wide. Of growing interest and importance to those organisations wanting to implement TQM is to win accreditation, to be awarded the seal of ISO 9000 or one of its equivalents. These standards are general models that propose a set of guidelines about improvements to be achieved.

Of special importance to the construction industry are the guidelines and suggested structure for the application of quality concepts in project management provided in the ISO/CD 10006. This document gives guidance on those quality concepts, practices and systems for which the implementation is important to and has an effect on the practice of project management. It is based on the quality principles of the ISO 9004-1. It further recognises that the success of a project depends not only on the quality of the end product, but also on the project management processes.

According to this, the document takes a Process View of project management and provides guidance on the application of quality practices, derived from five quality concepts which are seen as fundamental, to project processes.

The suggested fundamental quality concepts are:

1. Satisfaction of stakeholders needs is paramount;
2. Quality is achieved by considering that every activity is part of a process;
3. Quality is built in, not inspected in;
4. Management is responsible for creating an environment for quality;
5. Management should make a commitment to continuous improvement.

The suggested network of processes was organised into a hierarchy of processes, consisting of three levels, according to its functional objectives: Strategic (legitimise and set direction for the project), Operational (required to meet objectives) and Support (enable the realisation of the project activities). The Operational processes were further grouped according to their relation (affinity) to one another: scope, time, cost, resources, personnel, communication, risk, procurement, product and integration related processes.

In addition to this focus on a communication related process, the ISO/CD 10006 clearly states the need for establishing a Computer-Based Information Systems (**CBIS**) for each construction project:

- Process management - "a monitoring and control system should be applied to systematically collect information on the performance of the project results, schedule and costs" (pg. 9);
- Process improvement - "by capturing and acting on the information generated by the processes generated by the processes within the project, both effectiveness and efficiency of the project processes can be improved" (pg. 9);
- "At an early stage of the project the kind of information needed to learn from the project should be determined, and an effective system for collecting and processing the necessary data should be planned and established. Computerised systems are appropriate for this purpose" (pg. 36-37).

2. THE CULTURAL CONTEXT OF CONSTRUCTION PROJECT PROCESSES AND INFORMATION MANAGEMENT: A ROLE FOR THE SOFT SYSTEMS METHODOLOGY

The ISO/CD 10006 defines project objectives as what is to be achieved to meet agreed stakeholders needs and requirements. However, a construction project involves a vast range of people with different skills, knowledge and interests working together. This is seen as creating problems for the organisation of both the design and construction processes, due to the large number of interfaces and difficulties in communication (Aouad et al., 1994).

When construction project participants communicate with one another, problems of disagreement and conflicts may arise, and participants are seen as having to negotiate and resolve conflicts by employing their knowledge and experience, in order to co-operate (Oxman, 1995). This 'pluralistic' context (Flood and Carson, 1988) is characteristic of construction processes, as it is not unusual to the project decision makers to disagree on a common set of goals (Latham, 1994).

A process of accommodation between participants is necessary before a problem focus can emerge which will carry assent and commitment to consequential action (Rosenhead, 1989). Facilitating this process is of great importance and, according to this, it will be suggested in the methodology described in this paper that the Soft Systems Methodology (SSM) (Checkland, 1981; Wilson, 1990; Checkland and Scholes, 1990) provides an appropriate framework for facilitating accommodation between the project stakeholders.

When determining and planning a CBIS for the project, it is important to realise that the meaning attributed to project data depends on the stakeholders subjective cognitive frameworks, which are created by organisational and personal norms, standards, values and beliefs (Lewis, 1994). Consequently, the differing points of view, values and experiences of the different participants in the construction project have led to separate and sometimes conflicting information needs (McDonagh, 1995). As in a re-enforcing loop, it is not hard to picture this information fragmentation re-enforcing the fragmentation of the organisational context as well, by stressing the differences in terms of meaning and culture.

Information integration is attracting more thought and discussion in construction circles than before, and one definition suggested is that "integration is the ability to share information or subsets of information between different actors/disciplines" (Aouad et al., 1994). As pointed out by McDonagh (1995), "considerable opportunity therefore exists for construction to achieve dramatic improvements in performance in productivity and quality once the crucial stumbling block of integrated information can be achieved".

