HARNESSING KNOWLEDGE THROUGH SOCIO-TECHNOLOGICAL FUSION

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ABSTRACT

Knowledge is becoming a major source of wealth in post-industrial organisations. Compared to information, it is more difficult to package and process, since much of it exists in diffuse social networks. Computers can augment knowledge processing, often in unanticipated ways. The combination of technological and social forces is a powerful source of organisational transformation and wealth generation. This paper illustrates how this combination has improved organisation effectiveness in several different areas of application. These include business process redesign through empowered work teams, product innovation through co-operative knowledge networking, flexible work practices enabled by redefining work, personal development through networked learning.

Introduction

Wherever you look, organisations are in a state of flux, as they strive to adjust to their changing business environment. Concepts and programmes with fashionable names abound - business process re-engineering, the learning organisation, empowerment, culture change, core competencies, quality management. Each has its underlying theories and competing methodologies. Each often starts as separate initiatives in different parts of an organisation, but soon start interacting with each other. The reality is that they are all different facets of the same challenge - that of transforming organisations into enterprises that will sustain business success throughout the 1990s and into the 21st century. Bringing these different facets together in a cohesive way requires more fusion between them (i.e. shared vision, common language, managing and exploiting the interdependencies).

Nowhere are these challenges more marked than in the somewhat intangible area of creating value through knowledge. Yet, success in meeting this challenge is, we believe, one of the primary routes to future wealth for organisations participating in the post-industrial economy.

In many organisations today, knowledge is dispersed and fragmented. It exists in various forms - embedded in products and processes, lurking in databases, but above all, in people's heads. The exploitation of its potential requires fusion - between an organisation's technical systems, processes and people (the socio-technical system), and between theory and practice (the learning system).

This paper relates such concepts to some practical experiences from different cases within Digital. Through such exploration, we suggest some principles for managing enterprises through the nurturing of their knowledge assets.

The Transformation Challenge

The dynamic nature of both the external and internal business environment demands that organisations transform themselves to maintain the optimum strategic fit. The nature, scale and pace of these changes is like a kaleidoscope with ever changing patterns. Consider these features of the environment that affect most organisations:

- Globalisation - markets, sourcing and resourcing (e.g. obtaining specialist skills) are increasingly becoming global in nature;
- Boundaries are blurring - between companies, suppliers and customers; between industries; between employers and contractors;
- Large organisations are simultaneously suppliers, customers, competitors, and partners with each other;

- Standard products are becoming commodities - the focus of value added is shifting to customisation and service;
- Shifts in societal values are creating more discerning consumers, higher employee expectations, concern for the environment and more expression of individuality.

Add to these today's climate of turbulence and uncertainty. Who predicted, for example, the events in Eastern Europe, the dissolution of the Soviet Union, Danish "NO" vote, the changing economic fortunes of Japan, driven by forces not within an organisation's control? That makes it incumbent upon us to take a holistic perspective of our environment. Such a view affords us the opportunity to unravel the variables impacting our organisations and managerially influence the desirable outcomes. Our observations lead us to conclude that the successful handling of organisation transformations requires effective management of three dominant conditions:

CONTINUOUS CHANGE: The set processes, procedures, systems and structures of the past cannot cope with ever changing demands. Knowledge embedded in pre-programmed responses is insufficient to service customer needs. Additional skills and experience must be brought to bear in each new situation. Too many things are changing at the same time. The socio-technical systems and structures must be flexible and continuously adapt.

SIMULTANEITY: Horwitch (1992) describes the "concurrent, purposeful functioning of seemingly diverse and contradictory aims and contexts" as the essence of global management. Managing 'creative tensions' or 'dilemmas' are phrases used by others. Some of the commonly encountered dilemmas are:

short-term	<-->	long-term
uniformity	<-->	flexibility
specialisation	<-->	integration
quality	<-->	creativity
teamwork	<-->	entrepreneurship
incremental change	<-->	quantum change

As Hampden-Turner (1990) has pointed out, success requires turning these dilemmas from 'either/or' choices into the benefits of both.

