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Technology transfer: diffusion or translation?

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Abstract

There can be little doubt that over the last three decades diffusion theory has had a major impact on a large number of disciplines. However diffusion theory is but one way of thinking about 'technology transfer', and here we present an alternative view - namely the notion of **translation** embodied in actor-network theory (ANT). We believe ANT offers ways of thinking about transfer problems that diffusion metaphors fail to adequately address. Using a retrospective analysis of a case study, we examine and contrast key concepts of these two approaches to technology transfer.

Keywords

Technology transfer, Diffusion theory, Actor-network theory, Translation.

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1 INTRODUCTION

Rogers' (1962, 1971 with Shoemaker, 1983, 1995) theory of diffusion of innovations has evolved over the last thirty years or so, and represents a strong body of ideas that have had considerable influence on a number of disciplines, including for example marketing (Mahajan & Muller, 1979, Kotler, 1994), as well as studies concerned with the adoption of information technologies (IT) (Fichman, 1992, Levine, 1994). However, **diffusion** is only one way of thinking about IT innovations, and we suggest here that actor network theory (ANT), through the concept of **translation** (Law, 1986, Callon, 1986, Latour, 1987,1993) provides a valuable counterpoint to diffusion theory. In particular, ANT sheds light on the situated and intensely practical nature of the mechanisms involved in technology transfer; these processes, we will argue, are not adequately described in the diffusion metaphor. This paper thus aims to contrast two sets of ideas concerning technological innovation and adoption - Rogers' diffusion theory, and the translation perspective of ANT. The difference in perspective afforded by the two theories will be illustrated by applying them to a case study of what turned out to be a failed technology transfer initiative.

The paper is organised thus: in the second section Rogers' theory of diffusion is reviewed and terms defined; in the third section an alternative way of viewing technology transfer is presented using actor network theory (ANT); the fourth section contrasts Rogers' notion of diffusion with the ANT idea of translation using the case study; and in the last section we draw some conclusions concerning diffusion/translation theories of technology transfer.

2 KEY CONCEPTS IN DIFFUSION THEORY

Rogers (1983) defines diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. The key concepts of diffusion theory are **innovation**, **communication channels**, **time** and **social systems**.

Innovation refers to an idea, practice or object (we will use the term 'technology') which is perceived as new by an individual or other 'unit of adoption' (ibid., p.11), and, as an illustration applied to IFIP WG8.6, this might include for example a research finding, hypothesis, theory, model, generalisation, method, practice, insight or claim. It must be 'new' to the adopter, although it may not be new *per se*. For example Alan C. Kay, Chief Scientist at Apple (formerly with Xerox PARC), has related how it took 20 years for the design of laptop computers (for which he is widely credited) to get from the drawing board to the market

place.[1] Such lengthy lead times may not be so uncommon. Rogers too tells how it took close to 300 years for the British navy to adopt citrus fruit as a means of eradicating scurvy from its military and merchant seamen (ibid., pp. 7-8).

A curious anomaly is that sometimes diffusion does not occur despite the technical quality of the innovation or the intellectual merit of the idea. For example, Rogers (1995, pp. 8-10) cites the case of the Dvorak keyboard which has failed to become accepted (despite its 'obvious' superiority over the QWERTY keyboard) - Rogers attributes the cause of this failure to 'vested interests'. Failure to diffuse may be most easily brought to mind through physical technologies, such as the Dvorak keyboard and the Sinclair C5 as a means of transport for example, but it is also pertinent in the world of ideas - we still consider Columbus to have 'discovered' America regardless of the evidence of Vikings having settled at L'Anse-aux-Meadows in Newfoundland [2] some 500 years or so earlier, and we might also mention the previous millennia during which the lands were inhabited by indigenous native peoples.

The rate at which an innovation spreads through members of its potential adopter society is influenced by characteristics pertaining to the innovation itself, characteristics of the adopter, as well as other factors such as the culture of the organization, and the influence of opinion leaders. Characteristics of the innovation include **relative advantage** - the degree to which it appears superior to existing products, **compatibility** - the degree to which it matches values and experiences of individuals in the community, **complexity** - the degree to which it is relatively difficult to understand or use, **trialability** - the degree to which an innovation may be experimented with on a limited basis and **observability** - the degree to which the results of an innovation are visible to others. Characteristics of the adopter include social status, level of education and 'cosmopolitanism'. Organizational issues include size, structure, and degree of centralization or decentralization, while opinion leader influences include their technical competencies, social accessibility, the degree to which they conform to the 'norms' of the social system, and the degree to which they support or reject the innovation.

