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ITP4517

An Object Oriented Architecture Model for International Information Systems? An Exploratory Study

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ABSTRACT

A case history of an Australasian international enterprise is analysed to detect the causal factors in the difficulties this firm had in attempting to implement a global information system throughout its subsidiaries. A force field structure emerged in the case, as a forum for conflict between business users and information technology people. These conflicts were never resolved and the global information system was never implemented in its intended form. At the heart of the conflict was the inability of both parties to agree a split between application systems imposed by the centre and those for which the local offices would be responsible. A two-dimensional topology emerged as possible architecture paradigm conducive to forestalling such conflicts. The architecture model is furthermore useful as a design vehicle for participatory and consensual building of an international information system. Object orientation is investigated as the fundamental design principle. For enabling implementation differentiation and future changeability, it is conjectured that object technology is the optimal development strategy for international information systems. Directions for further research are outlined.

INTRODUCTION

Purpose of the paper

Information systems technology is often critical to the international operations of the globally oriented firm, either as the key to its expansion, or even as the main profit driver. Despite their obvious importance transnational information systems technology is still "largely unreported [and] unstudied" (Cash, McFarlan & McKenney, 1992) and "..generally ignored." (King & Sethi, 1993). While scholarly research into this field is sparse, there is an increasing amount of anecdotal evidence and technical reports indicating a strengthening interest by practitioners in this field.

This exploratory paper investigates whether there is a generic architecture common to international systems *sui generis* which would allow a more successful development approach.

Definition of 'International Information Systems'

The literature does not clearly identify a generally accepted term for information systems technology applied across borders. Often "global" is used (e.g. by Ives & Jarvenpaa, 1991), but "transnational" is also in general use (e.g. by King & Sethi, 1993) for such systems. The first inevitably invites associations of vast enterprises covering the planet, whereas "transnational" is open to possible confusion with the precise use of the term coined by Bartlett & Goshal (1989) for describing one specific style of a firm's operation in more than one country. In this paper, therefore, the term "international"[1] is used. Furthermore, to distinguish international information systems from other distributed systems, in this paper they are defined as

> *Distributed information systems that support similar business activities in highly diverse environments commonly found across country boundaries.* [2]

Structure of the Paper

The paper is structured as follows:

- First, the business strategies of global enterprises and their linkage with the structure of international information systems is discussed;
- Second, the notion of a specific architecture as the basis for the development methodology for international systems is evolved;
- Next, three case vignettes are examined to assess the usefulness of the suggested architecture model;
- Finally, the object nature of the architecture model and the need for object-orientation as the basis for the design of international information systems is set out and directions for further research are proposed.

GLOBAL BUSINESS STRATEGY AND INTERNATIONAL INFORMATION SYSTEMS

Strategies and management structures of global business

Many researchers of IIS architectures use a framework for the classification of enterprises operating in more than one country that was developed by Bartlett and Ghoshal in 1989.

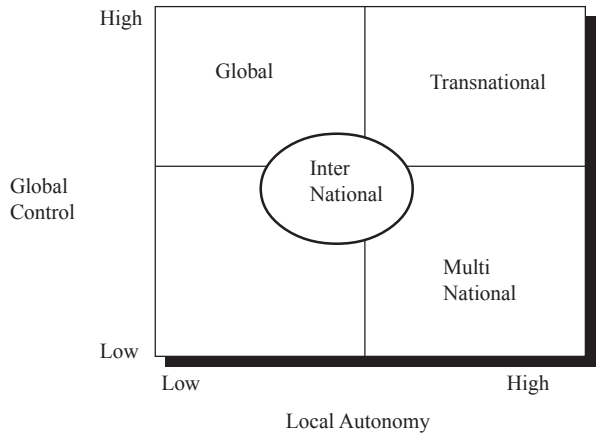
Their model, illustrated in Figure 1, is centred on the level and intensity of global control versus local autonomy:

- 'Global' means high global control while 'multinationals' have high local control;
- 'Internationals' are an interim state. transiting towards a balance of local and global;

'Transnational' organisations balance tight global control whilst vigorously fostering local autonomy. (Bartlett and Ghoshal, 1989). This strategy of "think global and act local" is considered optimal for many international operations.

Butler Cox (1991), furthermore, put a developmental perspective on the Bartlett-Goshal framework. While they use a different terminology, companies seem to become active internationally first as 'Exporter' of their goods or services - usually applying a *'Global'*[3] business strategy. Increased activity in any one location encourages autonomy for local operations, taking on the role of 'National Adapter', similar to the *'Multinational'* classification. In the next phase this degree of autonomy is counterbalanced by some global control as ' Central Co-ordinator', i.e. an *'International'* firm. Finally, as global operations mature, firms move towards a

Figure 1. Global Business Strategies



status of 'Global Co-ordinator' (equivalent to the *'Transnational'*). Figure 2 shows this migration.

