CHAPTER XX

AN INTERDISCIPLINARY STUDY OF INFORMATION SYSTEMS: CHRISTOPHER ALEXANDER AND IS FAILURE.

Chris Kimble[1] and William Selby[2]
[1] Management & Information Systems Group, Department of Computer Science, University of York, York, YO1 5DD, UK, +44 1904 433380, kimble@minster.cs.york.ac.uk
[2] British Telecom, Martlesham Heath, william.selby@bt.com

Abstract

This paper describes work carried out at the University of York; its contents do not represent the views or opinions of BT. It provides an example of how insights into the field of IS can be gained by looking at it from the perspective of other academic disciplines. Based on the idea that physical and virtual office spaces exist to serve parallel organisational requirements, it is argued that designers of information systems (IS) should be able to learn from the experience of architects in order to improve their methods and redefine their objectives. Firstly, the work of Christopher Alexander is reviewed to show how his work on architectural patterns has been of value to the designers object-oriented systems. Secondly, similarities in the literature between notions of failure in architecture and IS design are identified. These are then examined through interviews with practitioners to establish the relevance of the approach. Finally, the area that Alexander described as 'the quality without a name' is highlighted as a topic for further research.

1 INTRODUCTION

The aim of this paper is to show that new and interesting insights into the field of IS can be gained by looking at it from the standpoint of other academic subjects. It will not address the thorny question "is IS a discipline?" which has been dealt with at length elsewhere (Khazanchi

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

and Munkvold, 1999; Mingers & Stowell, 1997). In this sense, the paper should be seen as an interdisciplinary study in the field of IS in the spirit of two papers from last years conference: Li & Williams (1999) and Mutch (1999).

Li & Williams (1999) argue that despite the significant progress in research on information systems in recent years, a major shortcoming is the lack of an informed consideration of the geographical dimension: a surprising deficiency given the inherent spatial nature of networked information systems. They argue that the recent emergence of electronic space and the consequent co-existence of 'two spaces' (i.e. the electronic space and the physical space) represents a fundamental change. In their paper, they highlight several lessons for living in these two spaces that can be learnt from research by geographers on the information economy. They conclude that the information revolution does not mark the 'end of geography' or the 'death of distance' but that a complex new geography is being created that poses a significant challenge. Similarly, Mutch (1999) argues that a more informed appreciation of the problems faced in designing systems for information and knowledge management can be gained by drawing upon the work of historians and other social theorists.

The idea that the concepts of physical and virtual office spaces are interchangeable is a central theme of this paper. It argues (1) that physical and virtual office spaces exist to serve parallel organisational needs and (2) that in certain areas virtual office spaces fail to perform as effectively as physical ones. The combination of the two arguments leads us to ask if the field of IS has anything to learn from the field of architecture.

2 FROM ARCHITECTS AND OFFICES TO IS DESIGN AND IS FAILURE

As indicated above, the idea that the concepts of physical and virtual office spaces are interchangeable forms a central theme to this paper. Although it is beyond the scope of the paper to enter a detailed discussion of the nature of virtual environments and virtual offices, the following brief descriptions are given.

The Virtual Office is a term widely used to capture the idea that 'the office is where you are' (Stone & Luchetti, 1985). 'Telework' and 'telecommuting' have become part of our vocabulary, describing the growing phenomenon of working at a distance from the traditional office: whether in the car, on the train or anywhere else where there is access to the technology needed to support it. An analysis of the main functions of the office reveal striking similarities in terms of how both the physical and the virtual office serve common business objectives.

Harris (1997) argues that physical office space serves four basic functions: a systems infrastructure, a financial investment, a place for work and a focus for cultural interchange.

> *'The systems infrastructure is twofold. There are information systems … such as personal computers and networks that allow the business to operate. Then there are comfort systems that allow people to control their work environment: the technology that controls air handling, lighting, heating and lifts.'*

Thus, the systems infrastructure is simply the interface between the users of an office and the technology used to support it.