Communication (channels) are the means by which innovations are transferred from one person or group of persons to another or others. They may include mass media as well as interpersonal, face-to-face methods of exchange.

Time affects the diffusion process in three ways: First, in the innovation-decision process, that is the steps through which the adopter passes from first knowledge of the innovation to the decision to adopt or reject. Second, the degree of innovativeness of the adopter is purported to equate with the degree of earliness (or lateness) that individual is prepared to adopt the innovation relative to others in his

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[1] Lecture given at BAFTA in London, 1994

[2] Exhibits at the Viking Ship Museum, Oslo

or her social system. Third, the rate of adoption (alluded to above), or the number of adopters in a social system within a given time period.

Social systems are communities engaged in joint problem-solving. An important facilitating factor according to Rogers, is the degree of 'homophily' between individuals, or the extent to which they share the same or similar interests, since it is argued that this makes for better, more effective communication. Nevertheless, a degree of heterophily is necessary for diffusion to occur, since an identical technical understanding of the innovation means there would be no 'new' information to exchange and no unforeseen/fortuitous applications of technology. Other features are that the social system is structured, and has its own norms.

3 ACTOR-NETWORK THEORY AND TRANSLATION

Actor-network theory (ANT) proceeds from a radically different set of ideas, and is concerned with the building of facts ('black-boxes').

Facts (claims, machines, innovations), far from waiting passively to be uncovered (discovered or invented), are instead created across time and space from chains of weaker to stronger associations of human and non-human alliances. This occurs by virtue of the relative convergences of their respective interests. These 'lash-ups' of heterogeneous **actants** (Law 1986), at first *"an assembly of disorderly and unreliable allies"*, slowly evolves into *"something that closely resembles a black box"* (Latour, 1987, pp. 130-131). Each new ally strengthens the chain, making the box blacker, the fact harder, as the network lengthens across time and space. But this is not a description of some mysterious diffusion process. Each actant **translates** and contributes its own resources to the shape and ultimate form of the emerging black box. Whenever there is a clash between claim and counter-claim, the outcome will always be decided by that claim which is able to enrol and control the interests of the greater numbers and strengths of its allies (hence the futility of a few inscriptions enrolled in support of the Dvorak keyboard, against the enormous strengths of the QWERTY coalitions for example). The problem for those engaged in the building of facts therefore, is how to enrol and control the others.

Latour outlines a number of strategies for enrolling others in the creation of a black box: to appeal to the other's explicit interests; to get the others to follow our interests; to suggest a short detour (this is particularly strong when their road is blocked); to reshuffle interests and goals by tactics such as inventing new goals, inventing new groups; by becoming indispensable to the others. To build a black box others have to be enrolled so that the 'embryonic fact' is appropriated and spread across time and space; once enrolled the others need to be kept in line so that how the 'fact' is translated remains recognisably the same, hardening and blackening as the network lengthens. But the theory stresses that the control of any individual actor (even the author!) over this process is necessarilly limited; translation inevitably entails metamorphosis and loss of sovereignty, despite strenuous authorial efforts to retain control.

For example, in reporting a case study involving the introduction of an automated access control system (AACS) for a car park, Vidgen & McMaster (1996) note that in one sense the AACS is unchanged as a result of the implementation, since it still contains basically the same programs and physical components as it did before installation in that organization. They go on to argue that, in a more interesting sense, the technology has changed significantly through being translated by others in a way that the suppliers had not envisioned. The suppliers of the AACS wish to disseminate the AACS through time and space by enrolling others; the supplier's aim is to spread the AACS through lengthening the network, while at the same time exercising control over the form of the AACS, that is over the translations and inscriptions that occur. In the case study reported, the AACS has been translated in such a way that its progress through time and space has been slowed and runs a risk of being halted altogether. An IS failure might thus be seen as the outcome of new claims (translations) that clash at wider angles with a subsequent weakening of the network. In this sense the AACS, although physically unchanged, has nevertheless been translated differently to that intended by the suppliers, and therefore cannot be said to be the same object it was before the implementation took place.