This migration does not necessarily follow a set pattern of clear stages, nor does it move synchronously in all locations, or with all products, at the same pace[4]. Such a developmental perspective on global business strategies puts a strong requirement of flexibility to any systems architecture for international systems.

A SPECIFIC ARCHITECTURE FOR INTERNATIONAL SYSTEMS?

The literature is not conclusive on the link between the 'goodness' of systems architecture and the effectiveness of systems development approaches. However, the value of an 'infrastructure' (Weill, 1992 and Weill et al, 1994) of sufficient 'reach and range' (Keen, 1991) is accepted as essential for providing the flexibility to deal with future systems demands. Earl (1989) suggests that a typical information technology architecture (which he also defines as the prerequisite for such an infrastructure in Weill's sense) contains 'blueprints' for the development of application systems. It is thus safe to assume that establishing an appropriately specific architecture for international systems would have a beneficial impact on their development.

The structure of international systems in the literature

Butler Cox (1991) also developed a model of IIS where there is a direct, one-to-one relationship between Bartlett and Ghoshal's global business strategies and these systems architectures. They distinguish between:

- 'Centralised' systems;
- 'Replicated', i.e. copies of one central system;
- 'Autonomous', local systems;
- 'Integrated' systems developed at local and central sites.

Other researchers propose similar relationships between information systems structure and global business strategy. Karimi et al. (1993) describe (in the same sequence as above) 'centralised', 'inter-organisational', 'decentralised' and 'integrated' architectures.

Sankar, Apte and Palvia (1993) define three global information architectures by the way their elements are linked, namely:

- Integrated (separate elements, logically connected);
- Centralised (together and connected);
- Decentralised (separate and disconnected).

Jarvenpaa and Ives(1994), in a study of organisational fit and flexibility in IIS, which is also supported by previous case studies (Ives and Jarvenpaa, 1991, 1992, 1994) describe a framework of 'Global Information Technology Configuration' which also maps directly onto the Bartlett Ghoshal typology. Table 2 contains a comparison of the four frameworks discussed:

It seems that just as the '*international'* business strategy is an intermediary stage, so are the corresponding global information technology configurations. If these replicated/inter-organisational/intellectually-synergised structures are regarded as embryonic 'integrated' architectures, then just three generic architectures could be defined, namely

- Centralised;

Figure 2. Migration through global business strategies

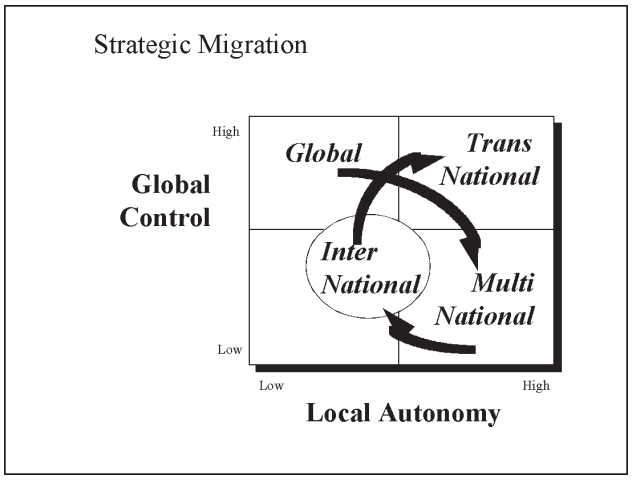


Table 2: Comparison of architecture styles/configurations identified in the literature

Bartlett & Ghoshal	Butler Cox	Kosynski & Karimi	Sankar et al	Ives & Jarvenpaa
Global	Centralised	Centralisation	Centralised	Headquarters-driven
Multinational	Autonomous	Decentralisation	Decentralised	Independent
International	Replicated	Inter-organisational	*(undefined)*	Intellectual Synergy
Transnational	Integrated	Integrated	Integrated	Integrated

- Decentralised (including autonomous and independent); and
- Integrated.

Whilst the centralised and decentralised structures have been researched over a number of years and are by now well understood, the nature of the 'integrated' structure/architecture has rarely been an object of empirical study

Research methodology

The dearth of research into the structure of an International Information Systems makes qualitative, case-based theory building methods an appropriate choice. Such methods are well established in organisational research and are becoming accepted in information systems research too (Benbasat et al, 1987, Galliers et al, 1987, Yin, 1989, Lee, 1989, Orlikowski et al, 1991, Zinatelli et al 1994). In particular, Eisenhardt (1989) describes the process of building theory, focusing especially on its inductive nature. In Sociology, Glaser and Strauss (1967) had already developed a specific inductive method which they termed the 'Grounded Theory' (GT) approach, where theory is left to 'emerge' from the data - in which it is 'grounded'. Turner (1983) was one of the first to apply the GT approach to management studies. Since 1984, GT had been used in a number of business studies (Glaser, 1995). Orlikowski (1993, 1995) has pioneered GT in Information System (IS) Research. Yoong (1996) and Atkinson (1997) are recent studies. Glaser and Strauss (1970) have also set out how to use grounded theory with cases, an approach that was selected for this research project.

