

An Evolutionary Theory of Information Systems Diffusion

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Abstract

Organisations may be viewed as products of culture. A recent theoretical view of the development of firms explains their evolution in terms of the replication of units of culture called memes. This paper seeks to develop an understanding of the role of IS in organisations in which they act as expressions of memes.

1. Introduction

Information systems (IS) form an integral part of the structure and function of any organisation. Any comprehensive description of an organisation, its products, services, people and processes must include a description of the information systems that reside within the organisation. The presence of information systems within the organisation provides both permanence and scalability to its processes and may confer advantages whether strategic in terms of competitive advantage or operational in terms of improved efficiency and effectiveness.

Key questions which still face IS researchers are: how does the IS get into organisations? What keeps the IS in the organisation and how does IS spread amongst organisations? This paper seeks to develop an understanding of the role of IS in organisations which draws on the biological concepts of evolution and a recently developed theory of the firm which applies memetics to explain the evolution of a firm in cultural terms. Information systems are viewed as the results of the evolution of cultural elements or memes which determine the structure of an organisation.

This paper develops the idea of 'selfish IS' which as expressions of memes, seek to replicate in host organisations. Their survival is subject to the forces of natural selection. The main concepts of evolutionary theory – variation, selection and retention – are discussed in relation to the diffusion of IS in organisations. We then explore the explanatory power of this theory and suggest some directions for research.

2. Information systems are part of the phenotype of organisations

An information system can be viewed as part of the phenotype of an organisation, along with the buildings, people, behaviour and visible processes. Just as blue eyes or tongue-rolling are part of the visible phenotype of a human, so IS are part of the visible phenotype of an organisation. The phenotype of a biological organism confers fitness to its environment on the organism. Such fitness to its environment increases its chance of survival.

Within the organisation, the IS evolves, changing its structure and function to meet the changing needs of the firm. This evolution occurs in response to changes in the environment and in concert with other evolving change within the firm or organisation. As the organisation increases in size, complexity and knowledge it may incorporate other IS. The organisation expands its structure and hence its phenotype as the organisation's genome expands. Hence the evolution of each IS and the

extension of the portfolio of IS are a response to changes in the environment as the organisation evolves in order to ensure its survival.

However, the relationship of the IS to the organisation should be seen more as one of a benign parasite to a host. Information systems may be viewed as analogous to selfish genes, as they seek to spread themselves through a population of organisations. By being of apparent benefit to the organisation, the IS ensures its own survival and has an opportunity to spread itself to other firms. Providing benefits and advantage to the host organisation may not be the only strategy that the IS can adopt. If the information system is not rejected by the host firm, it may exist within the firm without conferring any benefit. Indeed it may continue to function within the organisation while acting as a genetic burden providing disbenefits. All the IS wishes to do is to thrive within the firm and gain opportunities to spread. Some IS may continue to exist within firms and consume resources without providing any benefits. Conferring competitive advantage in the environment is secondary to the survival of the 'selfish IS' within its host. From the information system's point of view, the purpose of the organisation is to enable the continued existence and propagation of the IS. While this may usually involve the production of benefits which help the organisation to continue to exist within its environment and hence continue to provide a host for the IS, many IS confer no benefit and yet are sustained within organisations.

3. Information Systems are Expressions of Cultural Elements

In biological organisms, the physical attribute – blue eyes, long neck, large brain, fast legs – is the phenotype, a physical expression of the genotype. The genotype consists of the deoxyribonucleic acid (the DNA) which codes for proteins. These proteins are then expressed through transcription and translation and result in the physical expression of, for example, eye pigments in the phenotype. In some cases, there is a one-to-one mapping between a gene and a physical characteristic. However, many physical characteristics result from the combined expression of several genes, expressed as several proteins which interact to confer the physical characteristics.

We suggest that information systems are the physical expression of the organisational genotype, conferring structural and behavioural characteristics on the organisation and having a visible, physical existence in terms of hardware, software, information flows, screens, printouts, and websites and so on. The question that then follows is how is the genotype for which the information system is the phenotype, represented? If Information systems are the phenotype, what is the organisational equivalent of the DNA in which the code for the selfish genes resides?