As suggested before, and since the project organisational context and information management are inter-dependent, it will also be suggested in the methodology presented in this paper that if SSM can

be used as an organised framework for facilitating accommodation in the former situation, then it can and should also be used for facilitating integration in the latter.

3. COMPUTER-BASED INFORMATION SYSTEMS AND COMPUTER INTEGRATED CONSTRUCTION: A ROLE FOR THE ICON PROJECT

3.1. Computer-Based Information Systems

There have been many reported problems with CBIS in organisations and failed investments, which are seen as due to an insensitivity to the organisational designs, cultures and management styles (Hornby et al., 1992). Since failures are often understood as due to a mismatch between the provided CBIS and the expectations of the stakeholders and to social issues, CBIS are increasingly seen as primarily social systems that use technology (Hornby et al., 1992; Meyers, 1994; Watson, 1995).

A Computer-Based Information System (CBIS) can accordingly be defined (Jayaratna, 1994) as a social system which uses computer-based artefacts to:

1. Satisfy stakeholders information needs, by providing the most efficient technological means of acquiring, storing, processing, disseminating and presenting relevant data (e.g., databases, telecommunications, etc.);
2. Provide stakeholders with learning tools which can help improving their decision making processes in a more efficient and effective way;
3. Rethink and support the strategic, operational and control courses of action.

Typical examples of CBIS include Transaction Processing Systems (TPS), Management Information Systems (MIS), Office Automation Systems (OAS), Knowledge Work Systems (KWS), Decision Support Systems (DSS), Knowledge-Based Systems (KBS), Executive Information Systems (EIS) and Inter-Organisational Systems (IOS).

3.2. Computer Integrated Construction

Information Technology (IT) has been identified as a key enabler of integration in the manufacturing industry, leading to efficiency increases in project and enterprise management. This is taken to be true for the construction industry as well, but the latter fragmented context poses unique demands on the way this can be accomplished (Dupagne, 1991; Augenbroe, 1995). The corollary of Computer Integrated Manufacturing (CIM) for construction has been designated as Computer Integrated Construction (CIC).

CBIS would therefore seem to provide the grounds based on which CIC can be achieved. Hence, by primarily focusing on the organisational context, the authors subscribe the view that “CIC in itself will only begin to be realised once we have a clearer definition of how to integrate construction information. Thus Integrated Construction Information (ICI) is a fundamental prerequisite of CIC and the achievement of manufacturing-like productivity and quality goals within construction” (McDonagh, 1995: pp. xxviii).

3.3. The ICON project

ICON (Information / Integration for Construction) is a research project developed at the University of Salford, UK, by a group of researchers from IT and Construction backgrounds, assisted and guided by a group of industrialist and representatives of the major professional institutions (RIBA, RICS, CIOB, NBS)(Aouad et al., 1994).

The project and its approach led to the development of a set of models that were integrated within a single object-oriented database which accommodates the views of the different agents in the various activities of design, procurement and management if construction. Consequently, such a database could be used as an interface between the different disciplines to share information, whilst each of them could still use the application it is familiar with (Aouad et al., 1994).Using such a database of models, the construction industry would therefore ensure that integrated systems would be developed within a common framework, and facilitate communication between the project participants, whilst at the same time being in line with the concept of ICI and CIC. These features are of special importance to our methodology, as it will be explained later in this paper.

Due to the characteristics of construction projects, there is a need for CBIS to fulfil three goals: high quality, high speed of development, and low development costs. The main lesson to CBIS seems therefore to come from the latest trend in construction itself: Industrialisation, i.e., the production of unique high-quality final products from project-independent standard components.

Object-Oriented models fulfil this appropriate role in CBIS development, as new systems should, as far as possible, be built out of models that already exist, and that can be adapted to specific circumstances (reusability). The ICON database of object-oriented models provides these standard building blocks, and can therefore facilitate CBIS rapid application development.