LEVERAGE: This is the exploitation of the interdependence of many factors - seeking out synergy; identifying new and sometimes unusual combinations that generate new opportunities; designing systems from a holistic perspective - integrating and harmonising IT, business and human and organisational factors; energising the latent talent and motivation of individuals. Above all it is about creating new and higher value knowledge by combining the diverse knowledge and skills dispersed within the organisation.

It is also important to add that any transformation activity needs a foundation of a well articulated strategic intent, carefully defined core competencies along with core shared values (the underlying corporate culture).

Knowledge - An Assessment

Traditional (industrial) economics defines the factors of production as land, labour and capital. They are finite resources that enterprises use to transform raw materials into finished products of higher value. In the post industrial age, knowledge becomes an important factor for adding value. Further, its supply is limited only by the capacity of humans and supporting technology to generate and transfer it. The increasing recognition of the economic value of knowledge, yet of its intangible qualities is exemplified by the following observations:

".. three important flows that seem to be the centre of the emerging organisational relationships ... flow of parts, components and finished goods ... flow of funds, skills and other scarce resources ... flow of intelligence, ideas and knowledge."
(Ghoshal and Bartlett 1987)

"Intellectual capital is becoming corporate America's most valuable asset and can be its sharpest competitive weapon. The challenge is to find what you have - and use it."
(Stewart 1991)

"And yet, despite all the talk about 'brain power' and 'intellectual capital', few managers grasp the true nature of the knowledge creating company - let alone how to manage it."

(Nonaka 1991)

Table 1 - A Comparison of Information and Knowledge

Information	Knowledge
Tangible - informs humans	Human process - thinking/awarenesses
Processing changes representation	Processing changes consciousness
Physical objects	Mental objects
Context independent	Context affects meaning
Entity	Awareness and intuition
Easily transferable	Transfer requires learning
Reproducible at low cost	Not identically reproducible

The quantitative measurement of knowledge is an elusive art (one pundit in relating that a unit of information is a 'bit' has suggested that the unit of knowledge should be a 'wit'!). More easily measurable are the beneficial consequences of its good application:

- Faster product innovation - reducing the time-to-market
- Improved ways of providing customer service
- Better tailoring through technological leadership of customer services to individual needs
- Joint innovation with customers of new business opportunities
- Improved product quality

each of which eventually flows through to the bottom line in the form of price premiums, extra revenues or reduced costs. These are the returns on knowledge investment. But what is the nature of that investment?

Having witnessed the intense growth and subsequent decline of interest in artificial intelligence (AI) and 'expert' systems in the early 1980s, it seems to us that knowledge defies easy description. At best we can distinguish different kinds of knowledge. Our own experience and research leads us to these four categories - object knowledge, skills, probability and evaluative knowledge. Even then, other than object knowledge, these types are not easily amenable to codification. For instance, we estimate that, at most, only 10-30% of the knowledge needed to run an enterprise is codified into its procedures or systems. Much is in the heads of its employees.

Furthermore, knowledge is an expandable asset. The combination of different skills and expertise and the flow of knowledge between people generates new knowledge and increases the value of that which exists. The leap of understanding for what is commonly known as information processing to knowledge processing is immense as the comparison below suggests (Table 1).

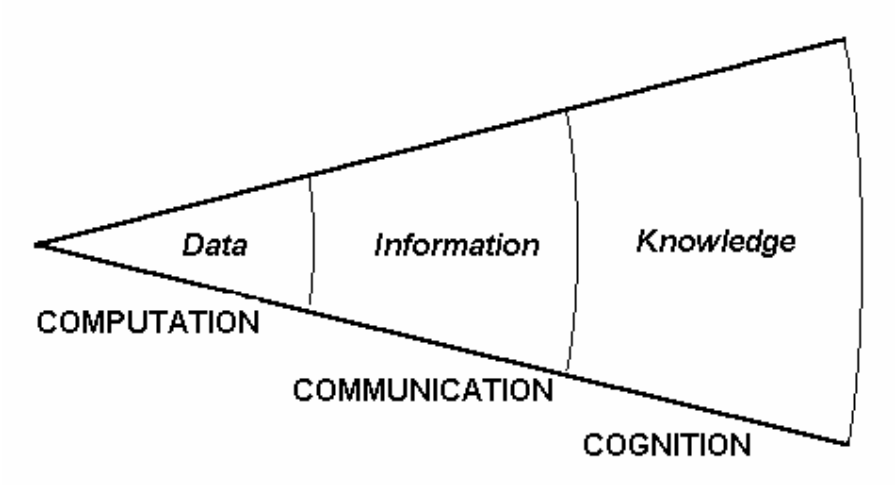
Knowledge processes are much more human related and haphazard compared to information processes. Supporting such processes with technology therefore needs an approach based not on 'thinking machines' (the AI paradigm) but 'thinking humans' participating in computer augmented and mediated knowledge processing. This is the emerging focus of IT in business - that of 'knowledge innovation', which we describe as the creation, exchange and application of new knowledge in products and services. How well such IT enhances business services is becoming a strategic core competence.