The following section gives a - highly abridged - description of a case history where a large multi-national enterprise struggled to introduce a global system to all their offices.

CASE HISTORY: AUSTRALASIAN FOOD PRODUCERS' CO-OP

Background

The marketing authorities for land-based industries (such as fruit growers, meat producers, dairy farmers, forestry, etc.) are often large companies with strong international presence. The Australasian Food Producers' Co-op (later also referred to as the 'Co-op') with some $4.5bn[5] revenue is one of the largest of those. Like the others, the Co-op is a 'statutory mo-

Figure 3. The Co-op's migration of global business strategy

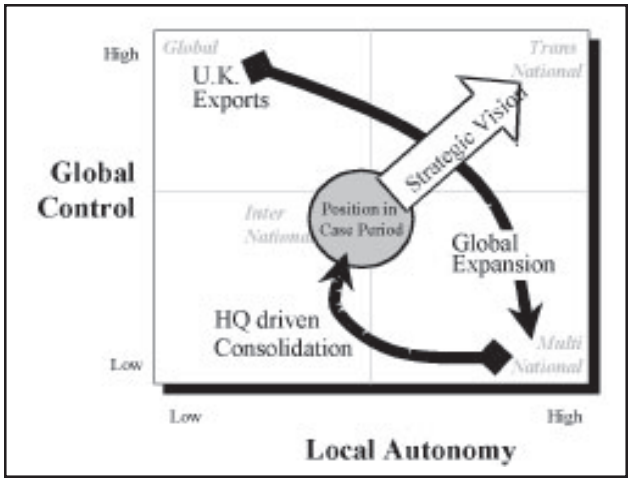
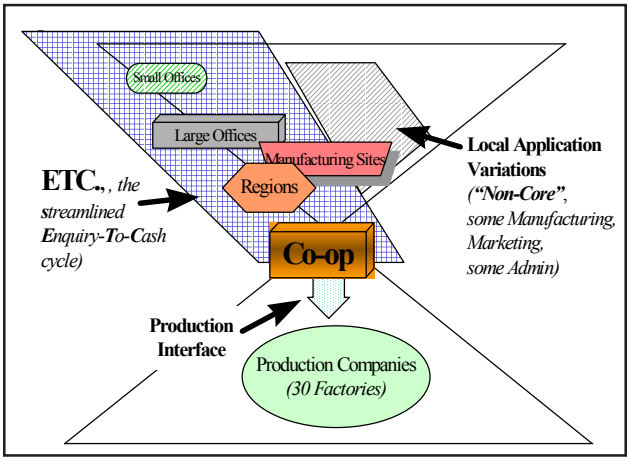


Figure 4. The "Core' and 'Local' components of the Global IS



nopoly', as there is legislation which prohibits any other organisation from trading their produce in international markets. With about a about a quarter from raw materials and manufacturing outside Australasia, the Co-op is a mature transnational operator. Structured into nine regional holding companies, in 1997 it has a presence in 135 offices in 40 countries.

The 15,000 primary producers are organised into 18 co-operative 'Production Companies' (ProdCos), in which the farmers own in shares proportional to their production. The ProdCos collectively own the Co-op. This tight vertical integration is seen as a big advantage. It allows the Co-op to act as one cohesive enterprise and to develop a critical mass needed in most of its major markets.

Business background

Prior to the mid 1970s Australasia exported the vast majority of its produce to the United Kingdom, who, under Commonwealth rules, used to accept it all. Once the UK had joined the European Union, however, they had to give free access to all other EU members, and cut the Co-op's quota severely. Australasia had to develop new markets. A number of subsidiary offices was set up rapidly and agencies were nominated in the US and Canada.

This policy of local autonomy was successful. Within a decade the Co-op had built a presence in more than thirty countries and had managed, throughout, to secure a satisfactory return for the all their primary producers.

At the onset of the 90s, however, competition for the Cop-op had become increasingly global. With the emergence of global brands (such as Coca Cola, McDonalds, etc.); the Co-op needed to develop global brands themselves and had to have sufficient command (and control) to mount synchronised international marketing and logistics operations. With the arrival of a new Chief Executive Officer in 1992 the Co-op began a concerted campaign to shift authority and control back to head-office, within a vision of balanced central control and local flexibility. Figure 3 above shows this development in terms of the Bartlett and Ghoshal classification.

Part of this new policy was a critical look at the role of information systems throughout the Co-op's operations.