Organisations may be viewed outcomes of a process of cultural evolution, rather than structures designed by autonomous individuals (Weeks and Galunic, 2003). Their structure, including their information systems, is a product of culture. Organisations may be seen as cultural artefacts, emerging social phenomena, resulting from the interactions of individuals in the firm, all of whom carry their own cultural identities. These cultures are made up of social distributions of modes of thought and forms of expression. The organisation is then made up of individual's culture, subcultures and cultural strands which spread through the organisation.

Culture may be defined as a pattern of shared basic assumptions, values, beliefs, knowledge, coding schemes, language and symbols which has been invented discovered or developed by a given group, as it learns to cope with its problems of

external adaptation and internal integration (Schein, 1991). Values will include moral values and individual's shared vision for the firm. Assumptions include the beliefs, habits and perceptions held by individuals. Ideas and concepts, and their interpretation also form part of culture. Ideas spread through organisations and become established as the basic assumptions which drive organisational activities and determine organisational goals. The culture may be embedded in organisational stories. It is the implicitly understood way of being, the way of behaving and the way of doing things.

These ideas, values, assumptions and beliefs which determine the nature of an organisation and are expressed in its structure and processes may be viewed as cultural elements, spreading from mind to mind of individuals in the organisation. In analogy to selfish genes, Dawkins (1989) coined the term 'memes' to describe these cultural elements. The meme represents the unit of cultural transmission. The collection of memes within the organisation constitutes the organisational genotype. The enactment of patterns of behaviour, resulting in organisational structure and artefacts provides the phenotypic expression of the organisational genotype. However, the phenotype requires not only the expression of memes, but the interaction of networks of memes. Memes combine and interact to produce the complex behaviour in organisations.

An evolutionary theory of the firm, as proposed by Weeks and Galinic (2003) must be tied up with the evolution of IS, since the evolution of the organisation requires the appearance of characteristics of control, identity, development of commercial practice, and the grouping of procedures, all of which result in expressions of IS and are influenced by IS.

4. What are memes?

Memes are units of information, spreading from person to person, but also subject to interpretation. They can be seen as the genes of culture, enabling the replication of concepts, ideas and values throughout the organisation. Meme may be passed on in stories and anecdotes. Hence, the stories that circulate in organisations are important for the establishing and evolution of culture. Memes may be considered as patterns of brain activity, expressed in behaviour or action within the organisation.

However, unlike genes, meme are not precisely transmitted. Some interpretation will occur when the meme is transferred from one mind to another. Precise transmission will be the exception rather than the rule. Confirming transmission, and hence removing errors in transmission, has to occur by rehearsal of the value, attitude or concept between individuals. Such rehearsal acts as a repair mechanism by which the selfish meme assures that its form is retained and preserved as well as spread through the population of individuals in the firm and between firms.

An organisation evolves as a network of interacting memes, operating a various levels in the organisation. These various memes all interact to give the organisation its characteristics which it expresses in its market or environment. The holistic nature of culture arises from the complex interactions of memes. The organisation – and its IS – emerges as a result of these interactions. Culture is spread unevenly in the organisation. There may be subcultures, individual cultures and anti-cultures within the same organisation. IS will be part of that culture with organisation wide systems,

in subcultural systems within departments and in individual end user computing in anti-cultures.

These cultures are expressions of memes. Some may dominate and spread organisation-wide, some memes thrive in subcultures and some remain in the minds of individuals as concepts, values and beliefs. At the heart of the organisation there may be stable core memes whose expression in behaviour is rarely questioned. These might be part of a hierarchy of memes in which stable core memes predominate.

In the same way that DNA does not reside in a vacuum, but is transmitted in a germ cell that already contains all the protein synthesis and control apparatus, similarly memes are transmitted in a cultural apparatus. The memes are packages with organisational structure and transmitted with organisational structure.

5. Why Information Systems are good for memes.

A meme seeking replication and self-preservation will favour expression in a IS because that provides a fast way for its transmission from mind to mind and encourages some standardisation of interpretation. Hence an IS may be seen as an expression of a successful meme.