IT and Social Evolution

The focus of advanced applications of IT in business has evolved from computation to information handling and communication. At each stage of evolution the description of 'what' is processed has changed. Where we used to talk of data processing we now talk of information systems. Ongoing trends are increasing the richness of information processing. It is becoming:

- more pervasive (most people have access)
- more functional
- more connected (global reach)
- multi-media (computer + voice/data)
- multi-mode (communications, cognition)

Figure 1 - The Broadening Arena of IT



Global connectivity and ISDN (integrated services digital network) will bring wide access and high bandwidth capabilities, even into peoples home. Portable PCs and global communications are also changing the locus of work. The arrival of personal phone numbering (rather than numbers for particular lines) will dramatically alter person-person communications. 'Groupware' will popularise Computer supported co-operative work (CSCW) across organisational and geographic boundaries. These and other trends are providing the momentum for the next stage of evolution - that of cognitive support, the use of IT to augment knowledge work (Figure 1).

Paralleling the technological evolution have been social trends that are influencing our thinking about workers and the work-place. Forward looking organisations regard their employees not as a unit of labour, but as a valuable asset. There is also more balanced contract individual-organisation, meshing of lifestyle needs and career. Lawrence and Lorsch (1967) anticipated such trends long ago:

> "Many problems arise in the shifting psychological contract between man and organisation. .. What balance is struck between dependence and independence, between conformity and creativity, between duty and self-expression? ... Is the organisation accumulating a reservoir of trained human assets and good will, or is it dissipating human resources built up in an earlier period? What is being done to anticipate and provide for the talents necessary to implement new strategies attuned to environmental change?"

Other significant dimensions of social change include demographics (e.g. working mothers), different lifestyle needs, and the demand for a higher quality of working life. The knowledge worker of the future will be seeking an environment conducive to their effectiveness, well-being and motivation. They will seek, and expect, to achieve to their highest expectations.

The successful enterprise of the future will embrace these social shifts and take advantage of the emerging technologies to support new ways of working and of nurturing and rewarding their people.

Fusion - Knowledge Networking

We refer to the fusion between human and IT capabilities in the creation and processing of knowledge as 'knowledge networking'. Savage (1990) emphasised the difference between the accumulation of known facts and the process of 'knowledging', a richer and more dynamic phenomenon where humans interrelate existing knowledge into new patterns. In knowledge networking computers augment this process, not

through the expert systems which rely on rules and inferences, but through a process of human and computer networking where people share information, knowledge and experiences to develop new knowledge and to handle new situations. Team working, shared information data-bases, participative modelling and business simulation, computer conferencing and using 'groupware' are some of the ways in which knowledge networking occurs.

Such processes harness the collective intelligence of the organisation and helps collective learning. Where the deliberations and outcomes are also recorded within the computer network, there also exists a form of 'organisational memory'. In a changing environment, organisational learning is fundamental to future success. Stata has described it thus: "the only sustainable competitive advantage of an organisation lies within its capacity to learn". Knowledge networking is therefore an important strategic tool.

In physics fusion is the result of combining two nuclei that releases energy. But before this happens the different particles must have overcome a threshold as they approach each other to overcome their natural resistance. The analogous situation in business is the fusion of different competencies to create new value. Just as in physics, the natural barriers that exist between different domains must be overcome. One example is the skills and language barriers between technologists and human resource consultants. Where such barriers have been overcome the resultant fusion can bring enormous benefits, as our cases below show.