The Global Information Systems Project

During the 'global' phase, the Co-op had built up a sizeable IS department with a mainframe operation at the head-office, linking up with all the main subsidiary offices and ProdCos throughout the country. Foreign activities were few and hardly needed computer support. The forced expansion drive in the 80's, however, lead to an increased need by local operations to be supported with information systems. By 1992 a number of regional offices had bought computers and software to suit their own, individual requirements

Against this background of a proliferation of uncoordinated local systems on the one hand and a declared policy of more control from the Co-op's centre on the other, the Co-op's IS Department, in April 1992 took the initiative to establish a "Framework for Information Systems".

This was going to be the basis for globally common technology, communications, data/information and application software standards, effective for all of the Co-op's 135 offices in 35 countries. Subsequently, late in 1992, the 'Food Information Systems Technology' (FIST) project was created by the IS Department to implement the 'Framework's' in three stages:

1. Development of a 'prototype' system with a representative site;
2. Implementation of the prototype in a small number of 'pilot' sites;
3. Synchronised 'roll-out' of the 'global system' into all the regions and offices.

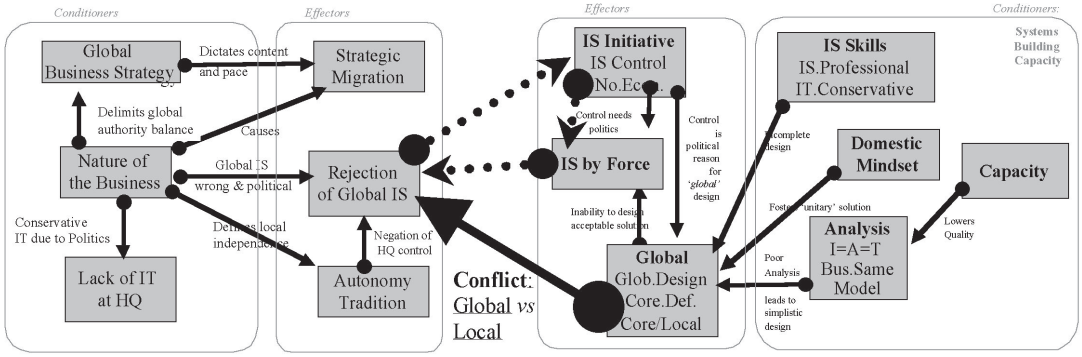
Estimated completion dates were late 1993, early 1995 and mid 1996 respectively.

In 1992 the North America region (NA) had started to embark on a review of its ageing IBM S/34. At the same time, Singapore was also looking to upgrade their fragmented PC-based installation to cope with the rapid growth in the region. Both sites thus became candidates for the development of the prototype and also as pilot sites for further implementation.

The Pilot Project(s)

The FIST team agreed to have selected technology, completed the prototype, tested and modified it as a pilot and to have gone live with the new system (which would at the same time be the first global system) by June 1994 - nine months hence. The requirements for NA were set out as a 'benchmark' for all other sites. However, Singapore were quite concerned when the FIST team restricted itself to comparing the 'benchmark model' with the South East Asia region and found a "90 - 95% match". Subsequently, Singapore opted out of the Pilot because they felt that as North America's predominant business is in the industrial produce market, this would not at all fit South East Asia ("nor Europe, for that matter"), as their scope of business mainly covers the consumer and food manufacturing markets. He was also very critical of what he called the "top-down-approach" taken by FIST. With very little participation by the regions, he

Figure 5. Force Field of Business and IT Dynamics: Interplay of main categories and relations



feared the systems would be missing the actual requirements of the local business - "just like the other past failures of the Computer Centre". By the end of 1993, North America was therefore the only pilot site.

As the North America pilot missed the June 1994 deadline, a Request for Proposal (RFP), asking for firm quotes for software, hardware and communications technology to be used internationally in the Co-op's 130 offices in 35 countries, was issued to ORACLE, IBM and UNISYS. After a rapid evaluation by the FIST team with some North America input, ORACLE was chosen as the main provider for data base middleware and, together with DATALOGIX, for applications software. Hardware and communications technology was not selected. At the same time**,** the 'benchmark model' was now compared with Europe and another "90% to 95%" match was experienced. However, as the regional manager Europe remarked: "These models are so general, they'd make Disney look like us." The European region subsequently opted out of the FIST programme.

At this stage, to counter the mounting resistance to one global, standard system for every subsidiary office, the FIST team began to look at what applications should be the same throughout the Group and which could be different for local subsidiaries.

The outcome of these definitions was a re-formulation of the 'standard' global system which has the main business operation ETC (the "**E**nquiry **T**o **C**ash") as the framework for the 'Core' information systems. This then leaves a residue of loosely defined "manufacturing and marketing operations "as the 'Local' applications to be selected by each office individually. Figure 4 below depicts this.

Thereafter, the FIST team began with the implementation of the software in North America in September 1994 - and immediately encountered serious problems: The manufacturing and distribution modules would not conform with the business processes they were selected to support. The changes were estimated to cost $1,8m.