The IS is a meme replicator, growing on the organisational culture and, possibly, conferring advantage. The information systems compete for staff resources, budget, usage and hence attention.

The expression of an IS is mediated by a variety of organisational elements including base technology – imported from outside and processes. That technology itself is the expression of memes. IS expression may require a network of interacting memes working in concert to produce the particular aspect of the organisational phenotype. Hence memes cannot be considered in isolation.

Information systems compete for homes in organisations. If that requires that IS to confer benefits on the organisation, it will do so. But in some cases, because the IS is linked to memes which may infect the organisation, IS will be implemented, spread and retained because they are an expression of a meme – which seeks only its own advantage – not because they confer any benefits. Indeed some IS may be retained despite putting the equivalent of a genetic load on the organisation.

An IS provides a good way for a meme to replicate in the organisation and to fix or retain its form. IS increases reliability of meme replication because the concept is turned into an inscription and does not only exist in people's minds. The IT structure is not only the output of expression of memes, but also transports the memes and provides the structure for replicating, repairing, storing and controlling memes.

IS depends on other surrounding IS. This may reflect dependencies amongst the memes that are being expressed. Furthermore, the development of an IS in an organisation will be very path dependent, and hence its historical origins or genealogy critically influence its current position and usage in the organisation. The IS evolves as the memes evolve over a period of time.

Meme exist as underlying cultural modes of thought. Hence IS expresses culturally

spread representation of a way of doing things, a representation of what is important, of what we do and don't want to know about, of what it is important to achieve, of what matters in terms of organisational goals and objectives.

6. Overview of Evolutionary Process

Like genes, memes are small replicators. Evolution does not take place at the level of the whole organisation or the IS but at the level of the individual meme or cultural concept. In order for evolution to occur so that the memes evolve and hence the IS which is an expression of the meme evolves, some basic processes of evolution must be possible. Memes must be able to replicate and spread. They do that by cultural transmission between people in the organisation. This involves language. The development of language and the use of language in the organisation will be important in the development of the organisation and the evolution of its culture and artefacts. There will be a high level of granularity and a complexity of memes operating in networks to give the resulting organisational phenotype.

For evolution to work, variation must be possible. Meme must be able to change form, to mutate and to recombine. Lack of accuracy in word-of-mouth transmission lead to and vary large level of variation which has to be reined in by cultural repair mechanism. However, the right level of variation enables new memes to be established in response to environmental change. These new meme will increase environment fit. In addition to variation, there must be a selection mechanism whereby unfit memes are eliminated from the population and only the fittest survive. There must be competition for scarce resources. In the case of a meme, it is competition for attention in the mind of individuals within the organisation. Finally, there must be mechanisms which retain and preserve particular memes in order to establish organisational identity and stability. Evolving organisations require increasing throughput that can only be supplied by IS. Absorbance of knowledge becomes too much for one person and hence relies on memes distributing knowledge in the organisation.

7. Variation

In exact replication results in variation. In moving from mind to mind, the meme is subject to interpretation. Memes are unlikely to be transmitted exactly, although their overall core cultural message may be preserved. Variation arises from reinterpretation and recontextualisation.

Variation may occur through the recombination of memes within the organisation. Combinations of diverse memes from different cultural directions results in novel cultural memes which results in novel IT. This recombination, where two or more memes combine to form a new cultural or organisational gene structure, results in the expression of a new IS. Such new ideas must be socially, culturally and historically linked to the organisation. New members of the organisation will import new ideas, which may influence organisational IS.

Variation can occur through copying errors such that non exact copying of memes results in variation in the way IS is used and hence new application usages. Copying

errors, certainly between firms, is the rule rather than the exception and promotes variation. Since memes operate in networks, surrounding environmental and national culture will affect the copying process and increase variation. So the problem is how memes are conserved when the potential for variation and hence dilution or loss of a meme is so great.

Although a very large number of new memes come into the firm, a large number are filtered out by individual avoiding information overload. However such information anxiety can result in overly vigilant filtering where existing memes are strengthened and new memes are excluded. Increases in potential memetic variation expressed through a mass of IT applications and possible uses can lead to technology overload such that there is a reduction in realised variation and individuals within the organisation avoid new technology. Repairs mechanisms which protect existing memes in the organisation will also dampen variation.