4. COMPUTER-BASED INFORMATION SYSTEMS (CBIS) STRATEGIES

CBIS Strategy development is the process by which the relationship between potential CBIS and their organisational context and environment is determined, along with the internal structure and features required to maintain these relationships. It is therefore concerned with defining the CBIS goals in the organisational context, and the related courses of action intended to attain them.

Core elements of a CBIS Strategy Plan would be:

1. Information Strategy
- Information Architecture: project organisational processes together with the necessary information to support them
- How CBIS will be used to support the project organisational processes
- Priorities for CBIS development: portfolio of suggested systems

2. Current Information Situation
- Inventory and assessment of current practices
- Portfolio of current CBIS

3. CBIS Infrastructure Strategy
- Data structures necessary
- Software applications involved
- Hardware architecture
- Networking resources
- Related Human Resources: training, skills, organisation
- Functionality (what the systems will do)

4. Implementation Plan

- Software acquisition guidelines
- Long-term and short-term actions
- Resources allocation

5. Pro-active Strategy Evaluation
- Do the CBIS improve the project organisation incrementally or transform it ?
- Do they support motivated, integrated and learning human activity?
- Do they support organisational continuous improvement and economic use of resources?
- Fit with external project environment (environmental forces, competitive and non-competitive best practice, understanding quality characteristics desired by customers and external stakeholders)
- Fit with project organisational strategy, structure, operational processes, cultures, and political systems
- CBIS related stakeholders
- Issues concerning future flexibility

6. CBIS Investment Assessment
- Costs and Benefits: tangible and intangible
- Investment appraisal: Return on Management, Information Economics and Strategic Contribution Assessment

5. TOWARDS AN INTERPRETIVE METHODOLOGY FOR FORMULATING A CBIS STRATEGY

In this paper, several issues and their implications have been highlighted. Among these the following should be emphasised:

- The need for an CBIS strategy in line with organisational, quality and project objectives and courses of action;
- The need for facilitating collaboration and integration at the organisational and project levels;
- The need for understanding the information needs according to the views of the different stakeholders;
- The potential role of the ICON database of models in facilitating the development of an IS strategy in line with the aims of ICI and CIC;
- The research need identified for developing a framework combining the above issues and the relevance of computerised information and communication technologies.

An interpretive methodology in line with the above issues and the adopted definition of CBIS would consequently reflect three main stages:

1. Project Organisational Context Analysis
- Development of process models for project management based on the ISO/CD 10006;
- Development of process models for project management based on literature review
- Development of process models for the specific organisational project management context (organisational stakeholders views, values and beliefs), based on the project organisational analysis/synthesis and environmental scanning: the 'LEARNING AND DEBATE' elements
- All the models above are developed according to Systems theory, concepts and principles
- Relevant process models to be considered in the next stages will be selected according to debate and discussion of their importance to the specific project context: the 'PROCESS MODELS' elements

2. Project Supporting Information analysis

- Information requirements are determined by considering for each process, in the relevant models, what information is required to carry it out, and what information is required to evaluate its measures of performance (efficacy, efficiency and effectiveness criteria): the 'WHAT' elements.
- By mapping the process models onto the project organisational structure, the information flows can be related to project organisational roles, and consequently the information stakeholders can be identified as to establish who is to be involved in the strategy development process: the 'WHO' elements
- The ICON database of object-oriented models is related to the information needs, and the data structures that yeld appropriate categories of information are consequently developed

3. Project Supporting CBIS Strategy Formulation
According to the processes considered and related information needs, the supporting data structures, and the associated stakeholders:

- Possible alternatives for CBIS are generated: the possible 'HOW' elements
- Their Technical (functional, logical, technological), Organisational (strategy, organisational processes and structure, culture, political system) and Personal (individual needs, job satisfaction, beliefs, fear of change, creativity) implications are analysed and evaluated: the 'T,O,P' elements
- Based on the possible alternatives, and their technical, organisational and personal implications, a portfolio of logically desirable and culturally feasible CBIS is discussed and suggested
- The outcomes of the whole strategy development process (3 phases) is formulated and described formally: the 'CBIS STRATEGY PLAN' element.