However, Oracle were negotiating with Datalogix about absorbing the Datalogix Distribution modules into their own ones. For the duration of these negotiations no work on the software was done. By mid 1995 North America reached an agreement to abandon the pilot efforts and to alter its software so that it reflected their local requirements.

In early 1995, the Co-op decided to open a new office in the Middle East region, in Dubai and by mid 1995, there were 12 people in the office. To replace North America, the FIST team selected Dubai as the new pilot site to test out the common global system for the Co-op. The first installation was going to be the 'standard' Oracle Financials together with business procedures defined around the system. The first target date for completion was September 1995. However, for want of adequate local support, the systems could not be developed on site - it was therefore decided to develop the first prototype at head office. In November 1996 the standard Oracle Financials were handed over to Dubai as a working system.

Developments concerning FIST at the head office

The major difficulties with the FIST project, especially the missed deadlines, the significant costs (by 1995 approx. $ 8m) without any noticeable results began to attract the attention of the CEO. Furthermore, the refusal by two major regions to accept the FIST system (because no agreement could be reached on the functionality of the system) put the effectiveness of any resulting system in question. In mid 1996 the CEO commissioned a large, big-Four consulting firm to evaluate the FIST projects. Their report was critical of FIST as being overly ambitious and not achievable within the time frame or the existing project set-up. Specific points raised as the causes of the negative prognosis were:

- the inability to achieve a consensus on the functionality of the system;
- inability to agree which parts of the system would be controlled by HQ and which parts were to be managed by regional/local management;
- inability of the proposed information technology structure to support the variety of sites, uses and user-literacy throughout the Co-op's international offices.

This proved to be a turning point: The CEO re-aligned the IT portfolio - and with it FIST - into the Finance department, whose General Manager had been an open critic of the project for a long time. As early as March 1995 he had called for a critical review of the "real" reasons for wanting to spend $21m and had advocated that business reasons should drive the project, not technology. In his first meeting with the FIST team he terminated the project and called for a broadly based study of global versus local information technology strategy.

FINDINGS AND INTERPRETATION OF THE CASE

The analysis of the case is based on interviews with key management and staff of the Co-op in Australasia, North America and Europe. Furthermore, a selection of internal documents (memos, minutes and reports) was used to underpin and extend the information gathered in the interviews.

Coding the interview transcripts (some 400 pages) and the supporting documentation (93 documents, combined of some 2500 pages) yielded an initial set of 133 basic, 'substantive' categories in the terminology of Glaser & Strauss (1967). These were then conceptualised, condensed and affiliated into 27 major categories. From those, 13 'core' categories were developed.

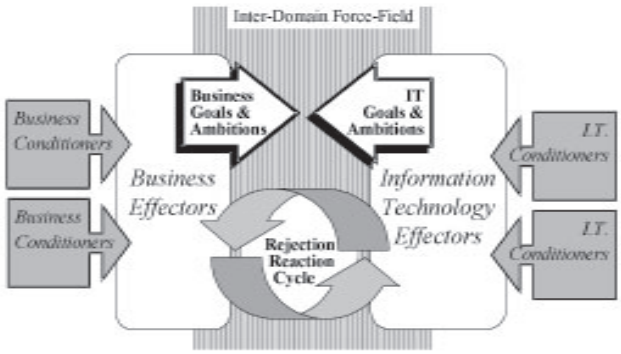
Glaser & Strauss, (1967) see theory as a process, in which 'categories' – the key influence factors - act upon each other in the form of 'relations'. Categories are directly grounded in observed fact, whereas 'relations' are conceptualised by inference from the unfolding story in order to bring to it a temporal, correlational; or even causal order.

The core categories found in the Co-op case fall into two domains, depending on whether the category stems from the business or information technology arena. In both domains the factors contributed to considerable dynamics in the interplay between categories.

The relations between the categories are analysed in detail elsewhere (Lehmann, 1998 and 1999). In this study, the main emphasis was placed on the interaction between the business and information technology domains and its causes.

Whilst most of the categories affect each other in a number of ways, the two dynamics domains seem to set up a force field (in the sense of Lewin, 1952), as an arena for the interactions between the business and information technology interests. The force field is dominated by the interplay of two key categories. The major interplay is between the Global Design category, which is a causal factor in the business Rejection of the

Figure 6. Essentials of the Force Field demonstrating the clash of opposing interests and the resultant destructive cycle of Business rejection and IT reaction