There is, in a sense, a battle going on between memes. Increased variation brings opportunities for new memes to establish themselves. However physicalisation of memes may make adaptation and variation more difficult unless the expression of the meme can easily change.

The expression of a meme required cultural apparatus to turn a concept into a physical artefact in the same way that cells require transcription and translation structures including ribosomes to produce proteins from DNA code. In IS these transcription and translation mechanisms are realised in systems development methods. Moves away from SSADM to RAD and extreme programming approaches may be an evolutionary response to increased rates of change. If memes are to be effective in establishing themselves, they must be able to change their expressions rapidly. Hence the methods by which memes are expressed as information systems must allow for rapid physicalisation which will not support method in which production of the information system takes a long time.

8. Selection

Selection is required so that effective memes can reproduce and memes that do not fit the environment may be eliminated. We have already suggested that selection will occur at the meme level, not at the IS or organisation level. Many memes (i.e. organisational genes) make up the firms structure, behaviours, organisational patterns and processes. Hence the unit of selection is smaller than the IS or organisation as a whole. The environment in which the organisation exist exerts selection pressure. Meme expressed as IS may confer competitive advantage, or may enable the organisation to fit in better with other organisation in the environment and received preferential attention in terms of business or customers.

The environment in which memes exists consists of other memes which apply selection pressure. Meme within other organisations may exert selection pressure. Other organisations, for example, may demand deployment of particular IS (expressions of their dominant memes).

Memes exist within contexts and may not replicate well in foreign contexts. Hence the IS which are the expression of memes are affected by contexts.

Fundamental memes concern basic assumptions and are taken for granted. Such fundamental memes may be expressed in IS which is then taken for granted. The purpose and value of the IS is not questioned, it is not subjected to any formal evaluation because it is informally assumed to be essential for the organisation. However, that basic assumption which is enshrined in the meme may be false. The meme may be hiding parasitically in the organisation, replicating and spreading at cost to the organisation. Weick (1979) argues that rather than selecting individual or behaviour, selection pressures on organisations select schemes of interpretation and specific interpretations.

Selection of a cultural meme will be influenced by the properties of the physical phenotype expressed and how that process, behaviour or artefact affects the organisation's survival in the environment. Three aspects of the phenotype may be considered which influence survival chances: function, fit and form.

8.1 Function

Memes will express a phenotype which helps achieve some kind of value to the organisation. This value may be seen in terms of functions which enable the organisation to survive in the business environment. Hence, the functionality of the computer system and its relevancy to the organisation may be important in the selection of the meme(s) which give rise to that functionality. IS functionality will be significantly culturally based.

8.2 Fit

Memes are selected because they further local or individual aims. The selection of a meme is not an isolated event, but occurs in a cultural and historical context. Memes are more likely to be selected which fit in – or align – with the existing network of memes and with the path dependent, historical progression of selection in that organisation. New memes are likely to have some structural connection or resonance with existing memes. This has a consequence for the alignment of information systems and the business. That alignment may be dependent on the relationship between the underlying meme which the information system is an expression of and the meme that make up the organisational genome. Cultural and historical frameworks are important in the development and diffusion of information systems. The perspective and identity of the IS is a product of its memes. Patterns of meme selection are very path-dependent, hence the IS used now depends on memes selected over a period of time and expressed in historical frameworks.

8.3 Form

The selection of a meme also is influenced by its form, Cultural concepts that resonant with the environmental culture and in particular are easy to imitate, will have an advantage over obscure concepts. Imitation is a key way in which memes spread. The understandability of the concept and the ease with which the concept can be linked with the recipient's mental map will affect its selectability. Stories which stand out, slogans in advertisements, theme tunes and melodies are all memorable and

easily transmitted. Concepts which are difficult to understand will diffuse only slowly through the actor network within an organisation.