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

Both buildings and information systems represent a considerable financial investment for most large commercial organisations. Eley and Marmot (1995) state that after employees' wages, the provision of physical office space represents the greatest cost factor to organisations: businesses demand that the physical spaces they provide represent value for money. Given that a constant process of change is the hallmark of many businesses' activities, architects and designers have responded to the requirement that offices cater for future working practices in terms of design. Jenkin (1997) states:

> *'Perhaps the most important idea built into these designs was the concept of 'reversibility'. Reversibility is the incorporation of an expectation of the need to change; it is an a approach that helps to 'future proof' the buildings.'*

The notion that the office should be a forum in which work is performed is probably the most universally accepted aspect of Harris's description of the four basic office functions. The nature of the work to be performed will typically be reflected in the physical design of offices. Today, in response to the dominant spatial concerns of third generation office (Bedford & Tong, 1997), offices typically reflect organisational working practices that may be either group-based or individual. The provision of communal workspaces is designed to assist in the exchange of ideas and knowledge between employees (Eley and Marmot 1995).

According to Harris, the office as "a focus for cultural interchange" relies upon the personal interactions that permit the exchange of ideas and knowledge that a company values highly. Van Meel et al (1997) state:

> *'Architects have several means to enhance interaction in a building. Popular gathering places are those that afford comfortable sitting, good light, and a view. Furthermore, interaction is affected by the layout of a building. Floor plans localise people and thereby modulate their interaction. Proximity is one of the basic factors in establishing communication, especially informal communication. The chances of meeting somebody are much greater if others are nearby'.*

We will clearly expect a successful virtual office space to provide a similar environment. However studies that have examined the effectiveness of the virtual office in terms of how well it supports groupwork, knowledge sharing and other forms of personal interaction, have found it lacking (Kimble et al, 1998). The term Virtual Environment (VE) is sometimes used to extend the rather sparse, functional view of the virtual office to incorporate some of these factors. In line with Conkar et al (1999), the term VE is taken to mean an interactive and collaborative social environment where computer technology is used to generate a tele-presence. Tele-presence is a sense of physical presence that derives from the meanings that the users attribute to features of the technology and the interactions that take place via the technology.

Having established a *prima facie* case that, at least in this area, the field of IS might potentially have something to learn from the field of architecture, we will now examine the work of the architect Christopher Alexander.

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

3 THE WORK OF CHRISTOPHER ALEXANDER.

Christopher Alexander work on patterns has been of particular interest to computer scientists and more specifically to object-oriented (OO) designers. For IS designers, the value of Alexander's work is in the format it suggests for creating a common vocabulary to express key concepts and a language for relating them together. It provides a structured approach to recording and re-using domain knowledge to solve a set of typical problems.

A Pattern Language (Alexander et al, 1977) was the product of Alexander's dissatisfaction with the quality of contemporary buildings, for which he partly blamed a misapplication of formal methods to architectural design. This, he argued, resulted in buildings that failed to fulfil the real needs of the people who lived and worked in them. Disaffected by what he saw as the failures of modern western architecture, Alexander looked to buildings created in other societies which contained what he described as 'the quality without a name' (Grabow, 1983). This recognisable but indefinable quality embraced feelings of being 'alive', 'whole', 'comfortable', 'free', 'exact', 'ego-less' and 'eternal'. Patterns are conceptual tools for helping people design buildings that might have these qualities (Pemberton and Griffiths, 1998).

Alexander's book has helped the software community to create a body of literature aimed at resolving recurring problems encountered throughout all software development. The theoretical value of Alexander's observations is based on the idea that by understanding the rules that govern any design process, we can formalise optimum solutions and improve the quality of the resulting systems. Pemberton and Griffiths (1998) state:

> *'[Patterns] could enable designers to benefit from the knowledge and experience of creators of successful systems, providing reusable templates adapted to fit the particular issues which the designer is addressing. Above all, patterns, because they are themselves alive and engaging, provide a means of communicating either between designers of similar artefacts, e.g. one architect to another, or designers looking at reshaping the environment at quite different levels, e.g. furniture designer to interface designer'.*

Thus, patterns are not only useful within a given field of design; they are also capable of spanning the boundaries between different domains.

3.1 Patterns and Pattern Languages

A Pattern Language contains 253 pattern entries, each representing a common, concrete architectural domain. Each entry contains five parts consisting of a descriptive name of the architectural feature, an example (e.g. a description illustrating prototypical application), the context (a delineation of situations under which the pattern applies), a description of the problem (including relevant forces and constraints and how they interact) and a solution. The solution identifies static relationships and dynamic rules (microprocesses) describing how to construct artefacts according to the pattern, often listing several variants and/or ways to adjust to circumstances.