The concept of translation is further elaborated in the work of Michel Callon (1986). Taking the ontogeny of scientific controversies as his domain of interest (i.e. their genesis, development and resolution), Callon identifies four phases ('moments') in the translation process. The first moment is that of **problematization** in which an issue is defined to be problematic by a group of actors (possibly one), e.g. there is a problem of access to the car park. The nature of the problem and the role of others is defined during this inaugural phase in such a way that the actors establish themselves as indispensable to the solution of the problem (the actors attempt to establish themselves as an 'obligatory passage point'). **Interessement** constitutes the second moment, consisting of the deployment of devices aimed at imposing the roles and identities defined during problematization on other actors. If successful, interessment leads to the actual **enrolment** (the 3rd moment) of these actors, and hence the establishment of a stable network of alliances. Once the network has been effectively created, it is **mobilised** (fourth moment) and whatever solution (fact / technology) the actors proposed gains wider acceptance, albeit subject to the translations that perforce occur.

4. A CASE STUDY

Diffusion and translation represent two fundamentally different models of technology transfer. In this section we will attempt to contrast these two paradigms with reference to a case study, before proceeding to a critical synthesis.

The case deals with the failure of a UK City Council (UKCC) to adopt a structured method (SSADM) as its systems development methodology. Such failures may not be so unusual. Wastell (1996) for example, in a separate study reports on a similarly abortive attempt at adopting SSADM, this time in a large commercial mail-order company. Problems encountered in both cases were similar, and both led to the abandonment of the innovation.

The bare bones of the case will be presented first before proceeding to two analyses from the perspectives of both diffusion and translation theories. A more detailed account of this particular case study may be found in Kautz & McMaster (1994).

4.1 A synopsis of the case

UKCC is a large organisation with 17 departments, employing (at that time) a total of more than 35 000 staff. The IT Unit which acts as a central IT Services provider for all departments, consisted of 130 staff in two groups: development and operations. The Unit was headed by an IT Manager with a Development Manager - known as the Chief Development Officer (CDO) and an Operations Manager respectively. The case study concerned only the development section.

Development staff were organised into teams, each led by a team leader who was also often a systems analyst. In addition the teams would typically contain one or more Senior Programmers, and one or more Junior Programmers. Teams were responsible for the development and maintenance of their client department's systems, such as Housing, Land and Property, and Education for example.

In 1988, at least in part as a response to the increasingly vociferous expressions of dissatisfaction with the services provided by the development section, the CDO decided that the IT Unit would adopt SSADM, the leading structured method in the U.K. She organized a grand speech, invited all the Chief Officers and other key figures from client departments, and declared that this innovation would be the answer to all of their problems. Development times would be reduced and therefore less expensive, systems would be more flexible, maintenance simpler, and so on.

Training and a CASE tool were procured and a Housing pilot project selected for initial implementation. However considerable problems were experienced from the outset with the attempt to introduce SSADM. In particular, and in a nutshell the development staff bitterly resisted this technological innovation with the end result being that the initiative had to be abandoned. The CDO left the organization shortly afterwards.

4.2 Diffusion theory

In essence, diffusion theory depicts technology transfer as a process in which three main sets of factors bear on the decision to adopt or to reject. These sets of factors pertain to the attributes of individual recipients (e.g. their attitude towards change), the characteristics (norms, values, culture) of the social system which they inhabit,

and features intrinsic to the technology itself (complexity, trialability, etc.). Certain configurations of these factors are held to dispose the adoption process to a felicitous outcome, while other juxtapositions are seen as less favourable. Rogers thus provides a framework which can be used for predicting the likely outcome of a transfer initiative or for performing a post hoc interpretative analysis. In essence, his framework is an example of what is known in IS research as a factor model (Newman & Robey, 1992), in which the analysis hinges on determining the 'settings' of certain key variables. Once these are known, the outcome follows with causal inevitability.