For the information system there are significant consequences of form. Processes should be easily understood, the prime concepts of the system should link with the prior mental map of users within the organisation and navigation, data entry and reporting should be intuitive and rewarding for the user. Hence form, and the effective diffusion of the information systems, may be much more dependent on usability than developers have previously thought. Usability engineering, which is often absent or an add-on to the system development process, should be addressed throughout the systems development project and given prominence. A business process or computer dialogue that is difficult to understand or explain will not spread through the organisation. Memes and their IS expression should have emotional resonance. Expression of meme must make sense, must be easy to understand and easy to use. Hence usability will become a key issue in the spread of the meme.

The selection of memes will also depend on power structures and the networks of influence within the organisation. Memes need networks of contacts in order to spread. The IT manager who is within the organisational network is more likely to pick up the cultural messages and hence spread them and express them in IS. If the cultural memes within IT do not fit with those in the rest of the organisations, then the expressed IS will be inappropriate or useless.

9. Retention

For memes to be established evolutionary, they must not only be selected but also become integrated into the organisational genome such that they survive across organisational generations. Since memes vary so easily because each mind inevitably interprets them differently, the survival of memes may suggest strong social environmental effects which serve to constrain variation. One evolutionary force which will encourage retention is standardisation within organisations – e.g. rationalising business processes, aligning business processes with SAP implementation, taking up ISO9000 or BS15000. Some memes may encourage standardisation because it acts as a force for uniformity and supports the retention of the meme. Standardisation will ensure that a limited subset of concepts and assumptions (the core memes) dominates. It will make it more difficult for new memes that are contrary to the standards to gain an organisational foothold. Information Systems may act as vehicle to promote standardisation of processes and hence to fix memes. Hence it is to the meme's advantage to be expressed as an information system since that IS will help fix the meme within the organisation.

9.1 Longevity

Hence the expressed information system confers longevity on the meme and contributes to its replication. It provides a means of retention and ensures that the form of the meme remains static. The meme is constantly reinforced by what is on the screen. It is encoded, inscribed in the artefact. A meme that expresses itself in an IS will survive longer because the idea is held in a form which is outside the minds of company individuals but which is exposed daily as the IS is used or even within every transaction.

Culture persists through constant reproduction, for example through storytelling. Information systems will provide the inscriptions and a mechanism of reproduction of culture. Memes persist through the reproduction of rules, ideas, values, and beliefs through social practices (Weeks and Galunic, 2003)

9.2 Fidelity

The retention of a meme depends on its accurate reproduction and the repair of any errors in replication. IS provides for accurate spread of memes. It provides control mechanisms which assure the meme is retained. Hence memes whose expression is in an IT system are more likely to persist. IS limits variation because behaviours and processes are forced through computer dialogues to follow a recipe.

9.3 Fecundity

A meme which can spread rapidly and reproduce itself in large numbers is more likely to be retained. Information systems including Intranet and Internet-based systems will enable the rapid spread and reproduction of a meme in a way that cannot be achieved by face-to-face communication.

IS, particularly Internet- based IS has several potential memetic effects. From one point of view it can increase variation, enabling individual memes in different minds to be made available to all. Hence the pool of available memes is increased and the population they can infect is that much greater. However, the use of Internet- based system can also assure that a limited set of memes are spread on a scale within the firm and outside which would not previously have been possible.

Meme spread will depend control and power structures. Memes residing with those in power have a better chance of survival than those with shop floor workers for example.

10. Exploring the explanatory power of an evolutionary theory

10.1 Explaining IS failures

A theory in which cultural elements are expressed as information systems leads to the idea that IS failure is a cultural failure resulting from selection pressures. If the meme which 'codes' for the IS is not retained and does not fit the environment, selection pressures will eliminate it from the meme pool.

In management, some firms attempted to copy matrix form of organisation without recognising and duplicating the underlying memes associated with the visible structure. Hence in IT, copying technology a management set up will not work without copying the underlying meme which drive the expression of the meme.