As an aside, it is interesting to contrast Eastern and Western management cultures as articulated by Tatsumo (1988):

> "Western creativity is based on the notion of individual freedom and expression. It is like nuclear fission in which individual atoms produced energy; by contrast Japanese creativity is more like nuclear fusion, in which particle must join together in order to create a reaction"

Thus whereas Eastern management practices include Kaiban, integrated innovation processes, career job rotation, traditional Western practices have favoured specialisation and business unit autonomy.). Once more the challenge is one of simultaneity - getting the best of both worlds.

Our four cases are examples of this challenge being met; in particular, of the fusion between the domains of information technology and human and organisational factors. They also illustrate the different foci of IT as portrayed in figure 1 - computation, communication and cognition.

Case 1 - High Performance Administration

This first example illustrates how standard data processing applications are redesigned by empowered work teams, aided by adaptive technology. The result is higher productivity and higher levels of customer service and satisfaction.

Background

Historically Digital's UK customer administration systems were developed according to organisational functions, such as order processing, manufacturing scheduling and invoicing. Each system used a fairly standard business process, but changes in business practice over time had complicated the interaction between the different systems. The complete order-delivery cycles involved eight different processing systems. This fragmentation caused delays and customer dissatisfaction as well as stress in the work groups.

What we Did

Similar situations today are viewed purely as a business process re-engineering task. However, this situation was approached from a socio-technical design perspective with better results than would normally have arisen if a conventional IT systems approach had been adopted.

The starting point was an organisation development (OD) intervention, where an OD specialist worked with a cross functional team that included several levels of management. A series of facilitated workshops over a period of several months. They:

- clarified the group's business purpose ("turning orders into payable invoices");
- empowered the administrators (giving them "cradle to grave" responsibility);
- designed the work and organisational system.

Only later were the IT systems needs reviewed. A novel approach using adaptive IT was used to integrate the information flows from the different existing sub-systems. This solved systems problem in weeks rather than the months quoted for traditional IS approach.

Results

- 40% fewer people
- one third the managers
- doubled throughput
- space and cost saving
- improved quality of working life
- customer satisfaction
- roll-out (knowledge sharing)

Explanation

A successful fusion of the knowledge within the group with a piece of advanced technology. The group were empowered to develop their own work systems and given expert help on socio-technical approach. The prototyping approach to IT meant that learning could take place and adjustments made before wide scale implementation.

In terms of the three transformation themes mentioned earlier:

Change: The former, highly procedurised systems could not adapt easily to changing demands. The new IT approach gave more discretion to users, giving them a set of tools to access and manipulate distributed data-bases.

Simultaneity: New IT systems modules coexist with the old. This was quicker and more adaptable than enhancing the old system or developing a completely new one. Routine and variety coexist. Standard transactions are processed efficiently yet variations can be handled effectively through knowledgeable humans.

Leverage: The knowledge existing within the group was exploited to the full. It was leveraged through interaction with knowledge of a socio-technical techniques and IT wizardry.

Case 2 - Flexible Work Practices

Here the IT focus is communications. This case is about working flexibly by doing work at the most suitable places and times. It represent the reconceptualisation of a traditional office primarily as a logical service centre rather than a physical entity. IT enhanced communication improves the information flow and support to workers resulting in increased knowledge worker productivity.

Background

Digital's UK strategic business plan showed the need for major changes in the organisation to meet the challenges of the 1990s. The 'People for the 90s' programme investigated a number of areas where IT could be used to meet these organisational challenges. Flexible work practices (FWP) that incorporated teleworking and flexible offices was one. During 1990-91 a number of flexible office pilots were implemented to validate the business benefits of this approach.

Sales Training Pilot

Traditionally sales professionals were seconded to sales training for a two year period. This involved relocation to Reading, where the office became increasingly overcrowded and inefficiently used.

Using internal and external expertise on flexible work practices, the group rethought and agreed a new way of working - sales trainers remained in their former territories (thus avoiding relocation); half of the group became home-based; the manager is a mother who teleworks from home. The Reading office was reduced in size and made more flexible (with more shared as opposed to personal space). The resultant savings were over £100,000 in the first year and the staff reported significant improvements in their productivity and QWL.

As a result of this and other pilots the learnings were extended to a major office rebuilding, that of Digital's Crescent office in Basingstoke.