6. THE ICON-BASED METHODOLOGY

6.1. Organisational Context Analysis

6.1.1. Background Research:

The core of this stage is based on the Soft Systems Methodology (Checkland, 1981; Checkland and Scholes, 1990) and the ISO/CD 10006. Other background relevant work includes (Galliers, 1995; Wilson, 1990; Beer, 1985).

6.1.2. Methodology Steps

The following methodology steps are illustrated in figure 1.

Step 1: Project Preparation - As suggested in (ISO/CD 10006; Ward, 1990; Galliers, 1995) it is important to consider a briefing with the project stakeholders regarding the aims, objectives and methods of the study, team organisation, the structure and the roles to be fulfilled, and a steering committee.

Step 2: Organisational Analysis / Synthesis - Collect as many perceptions of the project context as possible from the range of stakeholders involved, from which a range of possible themes can be elicited. Express the project organisational context according to the stakeholders appreciation, in terms of ‘structure’, ‘process’ and ‘climate’. It can be assisted by methods such as critical success factors, critical failure factors, critical decisions, critical assumptions, constraint analysis, and the use of the stages of growth models (Nolan 1979; Rockart , 1979; Earl, 1989; Galliers, 1991, 1995). Appreciate and express subjective ‘pictures’ of the situation, so that relevant systems can be explored.

Step 3: Environmental Scanning - Consider the organisational / project environmental factors concerning strategy (Galliers, 1995). Methods of utility include the analysis of competitive forces and extended value chain, a review of industry trends in the use of IT, and the SWOT and PEST analysis that emerge from the wider environment. Understanding strengths and weaknesses in the context of environmental conditions and trends, as perceived and appreciated by the project stakeholders.

Step 4: Creation of alternative scenarios - Based on the environmental scanning express scenarios perceived as relevant to the project context; identify implicit assumptions and perspectives.

Step 5: Root definitions of relevant systems - Express the selected notional systems in such a way as to make it possible to build systemic conceptual models. These will be essentially primary task notional systems, and be complemented by the CATWOE elements.

Step 6: Conceptual Models - Describe and model the minimum necessary activities each notional system must do in order to be the system named in the root definition. These are developed according to systems theory. The conceptual models show the potential activities and their logical dependencies for each of the root definitions.

Step 6a: Formal Systems Concept - According to the formal systems model, every 'human activity system' must have some ways of evaluating its performance, and ways of regulating itself where the designed performance is not being achieved. These monitoring and control mechanisms are made explicit in the conceptual model through measures of performance such as efficacy, efficiency and effectiveness.

Step 6b: Other systems thinking - Potential contributions include the models developed from considering the application of the Viable Systems Model (Beer, 1985) to project management, and the conceptual models developed from the process viewpoints in the ISO/CD 10006 (time, cost, quality, personnel, resources, risk, procurement, communication and integration). These have been modelled in our research and can be used to provide further insight, discussion and examination.

Step 7: Comparison of 2. With 6 - Compare the defensible version of what might happen (as expressed in the conceptual models) with what actually does happen in the project and organisational context. Debate mismatches and possible improvements. Organisational learning emerging from the discussion.

Step 8: Feasible, desirable changes - Based on the previous step, the suggested recommendations which are both culturally feasible and functionally desirable constitute courses of action to improve the situation.

Step 9: Conceptual models relevant for further exploration - In any situation there are many different ways of looking at the situation. The process of expressing them provides ideas about what, in systems terms, might be relevant to explore. The question is therefore not one of choosing the correct models, but of further exploring those models which are perceived as being potentially useful in discussing future information provision. These will be carried to the next stage of information analysis.

