Towards a semiotics of machines: the participation of texts and documents in the design and development of an information technology-based market device

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Introduction

This article presents a research project that used an actor-network theory inspired approach to study the design and development of an information and communications technology (ICT) based system for the settlement of securities transactions across six marketplaces and five jurisdictions. Through this account it is hoped that some broader issues relating to the implications of actor-network theory for the study of technological design can be outlined, especially in relation to the role of design project related documents and texts.

The article starts by outlining some of the key notions of actor-network theory judged of relevance to technological design in the setting investigated. It then goes on to discuss the suggestion by Latour and Akrich that technological objects can be analysed through what they call a "semiotics of machines" and to outline in more detail Akrich's notion of technological objects as scripts (Akrich 1992, Akrich and Latour 1992, Latour 1992, 1993). The empirical setting studied and how this was placed into an actor-network theory analysis are then described, focusing in particular on the use of documents in the design of the ICT system studied. The unusual role of documents in situations of technological design implied in actor-network theory is then contrasted with other research approaches premised on the use of documents and texts as evidence. Finally, the implications of this for researchers and practitioners with an interest in technological design are also discussed.

Actor-network theory and technological design

The central ontological premise of actor-network theory is that there are no such things as pure objects or subjects but heterogeneous assemblages of human and non-human entities defined through their interrelations (Latour 1999). Within such a view, objects result from the ordering of these entities (Law 1992, p.380). It is this ordering that can be seen as the closest to the notion of design. The empirical study of design or ordering, therefore, must focus on decoding and explaining how this order is achieved and how the constituent elements are fitted or – using actor-network terminology – articulated together to form a more or less stable whole.

The main difficulty when undertaking such studies is that the accounts of the engineers and designers themselves regarding how this ordering is achieved are not enough (Latour 1987, pp.3-15). This is because they depend on objects being well defined and unambiguous in order to be able to do their work. Such well-defined objects are referred to in actor-network terms as black boxes and it is the central task of any researcher of technology to find ways that do not depend on the accounts of those assembling them to open these black boxes in order to understand how they are put together (Latour 1987, pp.14-15).

It is situations of contestation and/or breakdown relating to one or more of the articulations that compose a black box that this becomes possible because the researcher then gets an opportunity to follow the ways through which order and stability are (re)established – or not – and identify the entities involved in the contests.

In actor-network theory machines are not treated as particularly different from other objects, apart from having a greater density or hardness (Latour 1987, p.122). This is because by using material things to bind entities imparts to the resulting assemblage greater durability and stability, making it easier to get the entities brought together to act as one (Latour 1987). Ultimately, however, just like other sociotechnical assemblages, a machine knits together a whole system of relations between human and non-human entities and machines, therefore, need to be studied as sociotechnical networks.

The key to studying the assembling of sociotechnical networks is to make the identification and following of the articulations of entities brought together the centrepiece of any investigation. This is likely to involve:

- Identifying and recording the entities being associated

- Understanding how the strength and persistence of their linkages is achieved

- Following how obstacles and resistances to articulations are dealt with

As the author or designer of a proposed sociotechnical arrangement moves from one element to the other tying them together, a trajectory is traced that can be followed and described by the researcher (Latour 1987, p.202). When resistance is encountered, for whatever reason, to an articulation proposed for a person or a thing, the way this resistance is dealt with (e.g. by-passing, reaching an accommodation, overcoming) provides a wealth of valuable material for the researcher as more entities get brought in to the process of assembling in order to overcome the impasse.

For things to be articulated with humans they have to be made compatible with human systems of communication and understanding (Latour 1987, p.223). A crucial notion in actor-network theory in this respect is that of immutable mobiles that serve to make the world mobile and combinable with other sociotechnical networks and their constituent entities. Immutable mobiles enable things from the past or far-away to be brought close-by and their mobility means that they have the ability to circulate around the networks they are part of (Latour 1987, p.223). In so doing, they also trace the system of relations that constitute a particular assemblage and a researcher can follow these as part of an investigation into the constitution of a sociotechnical assemblage. They are also combinable so can be shuffled, aggregated, and compared, generating new insights and knowledge and making calculations and the assessment of courses of action possible (Latour 1987, p.223).

Towards a semiotics of technology

Just like with languages, articulations of human and non-human entities have their own – even if highly local and idiosyncratic – syntaxes, grammars and logics that those studying their assembling must try and understand and describe.