The Crescent Office

The original Crescent, one of Digital's newest offices, burnt down one morning in March 1990, displacing 450 people from their work-place. Yet within two working days, all business systems had been fully restored and within a week most occupants had found alternative work-places, either at other Digital facilities or at home. The ease with which this happened raised questions as to the need for a replacement office.

The decision was taken to rebuilt a new Crescent office, but this time adopting FWP principles. One of the principles is that the more time a person spends in the office the more claim they have on personal work space. In practice, this means that secretaries are more likely to have their own desk than managers (none of whom has an enclosed office). The office was also rebuilt as an 'intelligent building'. Today it hosts 650 people instead of the original 450. The heart of the communications is computer integrated telephony that routes phone calls around the building, to mobile phones or to homes, controlled from screen menus on the ALL-IN-1 office system. Many facilities (e.g. printers) are shared. More use is made of FAX cards in computers than FAX machines. Many people work part of the time from home and there is increasing use of portable PCs.

Results

- over £2m a year saving in office costs
- more variety and choice in office space (meeting rooms, quiet areas, soft seating etc.)
- improved communications
- 'organisation change proof' environment
- low cost of internal moves (less than 1/10th of former levels)
- work patterns can be more tailored to suit individual's domestic needs and lifestyles

Explanation

Advanced telecommunications removes the constraints of time and space and offers improved communications and information access. However, technology alone does not account for success of these projects. Again it is careful management of the transformation factors:

Change: From the outset all employees are involved in a participative programme of change management. Much effort went into personal and team development associated with the changing facilities arrangements. Groups were given freedom from office conventions to create work environments that met their needs. Flexibility was actively encouraged. Ongoing reviews of arrangement and refinements continue.

Simultaneity: People work at home and in the office. It is not the 'either/or' epitomised by the main-stream thinking of many writers on telecommuting. Voice and electronic mail communications coexist as equals with routing between them. Office workspaces are both fixed and flexible - those who spend a lot of time in the office opt for more permanent arrangements, those who travel a lot share desks. Flexible office runs side by side with teleworking. Even though a project may start off from a focus on one or the other of these, invariably both are ultimately used.

Leverage: Technology is matched with individual and group working patterns and social needs. Knowledge networking is enhanced through improved channels of communication; access to information and people without physical constraints. Creative thinking is done in a conducive environment, which is more likely to be the home, in gardens, boats and riverside pubs, rather than a conventional office.

Case 3 - Innovation through dispersed teams

This example illustrates knowledge flows on an international scale. Global systems connectivity permits access to the best talent world-wide for co-operative product development, better and faster problem solving and improved customer service.

Background

Within Digital there are numerous examples of using the corporate network to help pool knowledge and expertise. One of the best vehicles for doing this is VAX Notes, our computer conferencing system. Over 1500 open conferences are used to solve service problems, gather inputs for new products, organise sales bids, and discuss marketing strategies. The cases that have been particularly successful are those where OD work has taken place alongside the use of the electronic network. The development of one of Digital's high technology disk drives provides a good example of this.

The challenge was to employ state-of-the-art technology, new manufacturing processes and to come to the market place in record time. Conventional development processes would have taken several years.

What we Did

A concurrent engineering approach was adopted. A core team comprising people from engineering,

manufacturing, product management and customer service managed the project. Development teams were created in seven locations over three continents - from Arizona to Munich.

To create the optimum conditions for dispersed co-operative working, face-to-face socialisation and team building was carried out at the beginning of the project. Multi-disciplinary task forces became a way of life. The full range of capabilities of the network were brought into play - electronic mail, computer, voice and video conferencing. Design changes were transmitted electronically around the world.

Results

- time from prototype to full production halved
- 45% fewer people involved in process
- 50% less manufacturing space
- improved reliability
- a world-class award winning product

Explanation

The face-to-face team development creates the climate for open communication and for supportive relationships. Computer conferencing allows people who would feel inhibited in meetings to make full contribution to the team effort. It encourages input of ideas in a fairly spontaneous manner. Expertise and knowledge is tapped in unforeseeable ways. The knowledge network encourages innovative thinking alongside its refinement knowledge based on quality
critique. Conferencing is used in three distinct ways:

- for team communications
- as a knowledge reservoir (organisational memory)
- as a meetings substitute

Change: Development is viewed as a social as well as a structured engineering process. For engineers this involves a change from their normally heavy task oriented perspective.