Figur 7. Vectors of Strategic Thrust in the Co-op

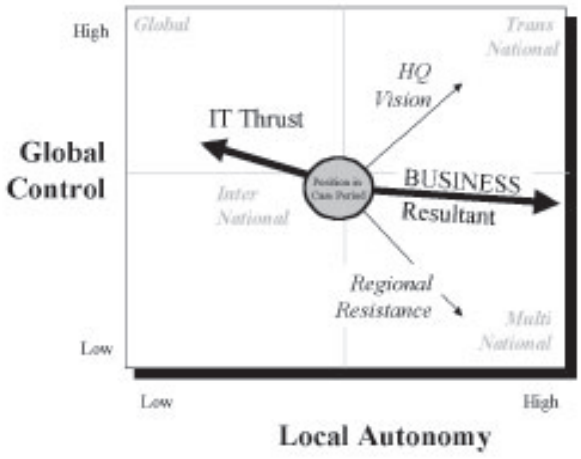
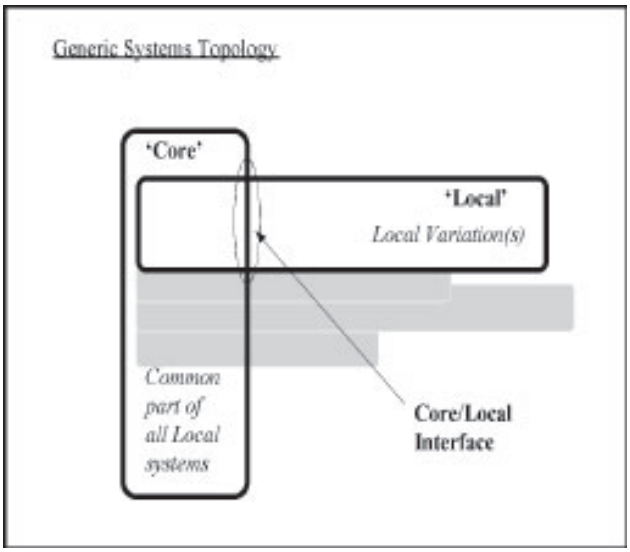


Figure 8. The generic 'Core/Local' topology. The local implementations of the 'Core' and the extent of their local systems varies from site to individual site (indicated bt the grey area)



Global System. Figure 5 below illustrates this.

The interactions between the opposing sides of the force field were driven by the confrontational stance of business and IT across a range of issues, characterised by antagonistic self-interest of both central and regional business entities versus the information technology faction. The antagonism was further aggravated by the absence of a framework that would have allowed the warring factions to accommodate and settle their conflict constructively.. The forces acting in that field were of considerable magnitude and eventually engaged the opposing sides in a cycle of rejection and reaction which in the end proved strong enough to stop the information systems project altogether. Figure 6 below depicts the essential dynamics of the force field.

The initial refusal of the business to accept or implement the global system in turn lead to an intensification of the IS Initiative category. This was especially the case after the initial attempts to incorporate business objections into the Global IS Design had floundered. The information technology people reacted to the business side's lack of co-operation by using political power play to achieve user acceptance and facilitate implementation of the global system.

The roots of the confrontation, the inappropriateness of the Global IS Design, however, has itself a deeper cause. The character of the system as an unbending standard design for all, without regard for differences in size, business culture, markets or strategies was seen by the regional business people as an attempt to roll back their autonomy and re-introduce

Figure 9. The standard INGREDIENTS MIX 'message' acts on all objects, taking country variations into account.

central control. Depicted as vectors, the respective strategic thrusts of the actors are shown in Figure 7.

The absence of a framework capable of accommodating such diametrically opposed functionality structures perpetuated the feud between business and information technology people and eventually ended the project altogether. A possible constructive resolution would have been an architecture for the application systems in the IIS, which recognises these opposing forces.

An architecture model for international information system

That there needs to be variation in international systems to accommodate differing local needs has been established early on by Buss (1982), when he found that using 'common' systems across different countries can be fraught with difficulty. However, a common sense deduction from this is the obvious requirement that such systems would have parts that are common to all sites and other parts, which are specific to individual localities. The basis of this concept, ie the need for variation in international systems to accommodate differing local circumstances has been established by Keen et al. as early as 1982, when a paradigm of a 'common core' of information systems applications with 'local' alterations was first articulated. There has been little further development of this model as far as the functionality of application systems is concerned and researchers conclude that "the literature offers little guidance for...local versus common applications"(Ives et al, 1991).

Building on 'lived' experience in the development and implementation of IIS, a two-dimensional topology systems has therefore been postulated (Lehmann, 1996a;b) as an architecture model for international information systems. The topology consists of a 'common core' and 'local variations' of the system, linked together by a 'core/local interface', as shown in Figure 8 below.