In IS terms, a pattern is a solution to a software problem that has been captured and

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

documented in a form others can understand and apply (Lea, 1993). Thus, in order to build a complete application a pattern language is required, consisting of individual patterns plus a network of connections among the patterns showing how they may be combined together. Like the English language, a software pattern language should allow for the generation of infinite combinations (Grabow, 1983).

Alexander's argument is that an apparently creative process is governed by an underlying set of rules or constraints:

> *'Once you admit that the rules are generative, then you have sort of got right to the heart of the creative core and one starts to wonder what exactly is the role of the creator in all this. A generative system is one in which the interaction of the rules and nothing else will create the thing. There is no immediate force of any kind'.*

Alexander's view that the patterns in the environment are generated by a language-like system of rules, or *pattern language* is, however, controversial because in his own words:

> *'The idea that the structure comes from these languages rather than from the creative brilliance of designers is initially repulsive.'*

More specifically, he states:

> *'Architects imagine they are creating buildings and, by extension, towns or parts of towns and that these entities are the products of the fertility of the imagination. To have a theory which claims that there are these systems of rules that we, by embodying these rules, produce particular versions of the structure implicit in the rules - but no more than versions – and that it is really the implicit structure which governs, is pretty much a shock to the ego.'*

In OO software design, rules and constraints will often be an explicit requirement of the system and may be seen to generate a fewer range of possibilities. Perhaps the reason why Alexander's work has won more friends in the OO design world than in the architectural community is that software designers are more aware of the rules that govern the design process.

Although Alexander never formally defined the term *pattern*, a number of common properties have been identified for use in software design (Lea, 1993). The patterns movement is now active in systems development, design (Gamma et al, 1995) and more recently in systems analysis (Fowler, 1997).

For example, interface design uses many metaphors associated with physical activities. Command line interfaces were based on a metaphor of conversations. The graphical user interface has made these metaphors become increasingly 'spatial' with desktop objects such as folders, file storage and reference facilities, windows and wastebaskets being common examples. These kinds of parallels suggest that Alexander's pattern language should lend itself well to developing patterns for interface design. In Pemberton and Griffiths' view, the specific value of Alexander's approach for interface design is that it supersedes HCI style guides because it acknowledges that whole patterns are being recorded.

In terms of patterns used to describe functionality, Pemberton and Griffiths (1998) state that

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

designers should aim to build systems which incorporate just those functions which help a user to do what they want. This accords with Alexander's view of building design patterns aimed to serve user functionality. A basic functional pattern could be an element from a requirement specification document together with a rationale from systems analysis or a workplace study. In ergonomic design terms, general solutions can be implemented to fit specific situations.

Setting out patterns in the way that Alexander intended thus provides a richer resource for the systems designer than a simple list of guidelines. The way that Alexander-style patterns should be created is with reference to experiences of success and failure and through user involvement (Grabow, 1983). In fact, Alexander's book, A Pattern Language (1977), was specifically designed to allow users to participate in the design process.

Alexander's observations are undoubtedly interesting in the sense that they challenge traditional notions of creativity being subject only to the artistic whims of the designer. A critical response to Alexander's work could be one which recognises the range of possibilities generated at each stage of the design process as quickly becoming so infinite that methodically recording each problem and solution would be impractical. However, is there anything further we can learn from the Alexander?

3.2 Alexander and Failure

The search for producing a formalised recipe for producing successful design was to preoccupy Alexander for much of his career. In 1994, at the *Doors of Perception Conference* on architecture, Alexander spoke about the lack of progress that had been made in formalising the qualities for which he had looked so hard. He stated:

> *'In my view, the biggest problem in architecture in the 2nd half of the 20th century is the connection between people and the physical world - the building of streets and so forth. Essentially, what we miss right now is the connection that one would call 'belonging' or possession in the true emotional sense'.*

An interesting question stems from Alexander's speech. If we re-write the paragraph above and substitute the phrase 'Physical World' with 'Virtual World' and the word 'Streets' with 'Information Systems' we begin to consider whether the qualities of 'belonging' or 'possession in a true emotional sense' are ones that we would or could expect to see in the virtual office.

The reason why Alexander wrote *A Pattern Language* was that he was disaffected with much contemporary architecture that in his view lacked 'the quality without a name'. Patterns were intended for use as conceptual tools for helping design buildings that might have these qualities.