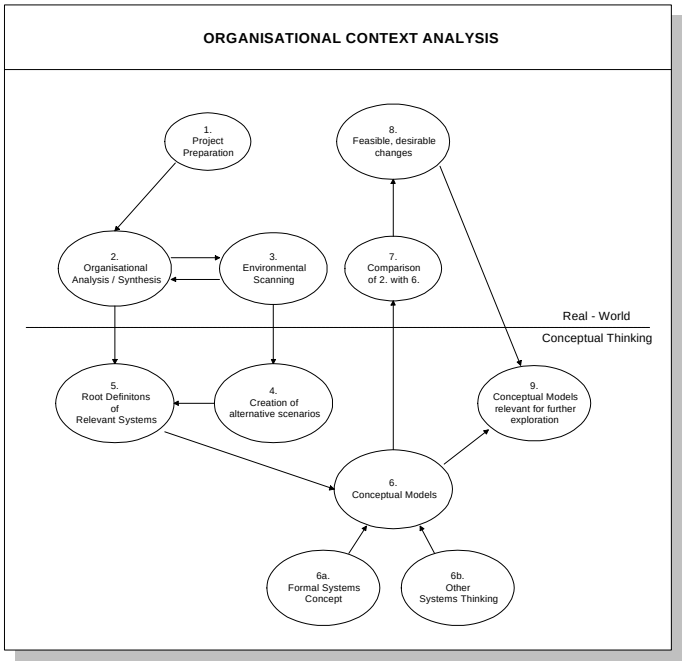

Figure 1 - Organisational Context Analysis

6.2. Supporting Information Analysis

6.2.1. Background Research:

The core of the research on which this phase draws is explained in Wilson's methodology (1990), Lewis' interpretive data modelling (1994) and the ICON database of object-oriented models (Aouad et al., 1994).

6.2.2. Methodology Steps

The following methodology steps are illustrated in figure 2.

Step 10: Information requirements and flows associated with conceptual models - Identify, for each activity in the relevant conceptual models, which operational information categories are necessary to perform the activity. Identify the monitor / control information items by considering, also for each activity, the measures of performance (in terms of efficacy, efficiency and effectiveness) and indicators for potential improvement.

Step 11: Organisational information flow analysis / synthesis - Analyse how and what information is currently provided in the project organisational setting. Describe the actually existing information processing structures and related data categories.

Step 12: Map organisation - Convert the 'activity- to activity' flows (in the conceptual models) in 'role-to-role' flows (in the existing project organisational structure), and map current project organisation to the specified roles, in order to identify each information category stakeholders (the 'who' elements).

Step 13: Comparison of 10. With 11. - Compare the actual information provision with the required one (derived from the systemic conceptual models). Identify gaps, redundancies and inconsistencies as to provide a course for focus.

Step 14: Identify organisational information requirements and associated stakeholders - According to the information mismatches identified (step 13) and the associated stakeholders (step 12), identify the project organisational information requirements. Define the project Information Architecture: define 'who' (in terms of role) needs what information for what purpose (in terms of the activities for which they are responsible), who supplies it, and a picture of how these needs are currently met (Wilson, 1990).

Step 15: Appreciate nature and structure of expertise involved with information requirements and related activities - Due to the subjective nature of information, deriving the supporting data structures needed implies the understanding of how basic, unprocessed data, will be transformed as to provide the support information categories required. It is therefore a step concerned with knowledge elicitation, and will consequently be facilitated by knowledge acquisition techniques.

Step 16: Other data structures thinking relevant to conceptual information requirements: the ICON models - The ICON database of models will be used as a library of data structures which might be retrieved or expanded to accommodate the elicited data needs elicited in step 15. This will also ensure the wider aims of CIC and ICI, through the adoption of a common framework of object-oriented models.

Step 17: Data structures that yeld appropriate categories of information - By comparing the information needs and the data structures elicited from them, it is possible to compare them to the ICON models. If the latter models account for the data needs, then they will adopted as represented in the database; in the opposite case, they will be adapted and expanded as to accommodate the new data items required. The outcome of this step is a complete set of object-oriented models which account for all the elicited project data needs.