Kautz & McMaster (K&M) present a thorough analysis of the failure in the UKCC. A 'Rogerian' reading of their analysis would attribute failure to the following inauspicious configuration of factors (not unlike astrological 'star signs' used to explain failure rather than astronomical theories with predictive ability):

- **Recipient variables**. It will be remembered that the recipients were the IT development staff. Rogers argues that a personality disposition that is receptive to change and a strong perceived need for innovation are critical in recipients. It is apparent from K&M that recipients were unconvinced of the need for change, and hence they resisted.
- **Social system variables**. K&M highlight the key role played by culture in the failed implementation, in particular the clash between the strict formal discipline required by SSADM (a claimed strength of the methodology) and the informal working practices that characterised the traditional work habits in the IT Unit. Thus the vicissitudes experienced in implementing SSADM can in large part be put down to the conflict between the values and norms implicit in the methodology and those prevailing in the UKCC.
- **Technology variables**. On top of the problems of cultural compatibility that we have discussed, SSADM also possesses a number of intrinsic features which are inauspicious: it is low on relative advantage and its benefits are not readily observable (there is lack of hard evidence of its superiority); moreover, SSADM is complex, hard to understand and therefore difficult to experiment with (low trialability).

Two further issues underlying the failure are suggested by a factor-oriented reading: **lack of staff involvement** - development staff were not involved in the decision to adopt SSADM, it was imposed on them by the CDO; and **lack of senior management support** for the SSADM project - the CDO appeared to be operating more or less on her own, with no support from other departments or the senior management echelon. These two factors, user involvement and senior management support, are generally held to be critical to the success of any innovation (Laudon & Laudon, 1994).

4.3 A translation analysis

We will now perform an exegesis of the case from an ANT (translation) perspective in order to examine the sort of contrasting narrative that emerges. The key to

technology transfer from this viewpoint is the creation of a powerful enough consortium of actant's interests to create the required 'fact' (carry through the innovation). The SSADM fiasco can thus be attributed to the failure of the CDO to create such a strong and stable network of alliances. Let us begin by looking at how she initially problematized the situation.

Three key groups of actants figure in the problematization: users, development staff and 'IT projects'. The latter group, though 'non-human' are nevertheless crucial players: symmetries of people and things, science and nature, organization and technology are a fundamental aspect of ANT. Latour argues that it does not matter whether we look at the things, such as SSADM, or at the people since these are two sides of the same coin, constituting an inseparable sociotechnical imbroglio (Latour 1993). The CDO then attempts to draw these actants into a coherent coalition by establishing a common interest in the solution she proposes - that is, the adoption of SSADM. Several interessement devices are deployed to this end.

The CDO attempts to recruit the support of users, arguing that SSADM would help overcome problems of late delivery and low quality by improved requirements capture, better project discipline, and so on. The support of developers is solicited by arguing that SSADM will help them cope better with the applications backlog by increasing productivity and quality. The projects themselves are enlisted in the argument, with the CDO proffering SSADM as a way of improving project management and documentation quality.

Through these manoeuvres we see the CDO attempting to build up a coalition of interests involving three significant actants - developers, users, and projects - establishing a mutuality of interest in the technology she is attempting to implement. The putative benefits of SSADM are used to make a common cause between the users, the developers and the IT projects; all have problems that SSADM can help to address: the users want systems delivered on time, the developers want to improve requirements capture, projects want to improve the quality of their documentation. SSADM is advanced as the answer to the needs of all, human and otherwise.

However, as we have seen, the SSADM project ended in failure, the translation process failed to produce the desired 'black box'. In essence, the failure reflects the CDO's inability to construct the required network of alliances amongst the other actants. Translation processes are dynamic, dialectical processes; a single actor does not hold privileged sway over the development of events, but different groups of actors compete in 'trials of strength' in order to establish their self-interested problematization. One 'entity' will attempt to enlist the support of others; the others may submit, but they may also refuse and attempt to forge alliances of their own to resist the plan.

In the UKCC, the developers having lost some ground fought back. They resisted the idea that SSADM was the answer to the IT function's problems. To this end, they recruited the support of both the other parties. The interessement device they used was the formal bureaucracy of SSADM, turning on its head in a nice irony the very arguments that the CDO had used for its adoption. The developers argued that

far from decreasing lead times, the bureaucracy of SSADM forced them to waste effort on unnecessary documentation which was causing serious dissatisfaction amongst the users. Common cause was made with the IT projects on the same basis, that far from improving documentation and efficiency, SSADM entailed the opposite: more, not less documentation and worse still, the diagrammatic representations required by SSADM were largely unintelligible to users. Thus the bureaucracy of SSADM was used by the developers to create a coalition of interests between projects and users which ultimately proved too strong for the CDO.