Alexander's approach to indicating a possible solution to these problems was one that might well be regarded as stakeholder-focused in IS terms. He felt that contemporary methods fail to satisfy the requirements of individuals and society, fail to meet the real demands of real users and ultimately fail in the basic requirement that design and engineering improve the human condition (Lea, 1993). *A Pattern Language* (Alexander et al, 1977) sought to resolve these issues by making the design process more available to users.

However, Alexander's own patterns were not sufficient to incorporate these absent qualities into the designs of those that followed his instructions. Alexander himself admitted that in

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

relation to producing 'the quality without a name', his work 'actually did not accomplish anything' (Grabow, 1983).

Although Alexander failed to produce a prescriptive framework for creating design that satisfies his own perceptions of 'quality', he did identify a number of categories of specific failure which could be used in a formal approach to evaluating the built environment.

In *Notes on the Synthesis of Form* (1963), Alexander identified a number of specific failings of building design:

1. Inability to balance individual, group, societal and ecological needs.
2. Lack of purpose, order and human scale.
3. Aesthetic and functional failure in adapting to local physical and social environments.
4. Development of materials and standardised components that are ill suited for use in any specific application.
5. Creation of artefacts that people do not like.

Could Alexander's insights into the failure of his Pattern Language to create designs that incorporate the qualities he originally felt were absent be applied to IS design? If Alexander's work has been beneficial to the software design process and if the analogy between physical and virtual office spaces is valid, it would seem reasonable to consider the extent to which the specific failings of building design above might be relevant to IS design.

Selby (1999) argues that the primary intention of Alexander's work was to benefit end users and that a comparable approach in IS terms would be a stakeholder model of IS evaluation. His thesis is that, like the concepts of physical and virtual office spaces, the broad concept of "failure" as defined by Alexander (1963) and Lyytinen and Hirschheim (1987) are also interchangeable.

Lyytinen and Hirschheim's (1987) stakeholder model of IS failure is subdivided into four categories.

1. **Expectation Failure** which arises from 'the inability of an IS to meet a specific stakeholder group's expectations' and is a superset of all the other classes of failure.
2. **Correspondence Failure** which occurs where design objectives are not met.
3. **Process Failure** which embraces two aspects of unsatisfactory performance: firstly, where no workable solution has been produced and secondly where an IS has been produced but has over run in terms of cost.
4. **Interaction Failure** which is related to poor levels of user satisfaction or acceptance.

Selby (1999) argues that, when looking at the five categories of failings identified by Alexander, there are a number of striking parallels with the stakeholder model of information systems failure described by Lyytinen and Hirschheim (1987).

Expectation failure, being a superset of all other failures, can naturally be related to all of those failings identified by Alexander. For example, Alexander's fifth category (creation of artefacts that people do not like) will become an expectation failure if users expect to like the new system but later object to it in some way. Given the similarities in the expectations of how physical and virtual office spaces should perform, expectation failures in both domains should occur in similar circumstances.

Similarly, correspondence failure may be linked to Alexander's third category (aesthetic and functional failure in adapting to local physical and social environments) as well his fourth

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

(development of materials and standardised components that are ill suited for use in any specific application). This is because, although the intended design may be valid, its execution causes it to fail in some way.

Process failure, where the benefits of any workable system are negated through overrunning targets is not explicitly linked to what Alexander identifies as architectural failings. However, lack of purpose (the second category) and lack of balance (the first category) would definitely be implied by a process failure. Process failure in IS terms is largely concerned with the risk of projects creating huge costs for the buyer in which case its economic benefits are lost. Although Alexander may not specifically refer to cost issues, economics is an important issue on the agenda of any business organisation deciding on office designs.

Finally, interaction Failure, where a system fails to be used can be closely linked to Alexander's fourth and fifth categories. The reason for lack of interaction is likely to be that the system is ill suited for use, or, that people simply do not like it. By implication, the other three categories could be a cause of interaction failure too. Thus in category 1, if individual needs are neglected, acceptance among some may be poor.

Having established a possible link between the broad concepts of "failure" as defined by Alexander and Lyytinen and Hirschheim, Selby (1999) tests these through interviews with of a senior designer in a software company and an architect working for a major development company. The interviews were structured around a number of written scenarios designed to translate the conceptual nature of either Alexander's or Lyytinen and Hirschheim's failure categories into situations that allow the interviewees to respond as if they were faced with these issues in real-life.