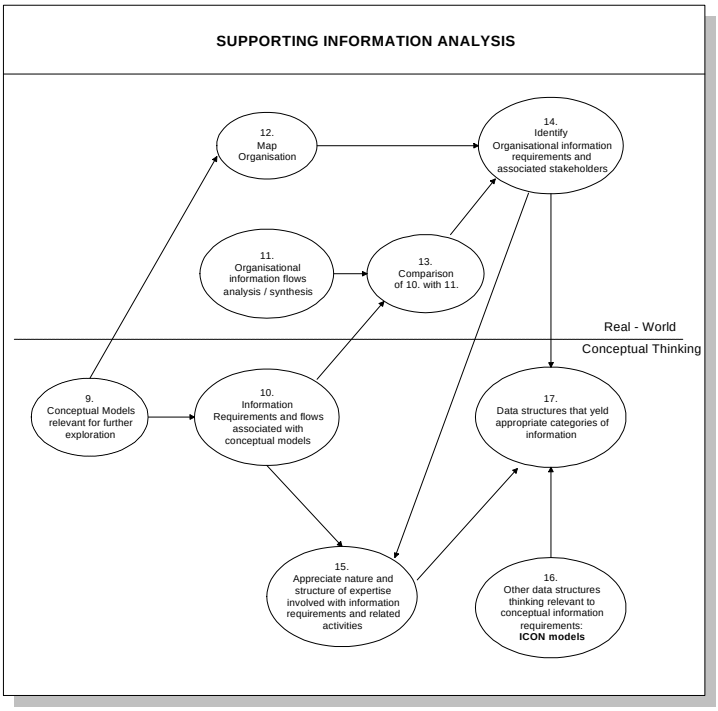

Figure 2 - Supporting Information Analysis

6.3. Supporting Computer-Based Information Systems strategy formulation

6.3.1. Background research

The evaluation of possible alternatives is based on the issues highlighted by Mumford (1983) and Avison & Wood-Harper (1991). Explicit consideration of technical, organisational and personal perspectives in based on Mitroff and Linstone (1993). The issues involved with IS strategies draw on (Ives and Learmonth, 1983; Wiseman and MacMillan, 1984; Porter and Millar, 1985; Earl, 1989; Ward, 1990; Robson, 1994, Galliers, 1995).

6.3.2. Methodology Steps

The following methodology steps are illustrated in figure 3.

Step 18: Derivation of alternative possibilities for manipulation of data structures: possible computer-based information systems - There are many possibilities for computer-based data manipulation systems which can provide the support identified in the previous stages. The question is not only on their design, but also on choosing which ones to design. Thus, ready-made software packages should be considered (e.g. project management software, spreadsheets, commercial packages, etc.) as in the specific systems development. Possible computer-based support includes TPS, MIS, EIS, KBS and IOS (e.g. learning from past projects could be facilitated through the use of Case-Based Reasoning technology (Watson and Marir, 1995)).

Step 19: Evaluation of possible CBIS: socio-technical systems analysis (T,O,P) perspectives - Acknowledges the influence in the methodology design from Ethics (Mumford, 1983) and

Multiview (Avison and Wood-Harper, 1991), by taking the view that human considerations (such as job satisfaction, task definition, etc.) are just as important as technical considerations. It does so by adopting the Multiple Perspectives framework (Mitroff and Linstone, 1993): Technical (functional, logical, technological), Organisational (strategy, organisational processes and structure, culture, political system) and Personal (individual needs, job satisfaction, beliefs, fear of change, creativity).

Step 20: Desirable, feasible CBIS - Determine which possible computer-based information systems are functionally desirable and culturally feasible, according to the set of potential alternatives, their implications and consequences (technical, organisational and personal), and the project and information stakeholders.

Step 21: CBIS Strategy: a holistic picture - Develop an analysis, development and implementation plan that translates the considerations above into a CBIS Strategy Plan, as described above in section 5.