Simultaneity: Concurrent engineering encourages the simultaneous carrying out of processes that would normally be carried out sequentially. This encourages more ongoing co-ordination and communication between the groups involved for various phases.

Leverage: Knowledge from many participants at many locations is leveraged, whether or not they have a direct responsibility for the task in question. They support the team effort. Answers to problems and new ideas come from unexpected quarters. Knowledge boundaries are not predefined. Detailed work processes cannot be designed beforehand. They emerge and evolve, synergising on the strengths and interests of different people.

Case 4 - Networked Learning

Networked learning is a new way of introducing learning into the work environment. It allows access to learning resources and knowledge on a 'just in time' basis, not when a course happens to be scheduled.

Background

Many of the conventional ways of training do not meld well with the needs of today's working environment. Pressures of work and time, not to mention travel and accommodation costs, often result in courses being given low priority by many managers. Distance education overcomes some of these problems but does not offer the learning support of face-to-face. With both, there is a problem of making the training relevant to current work problems. Using computer networks overcomes many of these issues.

At its simplest level, networked learning is computer based training (CBT) delivered to a terminal on the network. CBT on the Digital network is used for a range of commonly needed knowledge and skills e.g. keyboard skills, word processor training, introduction to financial management. It also offers a self-assessment questionnaire to help individuals understand their own personal learning styles. CBT, however, has a high initial cost, and courses must be well designed to provide learner usability and flexibility.

Above this level, computer conferencing offers more flexibility. Its use for management development is now more widely recognised. A good example of this are some of the management courses offered by the Open Business School. Here, MBA students (usually in full-time employment) work from PCs at home doing assignments using

the CoSy computer conferencing system. It is used in several modes:

- tutor-student dialogue: queries, problems
- student group work: developing assignments
- industry updates and comment
- access to experts: conferences where an external expert on a subject explores a specific subject in depth with the students.

Within Digital computer conferencing has used to allow people on management development programmes to work together on a project between face-to-face periods of their course. A particular example of technical training gives a good illustration of the complementary nature of the networked learning.

Technical Training

Here the need was to give 25 customer support specialists technical training. They were located at different offices and the training was to be completed within three months with minimal interference to the day-to-day demands of their job.

What we did

The training medium was a value added network (VAN) that allowed easy and secure interchange between external subject matter experts (the main content providers for the training) and Digital trainees. There was a one day start-up event attended by all those involved, in which the course arrangements were explained and hands-on training given in VAX Notes. During the training VAX Notes was used for:

- Course processes
  - outlining the curriculum
  - passing students their assignments
- Disseminating course content
- Student-expert contact
- Student-student contact
  - to share information, experiences

Other training software (DEC Mentor) was used over the network for on-line testing, marking and student administration

Results

- very cost-effective learning. A fraction of normal classroom teaching costs.

- easy access to external experts who would not normally be available.. a rare treat.
- benefits of on the job training (little disruption to normal work; live issues and current problems were integrated into the learning process)

Explanation

Learning is heavily related to the needs of the job and is student centred. Expertise is on hand. The course material is through live examples (which in turn can be incorporated into the base material of future courses).

Change: The learning environment is new for tutors and students. Standard courses give way to adaptive learning processes. The pre-course meeting was an opportunity to learn about the differences to normal ways of learning.

Simultaneity: On-the-job and off-the-job learning are combined in a fairly seamless way. Learning merges with work.

Leverage: Expertise was leveraged from all participants. Student-to-student exchange proved as valuable as that from tutor to student.

Managing the Fusion - An Architecture

These four cases illustrate different types of IT-social fusion. For example, in one case IT provided communications support and in another supported knowledge flows. Social aspects ranged from meeting individual psychological needs to empowerment and group effectiveness. Common to each was a blend of the methods and principles of social science and OD with those of IT. Each pooled the knowledge of the participants in a semi-structured way to create new ways of working together.