5. DIFFUSION OR TRANSLATION?

Diffusion theory suffers from a number of weaknesses. There is for example the 'Schumpeterian thesis' which suggests that capitalist-driven organizations have little interest in transferring technology, or the necessary skills, knowledge or information to support it (Attewell, 1992, p. 6). Other problems acknowledged and recognised by Rogers, include 'pro-innovation bias', and the troublesome concept of 'blame' (individual or system).

In addition we recognise further problems stemming from the **separation** of society (people) and technology (things), that are inherent in models of diffusion. A key problem is the notion that facts (and machines) occupy an existence which is somehow independent of humans, through which they are thereby able to diffuse, reproducing themselves through their own velocities and trajectories, or what Latour calls **vis inertia** (1987, pp.132-136). The implication is that once the 'fact' (discovery or invention) has been pointed out to people, it is simply (more or less) a matter of time before everyone recognises it as being obvious. It had existed, at least in principle, all along, and was simply waiting to be uncovered. Those who refuse to acknowledge these facts are **resistors** (with subsequent attendant notions and theories of resistance) who, it is claimed are often protecting a 'vested interest' of some description.

This notion about facts leads to another problem for diffusionists, and that is their need for **geniuses**; discoverers and inventors who are in some way superhuman; who appear to single-handedly uncover hidden truths (facts), or who invent new technologies (innovations) for the benefits of the rest of an intellectually inferior humanity of mere mortals. ANT has no need for people of such special status, recognising that they are merely links in a longer chain.

In table 1 we interpret the key themes of Rogerian diffusion theory using the language of ANT.

	Diffusion	**Translation**
Innovation	a technology perceived to be new by the adopter	a technology yet to be "black-boxed"
Communication	channels (cosmopolite / localite) (mass media / interpersonal) through which innovations are transferred	inscriptions and translations are made
Time	speed of decision to innovate; earliness of adoption; rate of adoption	network dynamics in enrolment, control, and dissemination
Social system	homophily - sharing of interests of human actors	interesse - between actants (human and non-human 'actors') and goals - black boxes form when interests move in the same direction
Technology	changes are made to the form and content of technology as a result of experiences of implementation (reinvention)	the technology changes (is translated) through being enrolled - regardless of whether the form or content of the technology is modified
Sociotechnical stance	social system and technology are separate - diffusion is adoption of technology by a social system (technology transfer requires the bringing together of social and technical elements)	social system and technology are inseparable - successful technology transfer gives the appearance of separation, but this is merely evidence that the actor network has stabilised

Table 1: Diffusion reinterpreted as translation

In many ways it might be argued that diffusion theory and translation are remarkably similar, using different words to describe what is to all intents the same thing. We argue that this would be a misleading and superficial analysis of the two schools of thought. The Rogerian project seems to us to be an exercise in factor analysis; a search for causal factors that explain why some technology transfers are successful and others failures. The factors are then operationalized such that they can be tested through experimentation and their predictive ability assessed. As such, diffusion theory is firmly rooted in 'high modernism' and a desire to make links between cause and effect. The ANT approach is concerned with the highly-situated, mundane translations that arise in actor networks rather than the politics of explanation, *"belief in causes and effect is always, in some sense, the admiration*

for a chain of command or the hatred of a mob looking for someone to stone" (Latour 1988, p.162).

In diffusion terms, SSADM failed to be adopted by UKCC; the technology remains essentially unchanged as a result of this experience - certainly the contents of the SSADM manuals and training courses are unlikely to be affected. In ANT terms SSADM is not the same technology - it has been translated, in the eyes of the UKCC at any rate, who now perceive SSADM to be cumbersome and difficult to use. Although this might not be a strong enough inscription to affect the wider usage of SSADM, should other users make similar inscriptions then the network of alliances that make SSADM a black(ish) box might well begin to unravel.

A diffusion approach to IT innovation is concerned with the identification of factors that contribute to, or inhibit, successful transfer of technology, whether it be a methodology, a piece of software, or a concept such as 'quality'. Technology transfer becomes abstracted and generalized and of little practical value since although it might explain success and failure after the event there is little evidence that it could provide real predictive power. ANT on the other hand requires that we throw away our naive belief in cause and effect (i.e. factors) and focus on understanding how actor-networks (people **and** things) are created, strengthened and weakened. This means that we need IS research that documents the translations in all their glorious messiness and irrationality, rather than in sanitized accounts created after the fact.

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