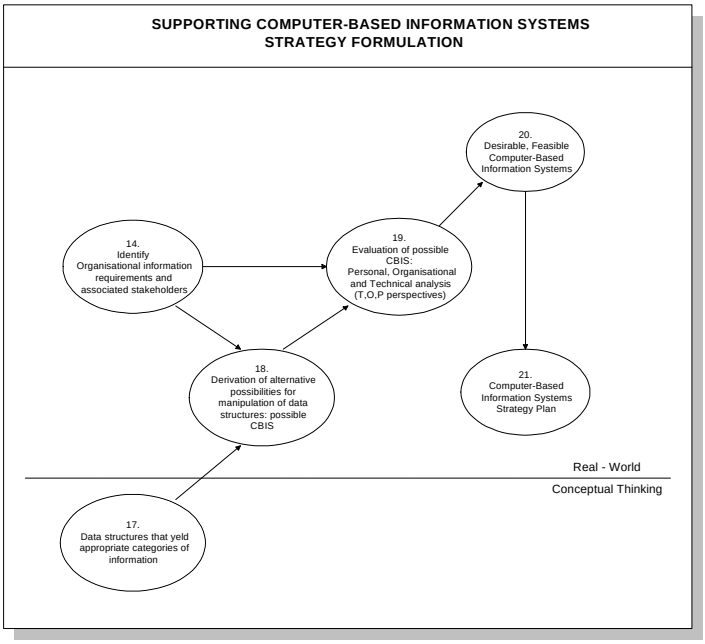

Figure 3 - Supporting CBIS Strategy Formulation

7. REVISITING THE ISO/CD 10006 QUALITY CONCEPTS

Concept 1: Satisfaction of stakeholders needs is paramount
The adoption of the Soft Systems Methodology (SSM) facilitates the identification of stakeholders, the understanding of their needs as perceived by them, and ensures that the functionally desirable and culturally feasible courses of action contribute to satisfying those needs.

Concept 2: Quality is achieved by considering that every activity is part of a process
The systems theory behind phase 1 (in its use of the SSM), and phase 2 (in the systemic derivation of information needs), according to the notional systems relevant to the stakeholders, ensures that the processes and the information provision create value for the stakeholders and in line with their goals. Effectiveness and efficiency are analysed and designed through the use of systems concepts

(hierarchical structure, emergent properties, communication and control) in the development of the conceptual models.

Concept 3: Quality is built in, not inspected in
The focus on the stages and sequence of the ICON-based methodology is on 'getting it right the first time'. The use of SSM facilitates the perception and debate towards 'doing the right thing', the system derivation of information needs and the socio-technical consideration of its potential provision and manipulation is a step towards 'doing the thing right'. Furthermore, the cultural stream of analysis of SSM propitiates the commitment of people in the project context, which is a necessary condition for quality achievement.

Concept 4: Management is responsible for creating an environment for quality
The setting of quality objectives from the customers, external stakeholders and project stakeholders is dealt with by SSM. Relevant notional systems for exploring the implications in terms of structure, support, involvement of personnel, and assessment and follow-up can be developed, and their implications debated as to set courses of action. Based on these conceptual models, the information provision and its computer manipulation will contribute to the environment for quality.

Concept 5: Management should make a commitment to continuous improvement
The CBIS developed for the project will collect and analyse the information generated during the project, and this analysis can be used for continuous improvement, as planned for in step 9. Learning from the past can be further facilitated by the use of artificial intelligence techniques, such as Case-Based Reasoning.

8. CONCLUSIONS

This paper described the ICON-based methodology, which was structured and developed according to the following aims:

- To suggest possibilities for use and expansion of the ICON database of models in the area of project management and, by doing so, in line with the wider debate on computer integrated construction;
- To explore how a CBIS strategy might be developed and elaborated for project management, according to the ISO/CD 10006 guidelines, and which is logically desirable and culturally feasible for the project stakeholders;

It was suggested that the methodology should comprise three main phases, leading to a CBIS Strategy Plan:

1. Project Organisational Context Analysis;
2. Project Supporting Information Analysis;
3. Project Supporting CBIS Strategy Formulation

The potential outcomes for an organisation undertaking this strategy development process would consequently be:

1. Better understanding of its current situation, practices and possible re-alignment, according to its cultural and political context;
2. Enable rethinking of processes, rather than their straight automation, and exploiting uses of current technology;
3. Development of a CBIS Strategy Plan supporting, and integrated with, the organisational strategy, structure, processes, and cultural / political context;
4. CBIS support in line with the ISO/CD Quality Guidelines for Construction Project Management;
5. Evaluation of the issues raised by, and investment involved with, the CBIS Strategy Plan.

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References

Aouad, G.; Betts, M.; Brandon, P.; Brown, F.; Child, T.; Cooper, G.; Ford, S.; Kirkham, J.; Oxman, R.; Sarshar, M. and Young, B. [1994] *Integration of Construction Information (ICON): Final Report - Integrated Databases for the design, Procurement and Management of Construction* (University of Salford, Salford).