IS failures may result from the wrong memes being introduced into the firm and failing to get established or by errors in expression of the IS resulting from the meme. Software development methods represent the means by which memes – cultural elements, ideas, concepts, accepted ways of doing things are transcribed and translated into expressed IS. Wrong approaches may lead to inaccurate translation and hence failure of the IS within the organisation because it does not correctly express the meme. However, it is more likely that the cultural assumptions, i.e. the memes on

which the IS is based, do not fit the intra- and inter-organisational environment and are eliminated

10.2 Procured software as a means of spreading memes.

Software companies harbour memes. Their output provides a vehicle for the beliefs, values, assumptions, and ways of seeing things. i.e. the memes to be transmitted from organisation to organisation. However, there may be an interaction between existing memes in the firm and the memes expressed in the bought in package. Lack of connection or mismatch may stop the software package being taken up and used.

Software houses encourage meme fecundity and retention. The memes are expressed in the software. The software acts as a physical inscription of those memes and carries them into any host organisation that procures the software. Software house may reduce variation by strengthening particular memes. For example, the cultural elements embedded in MS Powerpoint become globally establish and fixed. Open source may increase variation by enabling cultural input from many developers and organisations.

10.3 Why IS requires organisational champions

It is well known that successful diffusion of IS requires organisational champions, usually at a senior level. An evolutionary theory might explain this. Cultural champions will act as super hosts and spreaders of memes. Hence key role of champions in the take-up of IS because that IS is really only expressed memes and the spread of memes must be done whether intentionally or unintentionally by organisational champions. The champion's task is one of spreading the meme by promoting the assumptions, values and beliefs (i.e. the culture) that would be expressed phenotypically in the IS.

10.4 Escalation

Information systems may persist and be promoted in organisations despite the absence of any visible benefits. IS developments may be pursued to destruction, with the never-ending addition of resource when the development is clearly failing. It has already been suggested that IS may be present because it is the expression of selfish memes. The presence of the IS ensures the survival of the meme which it inscribes at the detriment of the organisation.

The presence of a selfish meme may cause an information processing bias in which organisation members seek evidence which supports their current beliefs.

The meme encouraged escalated commitment to the IS which expresses it. This is almost parasitic as the organisation strives to implement an IS, driven by the meme, despite evidence that the IS is draining firms resources without benefit. IS escalation may result from clinging to dysfunctional beliefs.

10.5 Benefits Management.

Some memes will tend to survive and propagate because they benefit their host (Weeks and Galunic, 2003). Hence IS, the expression of a meme, will survive where it benefits the organisation that hosts it. This benefit of the IS should be closely associated with the benefit the underlying memes confer. In other words the benefit

cannot be judged separately from the cultural elements and cultural apparatus of the organisation.

If we are seeking to identify the benefits an IS confers on an organisation, we must seek to identify and understanding the memes in the meme network which results in the expression of the IS.

11. Research possibilities

This theory suggests that we cannot understand how IS develops and spreads unless we understand the underlying cultural elements or memes which drive the spread of the IS. Hence there is a need to identify memes within the organisation and establish their connections with the expressed information systems. How do we know when we have identified a meme and how do we know that certain IS represents the expression of that meme?

Charting the spread of an IS within an organisation and between organisations may then be linked with the spread of memes and correlated with changes in culture. This may enable the IS phenotype to be linked with the underlying cultural elements forming the genotype.

Hence a key focus should be in the search for the memes and networks of memes that control the development and diffusion of the IS. Part of this effort would involve examining the stories associated with the IS within the organisation. This may involve critical reading of IT strategy documents, requirements definitions, user manuals and even program code to identify memes. Indeed there may be a problem in clarifying what is a meme within an organisation and viewing the culture of the organisation at the right level of granularity.

It may then be possible to consider how changes in memes in the evolution of firms result in or align with changes in information systems. The effect of IS on memes could then be investigated to see if IS promoted rapid replication and selection of particular memes.

12. Conclusion

Weeks and Galunic (2003) argue that firms should be seen as evolving cultures. We have expanded this idea to suggest that IS are cultural artefacts, expressions of underlying memes. Information systems are not just tools at our disposal, but have their own life and existence. They express organisational characteristics and may alter them. They seek to proliferate in and amongst organisations.

Such a theory may lead to better explanations of the role of IS in organisations, their development, implementation and use and why IS implementations may have unintended consequences.

13. References

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