The Core's main purpose too is "to provide a stable base to ensure that applications can be implemented in the right balance of functionality to adapt optimally to local culture and provide at the same time the required level of global control

The 'Local' systems elements are the ones unique to the local site. In

Figure 10. The PAYMENT transaction is applied differently in each country, although the accounting module/object is a global standard

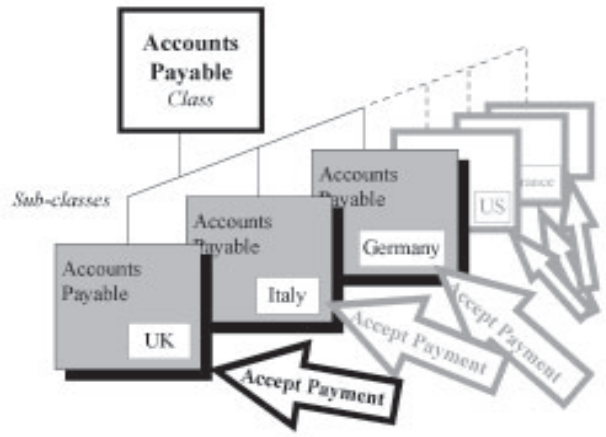
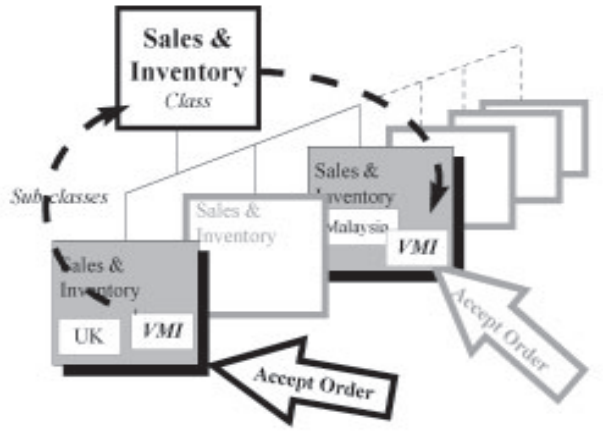


Figure 11. The Vendor-Managed-Inventory system enhancement (developed locally in the UK) would become part of a SALES & INVENTORY object class - and thus instantly available to e.g., Malaysia (and others, if they choose to adopt it).



Weill's (1992) model, however, each elements would be defined twofold: Once in terms of its own functionality and then in terms of the interface with its correspondent part in the 'Core';

In practical terms, the model therefore consists of three parts, namely the 'Core' the 'Local' systems structures and the 'Core/Local Interface' which links them together.

AN IMPLICIT OBJECT ORIENTATION OF THE ARCHITECTURE MODEL?

CSC (1995) in a case study of the way in which a number of multinational firms deals with the issues of global information systems versus local business requirements summarise that building systems to satisfy a multiplicity of diverse business needs can take two different forms:

- The 'core' system is formed around the '*lowest common denominator*'[6] of all the requirements (i.e. the sum of all local business system needs) in system building terms, however, this can be a disappointingly small proportion of the overall information system;
- The opposite stratagem, in CSC terms '*the grand design'*, attempts to specify a system which contains all the requirements of all local and global business units and agglomerates them into one information system; in mathematical terms this may be called the 'lowest common multiple' - and such a number can be alarmingly large. CSC point out that – just as the Co-op's case - some of the more spectacular information systems failures fall into this category: during the systems development time the business changed so much that there could never be a 'final version' of the software.

In mathematics, however, there is a third possible stratagem for finding common elements among divergent number sets - multiples of common prime factors. In systems terms, these would be 'components' in the form of building blocks that would be used to assemble systems. The 'components' would carry the *global* standards, but their assembly could then follow individual *local* requirements. Information systems built in this way would satisfy both 'common' and 'local' needs and would avoid the conflicting trade-off stance altogether.

Such 'prime factors' for the establishment of global commonality can be implemented in three forms:

1. as infrastructure to enable common basic applications in this way, global standards are implemented in a form which would be immediately useful for the local business unit;
2. as a 'design template', i.e. a set of design outlines and specifications for the global standard part of an application, from which the individual local systems can be built;
3. as software components;

Both design templates and actual software components will consist of data and processes - defining them unambiguously as *objects*.

The benefit of 'Object' qualities for 'Core' systems elements

Three key qualities of object orientation with respect to the common/local issue in international information systems are discussed below:

1. Objects are defined as *encapsulating* both data and processes/functions in one unit. This combination makes them very useful for vehicles of 'global;' standards, incorporating both data/information standards as well as 'prescribing' standard ways of operating.
2. Objects communicate with other objects using 'messages'. *Polymorphism*, defined as the capability of objects to deal differently with identical messages, is an essential quality for implementing 'local' requirements onto standard processes. An example from the Co-op case would be the ingredients mix for the local varieties of globally branded. Figure 9 depicts this.
3. *Inheritance* is the quality of objects to structure themselves hierarchically into 'super-classes and sub-classes pass 'down' characteristics (data and/or processes). This has two main uses in the global/local dichotomy:

(a) Consider 'Payments' transactions across the Co-op's international subsidiaries, as shown in Figure 10 above. Whilst the gist of payment processing (application into a ledger, cash-book/bank reconciliations, etc.) is common, the operational detail of the payment process is not. Each 'local' object would inherit the common processes from a standard Accounts Receivable module, but implement typical local payment types (e.g. 'Fedwire' transfers in the US, Direct Debits in the UK, Bank-Account-Transfers in Germany, negotiable promissory notes in Italy, etc.);

(b) The second use would be the introduction of new functionality across the organisation - be they new and/or updated global standard/common data and process prescriptions or new operational software developed for local needs in one site but - perhaps - useful elsewhere. The Co-op's UK subsidiary developed a system of vendor-managed-inventory (VMI) with a large supermarket chain whereby the supermarket would pay for goods sold on the basis of their own point-of-sale records, without orders or invoices involved: the Co-op would replenish their wares in their allocated space as they saw fit. Implemented in object-oriented form, this functionality would have been instantly available to all other local sites through *inheritance* from the Sales & Inventory object (Figure 11 below).