The analogy between Alexander's five categories of architectural failings and Lyytinen and Hirschheim's four IS failure types can be summarised as follows:

Lyytinen & Hirschheim	**Alexander from Notes on the Synthesis of Form**
Expectation Failure	• Aesthetic and Functional Failure in adapting to local, physical and social environments • Development of materials and standardised components that are ill-suited for use in any specific application • Inability to balance individual, group, societal and ecological needs
Correspondence Failure	• Lack of purpose, order and human-scale • Aesthetic and functional failure in adapting to local, physical and social environments
Process Failure	• Inability to balance individual, group, societal and ecological needs.
Interaction Failure	• Development of materials and standardised components that are ill suited for use in any specific application. • Creation of artefacts that people do not like.

The results of these interviews helped to clarify some of the implications of the different failure types. Each interviewee stated that failure notions in the other's field of practice would be regarded as a failing in their own area of work. Thus the architect stated that he would regard all

of Lyytinen and Hirschheim's IS failure types as applying to building design in some form. Similarly, the software engineer stated that all of the scenarios presented to reflect Alexander's perceived failings in building design were applicable to IS development. The analogy thus proved to be valid taken from both perspectives. Furthermore, measures taken to prevent failure, as well as the difficulties confronting practitioners in identifying failure, also showed similarities between the two fields.

For example, in the case of expectation failure, the architect stated that walk-through visuals were used, which was similar to the use of prototyping in IS development. Furthermore, consultation with ultimate users was an essential part of the development process according to both interviewees, although it appeared that architects had developed more established methods for identifying preliminary expectations.

The issue of using 'standardised components' according to both interviewees was a way for allowing for change later. It allows buildings to be refitted every five years and allows for rapid application development in IS. Certainly, if the result were 'ill-suited' for any specific application, it would be useless in both physical and virtual office spaces. The built-in ability to modify the design was a clear feature of both design areas. The IS practitioner stated that his designs could be easily amended post-implementation where there was an imbalance of stakeholder needs and the architect indicated that it was an essential requirement that offices could be refitted later. Therefore, standardisation of components could be of benefit to the client if used appropriately for providing flexibility.

Both interviewees agreed that the client might also represent a barrier to successful design under certain circumstances. IS development may be constrained by a rigid requirements briefing, thereby leading to an 'inability to balance individual, group, societal and ecological needs' and process failure may be caused in a situation where the client's demands change almost daily.

Finally, aesthetics were also an issue in both domains. Aesthetic and functional failure is an issue in IS interface design, as it is in the design of office buildings. An appropriate interface or aesthetic appearance will fulfil user expectations and correspond with their requirements.

4 CONCLUSIONS

This paper provided a further example of how insights into the field of IS can be gained by looking at the area from the perspective of another academic discipline. It has argued that, in order to improve their work, the designers of information systems (IS) can learn from the experience of others outside their field.

The empirical work has shown that the failings in both domains need to be seen as a whole so that together they represent what are seen as failings in each field. It is within this context that this research has shown the analogy to be valid. The fact that both practitioners regarded all failure types in the other's domain as being relevant provides strong evidence that there is a clear link between the objectives of physical and virtual office spaces. In particular, it has been of value in identifying, more accurately, how IS might fail. However, it would be unrealistic to suggest that the results of the work provide an absolute and straightforward correlation between

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

failure in the built environment and the virtual environment. For example, several elements of a given Alexander category may be seen to correlate with just one IS failure type.

A quality was mentioned by Alexander, 'the quality without a name', which he hoped to see in successful building design, is not specifically identified by Lyytinen and Hirschheim. The authors believe that this area deserves further research. In terms of IS literature, a sense of 'belonging', to an organisation or to an identifiable group of people, is related to the need for the virtual office space to support certain kinds of work (Conkar et al, 1999) and forms of work organisation (Hildreth et al, 1999). However, if it can be shown that these are distinct qualities and that should become a feature of the virtual office, this might suggest the need to establish a further fifth category of IS failure to be included alongside those described by Lyytinen and Hirschheim.

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

REFERENCES

Alexander, C (1963) Notes on the Synthesis of Form. Harvard University Press.