These new ways of working also need new ways of management. Based on the results of research, learnings from cases like those just described, and a re-examination of our own management systems, an Enterprise Management Architecture (EMS-A) has been developed. This is a set of inter-related standards that extends the notion of socio-technological fusion to cohesion between five different dimensions:

Table 2 -Explanation of Cases in terms of EMS-A Factors.

Factor	Case 1- HPA	Case 2 - FWP	Case 3- Innovation	Case 4 - Learning
A. Performance (Return on Assets)	Reduced time spans Productivity	Better use of key assets - office space - people (and their time)	Faster time-to-market	Improved personal performance without service disruptions
B. Structures	Self managed teams	Networking in time and space	Globally dispersed teams Formal and informal networking	Internal/external collaboration Dispersed individuals with common goals and needs
C. People	High autonomy Empowerment	High individual autonomy Group consensus and 'norms'	Individual and team creativity Motivation to achieve a demanding challenge	Skill enhancement Motivation to learn increased through job relevance
D. Processes	OD intervention Cross-functional Aligned to information flows	Team development Individual/Group 'contracting' Multi-discipline design teams	Concurrent engineering OD team development	Learning through network of experts
E. IT	Adjunct - data extraction, formatting and routing	Location independent communications	Global networking Computer conferencing	Computer conferencing allows trainer-student interaction

A. ECONOMIC. What is measured to assess goodness.

B. SOCIOLOGICAL. How to structure managerial roles and role relationships.

C. PSYCHOLOGICAL. Assumptions about the motivation and problem-solving capabilities of people.

D. MANAGERIAL. Cross-organisation processes to co-ordinate work and manage outcomes.

E. TECHNOLOGICAL. The information and knowledge processing support systems.

Application of this architecture forces teams and manager's to think systematically about the interaction and harmonisation of the different factors affecting an organisational transformation. Table 2 shows how each of the architectural factors were addressed in the four cases.

From the learnings of such cases and other research we can start to articulate the characteristics of viable enterprise management systems based upon the architecture. These are being developed through a global management science research network (MSR-Net) with participants from inside and outside Digital.

An illustration of a viable and cohesive set of characteristics within EMS-A is provided by reference to a form of organisation which we call the Dynamic or 'D-form', in contrast to a Multi-divisional 'M-form' (Table 3). The 'M-form' had its origins in the General Motors of Alfred Sloan in the 1920s. Not until the 1950s and 1960s did organisations, like Digital, begin experimenting with other, somewhat "unscientific" organisational forms. Management writers have given these forms such labels as organic, matrixed, ad-hocracies and networks.

Table 3 - Comparison of Two Organisational Forms

EMS-A Factor	**M-form (multi-divisional)**	**D-form (dynamic, networked)**
A. Business Performance	Budgeting and investment for independent business units	Dynamic ROA (time value of assets); investment for profitable growth
B. Organisational Structure	Strategic Business Units (SBUs) Emphasis on *independence*	Strategic (value adding) Business Networks (SBNs); exploitation of *interdependence*
C. People	Based on specialised functional skills	Based on motivation through learning and achievement
D. Process	Minimised overlaps; authority based on hierarchy	Leverages cross-functional virtual teaming; authority based on knowledge in a given situation
E. Information Technology	High routine processing. IT standardises business processes and work flows.	Support for knowledge creation and processing; IT augments human cognitive processes

The 'D-form' represents an explicit combination of characteristics within the enterprise management architecture that describes the networked, knowledge-leveraged type of organisation. It must be appreciated, however, that elements of 'D-form' and 'M-form' can coexist within a given enterprise, though at different levels and in different situations. The challenge of managing simultaneity is alive and well!

Knowledge Flows

Advances in technology have made the 'D-form' organisation practicable. IT allows enterprises such as Digital to store and process information on a global scale. Over 100,000 employees are connected to each other through 80,000 computer nodes in over 1000 permanent locations (not counting homes, temporary or mobile locations).

Moreover, it is not just the information flows, but the knowledge flows (between people and augmented by IT) that will provide the real strategic advantage for the future. Thus, allied to EMS-A are a set of new management principles for handling the knowledge agenda. We have encapsulated these into the mnemonic KNOWLEDGE:

Knowledge Agenda - the intellectual assets of an enterprise are to be valued and leveraged.