The advantages of using an object oriented approach to the design/definition of the common and local parts of an international information system are, however, not restricted to the building of the system. As Butler Cox (1991) postulate, the business style of multinational enterprises is fluid and changes with their development. Moreover, King and Sethi (1993) demonstrated that multinational enterprises are hardly ever homogenous - they work at the same time in different modes and at differing degrees of 'penetration' into the 'Local' systems of different countries (e.g. applying a 'global' style in small subsidiaries and a 'transnational' style in larger, more sophisticated local environments). The ease and flexibility with which an object oriented information systems architecture can be maintained and changed would certainly seem to make such an object oriented approach an essential design consideration.

Conclusion

The - sparse - literature on international information systems has lead to the definition of a proposed architecture model consisting of a two-dimensional topology, which describes any international information system as consisting of a common 'Core' and 'Local' variations in each individual, subsidiary, site. This generic structure model has been shown to be a practical and flexible tool to describe and understand data from a case history about an international firm's problems with designing and implementing international information systems acceptable by local and central users.. . The case further showed that the requirements for an architecture framework are a pre-requisite for creating an acceptable design. Together with professionalism and in-depth understanding of international issues such a framework is essential for the building and implementing steps within an international information systems project. Absence of any of these ingredients seems conducive to establishing an environment for antagonistic political interaction in a 'force field', which is unproductive and does not further the implementation and acceptance of the international information systems. Engaging in political battles, especially, could be seen in the case as detracting from the objectives of the exercise and ultimately resulted in the demise of the project altogether.

It also seems to fit in well as an explanatory construct and candidate for a more extensive theory of international information systems. It may therefore be concluded that the postulated architecture model may well be of use as a paradigm for future research into the structure of international information systems. In order to start formulating a more detailed – and verifiable - theory, however, a number of the categories need more detail before they. are 'saturated' in terms of the grounded theory methodology. 'Theoretical sampling' for similar or contrasting cases needs now to occur to make this possible.

Because the architecture model prescribes a way of structuring international information systems it could also have significant implications for the modus of developing them. Using it as a framework for the building and implementation of international information systems would allow in the first instance a systematic accumulation of a body of knowledge about this process and in the second instance enable a modular and parallel systems building approach, as "Core' and 'Local' systems and their interfaces could all be developed with significant independence. This could make the development process more predictable, shorter and less risky. The two-dimensional structure *eo ipso* could also provide for in-built flexibility for gradual future enhancement.

The 'goodness' of the design for an international information system seems to hinge on how well the 'Core' systems (technology and applications) is designed, as this determines to a large extent how easy it will be to apply, maintain and change the global standards of the enterprise. 'Local'

systems - and their interfaces - are contingent on the 'Core's ' technology. Assessing the qualities of Object Orientation as a base paradigm for the design of 'Core' elements it was found that in particular the principles of *encapsulation*, *polymorphism* and *inheritance* are of great usefulness for ensuring that the 'Core' systems are flexible for being implemented in differing degrees of 'penetration' and are furthermore easy to maintain, enhance and/or change as future business needs and the evolution of the international firm itself dictate. It is conjectured[7] that Object Orientation should be the preferred modus of analysis, design and development for international information systems.

To be of practical use, however, this architecture model now needs to be validated on a larger and more diversified scale. More empirical research, for which a grounded theory approach seems appropriate, aimed at analysing the structure and architecture of international information systems is needed.

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NOTES

1) This too has been used by Bartlett and Goshal, but in a more general sense.
2) For a fuller treatment of this definition refer to Lehmann ,(1996)
3) Italics denote the Bartlett & Goshal classification
4) The McDonalds hamburger chain is a demonstration of this development notion: having progressed from domestic operations straight to a multinational stance with their policy of global expansion through (mainly) franchising, they are now reviewing the need to exercise more global control or co-ordination. ('Big Mac's counter attack', The Economist, November 13th 1993)
5) All names within the enterprise have been changed. All figures are in US Dollars
6 ...although one could opine that this is mathematically incorrect - it should be the 'highest common factor'
7) So far, neither the literature nor the author's own experience and research have witnessed international information systems projects which use Object Orientation as the main design principle