Augenbroe G (1995).; "Design systems in a computer integrated manufacturing (CIM) context", in Brandon and Betts (1995): pp. 194-212

Avison, D.E. and Wood-Harper, A.T. [1990] *Multiview: an exploration in information systems development* (Henley-on-Thames, Alfred Waller Limited).

Beer, S. [1985] *Diagnosing the system for organisations* (Chichester, John Wiley & Sons)

Brandon, P B and Betts, M; (1995); "Integrated construction information", E & FN Spon

Checkland, P B (1981), "Systems thinking, Systems practice", Wiley, Chichester.

Checkland P B and Scholes J (1990), " Soft Systems methodology in action", Wiley.

Dupagne A (1991); "Computer integrated building", Strategic Final report, Esprit II, Exploratory Action no. 5604, CE commission DGXIII, December

Earl M J (1989); "Management strategies for information technology", Prentice Hall, London

Flood R and Carson E R (1988); "Dealing with complexity - an application to the theory and practice of systems science"

Galliers, B. [1995] *Re-orienting information systems strategy: integrating information systems into the business*, in Stowell, F. (ed.) [1995] Information Systems Provision: the contribution of soft systems methodology (London, McGraw-Hill)

Galliers R D (1991); "Strategic information systems planning: myths, reality and guidelines for successful implementation", European Journal of Information Systems, 1(1), January, 55-64

Hornby, P; Clegg, C W; Robson, J I; McLaren, C R R; Richardson, S C S and O'Brien P (1992), "Human and organisational issues in Information Systems development", Behaviour and Information Technology, 11 (3), pp 160-174.

ISO [1994] *ISO/CD 10006: Quality management and quality systems elements - guidelines to quality in project management* (Geneva, International Standards Organisation)

Ives, B and Learmonth, G P; (1983); "The information system as a competitive weapon", Comunications of the ACM 27 (12), 1193-1201

Jayaratna (1994), "Understanding and evaluating methodologies", McGraw-Hill

Latham M Sir (1994); "Constructing the team", HMSO, UK

Lewis, P J (1994); " Information-Systems Development", Pitman Publishing

McDonagh (1995); "Foreword", in Brandon and Betts (1995), pp. xvii-xxiii

Meyers M (1993); "A disaster for everyone to see: an interpretive analysis of a failed IS project" , in Proceedings of the 4th Australian Conference on Information Systems, Brisbane, Queensland, Australia, 28-30 September, pp. 596-614

Mitroff, I and Linstone, H, (1993), "The unbounded mind: new thinking for the 21st century", Oxford University Press.

Mumford, E. [1983] *Designing human systems* (Manchester Business School, Manchester).

Nolan R L (1979); "Managing the crisis in data processing", Harvard Business Review, 57(2), March-April, 115-126

Oxman, R (1995); "Multi-agent collaboration in integrated information systems", Brandon and Betts (1995), pp.316-325

Porter, M E and Miller, V E (1985); "How information gives you competitive advantage", Harvard Business Review 63 (4), 149-160

Robson, W (1994); "Stategic management and Information systems, an integrated approach", Pitman Publishing

Rockart, J F (1979); "Chief Executives define their own data needs", Harvard Business Review, 57(2), March-April

Rosenhead, J. (ed.) [1989] *Rational analysis for a problematic world* (Chichester, Wiley).

Ward J, Griffiths P and Withmore P (1990); "Strategic planning for Information Systems", Wiley, Chicester

Watson, H (1995); "A critical study of the Multiview methodology: a textual analysis of concepts in inquiry", Phd Thesis, University of Salford, U.K.

Watson I and Marir F (1005); "Case-Based Reasoning: A review", The knowledge engineering review, 9(4), 1994

Wilson B (1990), "Systems: concepts, methodologies and applications", 2nd ed., Chichester: Wiley.

Wiseman, C and MacMillan, I C (1984); "Creating competitive weapons from information systems", Journal of Business Strategy 5(2), 42-49