Alexander, C (1995) Doors of Perception. Http://www.mediamatic.nl/Doors/Doors2/Alexander.

Alexander, C, Ishikawa S, Silverstein M, Jacobson M, Fiksdahl-King I and Angel S (1977) A pattern language, Oxford University Press, New York.

Bedford, M and Tong, D (1997) Planing for Diversity: new structures that reflect the past. In Worthington, J (1997) Rethinking the Workplace, (Institute of Advanced Architectural Studies, University of York) Architectural Press.

Conkar, T; Noyes, JM & Kimble, C (1999) CLIMATE: A framework for developing holistic requirements analysis in Virtual Environments. Interacting with Computers 11 (1999) 387-402.

Eley, A and Marmot, F (1995) Understanding Offices: What Every Manager Needs to Know about Office Buildings. Penguin

Fowler, M (1997) Analysis patterns reusable object models, Addison-Wesley, Menlo Park, CA.

Gamma, E, Helm, R; Johnson, R; and Vissides, J (1995) Design patterns elements of reusable object-oriented software, Addison-Wesley, Reading, MA.

Grabow, S (1983) Christopher Alexander: The Search for a New Paradigm in Architecture. Oriel Press.

Harris, R (1997) Real Estate and the Future. In Worthington, J (1997) Rethinking the Workplace, (Institute of Advanced Architectural Studies, University of York) Architectural Press p. 39.

Hildreth, P; Wright, P and Kimble, C (1999) Knowledge Management: are we missing something? Proceedings of 4th UKAIS Conference, April, University of York, McGraw Hill, pp 347 - 356.

Jenkin, D (1997) Emerging Building Forms. In Worthington, J (1997) Rethinking the Workplace, (Institute of Advanced Architectural Studies, University of York) Architectural Press, p.152.

Khazanchi, D and Munkvold BE, (1999) Is Information Systems a Science? Proceedings of 4th UKAIS Conference, April 1999, University of York, McGraw Hill, pp 1 - 13.

Kimble, C, Hildreth, P & Grimshaw, D (1998) The role of contextual clues in the creation of Information Overload. Matching Technology with Organisational Needs, Proceedings of 3rd UKAIS Conference, April 1998, Lincoln University, McGraw Hill, pp 405 - 412.

Lea, D (1993) Christopher Alexander: An Introduction for Object-Oriented Designers. http://gee.cs.oswego.edu/dl/ca

Li, F and Williams, H (1999) Organisational Innovations through Information Systems: Some Lessons from Geography. Information Systems - The Next Generation. Proceedings of 4th UKAIS Conference, April 1999, University of York, Pub McGraw Hill 1999, pp 471 - 487.

Lyytinen, K and Hirschheim, R (1987) IS Failures - A Survey and Classification of the Empirical Literature. Oxford Surveys in IT volume 4, pp 257-309.

Mingers, J and Stowell, F (1997) Information Systems: an Emerging Discipline, McGraw Hill, 1997

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6

Mutch, A (1999). Managers and Information: Agency and Structure. Information Systems - The Next Generation. Proceedings of 4th UKAIS Conference, April 1999, University of York, Pub McGraw Hill 1999, pp 51 - 61.

Pemberton, L & Griffiths, RN (1998) The timeless way: making living co-operative buildings with design patterns, Co-operative Buildings. Integrating Information, Organization, and Architecture. First International Workshop, CoBuild'98 Proceedings. Springer-Verlag, Berlin, Germany; pp. 142-53.

Selby, W (1999) Evaluating Information Systems Using Christopher Alexander's 'Notes on the Synthesis of Form', MSc Thesis, University of York.

Stone, P and Luchetti, R (1985) Your Office is Where you Are. In Harvard Business Review March-April, 1985.

Van Meel, de Jonge and Dewulf (1997) Workplace Design: Global or Tribal? In Worthington, J (1997) Rethinking the Workplace, (Institute of Advanced Architectural Studies, University of York) Architectural Press p.50.

C. KIMBLE. & W. SELBY. - An Interdisciplinary study of Information Systems: Christopher Alexander and IS Failure. Proceedings of 5th UKAIS Conference, , University of Wales Institute, Cardiff, McGraw Hill, April 2000, pp 256 - 265. ISBN - 007 709755 6