Network of Value added business units - each business unit must add value, not just to itself but to others (e.g. suppliers and customers) within its network.

Organisational Transformation - to dynamic D-forms (or other consistent forms, through change, simultaneity and leverage).

Wealth Creating Measurements - ROA must look at the dynamic (time-based) value that is leveraged from knowledge based assets (e.g. competencies).

Learning Enterprise - each problem, decision and outcome is an opportunity for reflection and learning, by individuals, teams and the enterprise.

Entrepreneurial Teamwork - teams are the value generators of the enterprise; individual ingenuity is co-ordinated in a cohesive group to effect innovation.

Dynamic of the system - changes in one part of the EMS-A affect the other parts; these must be explicitly recognised and managed.

Global interdependence - knowledge flows easily across organisation and geographic boundaries; future winners will be those who can tap into and harness expertise wherever it may physically reside.

Exploitation of Complexity - the complex interactions and between multiple factors are often the source of new insights and innovation.

The Challenges Ahead

We are the early stages of refining the architecture and principles and deploying them in practice. Already, though, Digital's current transformation is structured around an interdependent network of value adding business units. Our new management system uses dynamic measures to inform investment decisions. Management structures have been simplified. Entrepreneurial teams are leading change.

What have we learned from linking our research with practice?

1) *Our business is increasingly customised.* There is no standardised response to transformation. Every circumstance is different.

2) *Transformation must be managed and not left to serendipity.* The management process, however, is one of coaching, mentoring, challenging and leveraging. Managers must resist the temptation to overdesign management systems. The better systems are those that are self managed whose design emerges from well defined and agreed principles. Top management's role is to define the 'what' leaving work-teams to determine the 'how'. Teams are helped with methods, insights and models, but they are encouraged to adapt them to their own ends.

3) *Learning must be valued.* Each change must be viewed as a learning opportunity. People, not directly involved with the management of change, monitor and evaluate what happens to refine our models and organisational knowledge.

4) *Effective enterprise management systems are interdisciplinary in nature.* Perspectives from several disciplines are needed to inform those involved in designing them. Cross disciplinary insights are what catalyses the thinking and determine business success. It is necessary, but it will take a long time, to bridge the gaps between

different disciplines - a heritage of our traditional educational and management systems. For example, the outlook, methods and disciplines of IT and OD are uneasy bed-fellows. It will need new methods such as human centred methods for systems development (the topic of one of our current research programmes); it will need new approaches in management education and skills development (e.g. those of hybrid managers).

5) *There is a need to integrate 'soft' science research into mainstream management practice.* Our management research focus is now at the multi-disciplinary intersections of the domains in the EMS-A. We need hybrid approaches - between disciplines, between theory and practice, between formal research and organisation interventions, and between industry and academia.

A major enterprise, like Digital, must as quickly as possible become a networking organisation, a learning organisation, a flexible organisation, a self-designing organisation, an innovative organisation and an adaptive organisation. Managers must recognise the dynamics of **change**, build **simultaneity** into their management and **leverage** the interdependencies across functions, business units, industries and geographies.

The nature of enterprises will transcend traditional definitions to include alliances, suppliers and partners of all sorts. Knowledge (beyond information) will flow freely across these boundaries. Managing this capability through socio-technological fusion may be the key to a sustainable collaborative future.

References

Bartlett, Chris and Ghoshal, Sumantra, "Managing Across Borders", *Sloan Management Review*, (Fall 1987).

Hampden-Turner, Charles, *Charting the Corporate Mind - From Dilemma to Strategy*, Basil Blackwell (1990).

Horwitch, Mel, *Post Modern Management: Emergence and Meaning for Strategy*, Free Press (1992).

Lawrence, Paul R. and Lorsch, Jay W., *Organisations and Environment*, Harvard University Press (1967).

Nonaka, Ikujiro, "The Knowledge Creating Company", *Harvard Business Review*, pp 96-104, (Nov-Dec 1991).

Savage, Charles M., *Fifth Generation Management*, The Digital Press (1990).

Stewart, Thomas A., "Brainpower", *Fortune*, (3 June 1992).

Tatsumo, Sheridan, *Japan's New Challenge: Shifting to Creativity*, Dataquest Special Report (Oct 1988).

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