Developing this parallel with language further and drawing from the toolbox of semiotics, Akrich puts forward the notion of technological objects as scripts according to which the designer of a technological object, like a scriptwriter, assigns to human and non-human entities roles, actions, and attributes (Akrich 1992, pp.207-208). Like a play with actors, props, scenery, a stage, an audience, a venue and so on, a technology is performed when all the necessary elements are brought together successfully.

Taking such an approach, the work of the researcher is to "de-script" these scripts and put on paper the text of what the various actants in the setting being investigated are doing to – or with – one another (Akrich and Latour 1992, p.259).

While such de-scripting can encompass the entire set of relations and entities that come together when a technology is performed, for Akrich analytical attention is more fruitfully focused on "controversial zones" that are usually found at the boundaries of technological objects where "the battle leading to the supremacy of one design over another are waged", rather than on the more extensive zones of consensus (Akrich 1992, p.223). This is because it is in the struggles that ensue from these controversies and that are part of the mechanisms for dealing with them that "objects are defined by subjects and subjects by objects" (Akrich 1992, p.222).

The research setting

The technological design project studied in the research being presented here was for an information and communications technology (ICT) based system for the settlement of financial securities transactions across and five jurisdictions (UK, Ireland, France, Belgium, Netherlands)[1].

The settlement system in an essential component of any financial marketplace such as a stock

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[1] The main securities involved are equities and corporate and government bonds.

exchange. When two transacting parties trade on such an organised marketplace they essentially agree to exchange a certain number of, say shares in a company, for a certain amount of money. While it may appear that once a deal has been agreed the transaction is effectively over, in reality there are a number of back-office procedures that need to be completed before what is referred to as "finality" is achieved on a legal basis and all obligations between the two parties are irreversibly discharged. This is where the settlement system comes in and (Fig. 1) illustrates the key steps that follow a trade and that are dealt with by the settlement system.
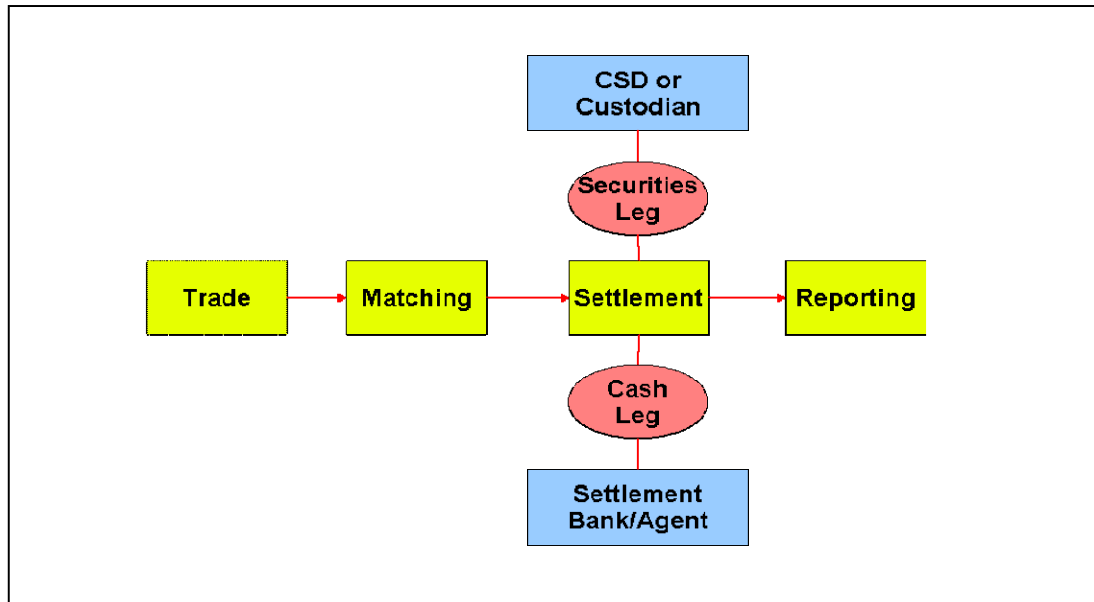

Figure 1: The role of the settlement system in financial marketplace transactions

First, the instructions and terms of the trade that have been inputted by the two sides have to be compared and any ambiguities or mismatches reconciled in what is referred to as matching. Then, once the two instructions are in complete agreement, they are put into a queue and when their turn comes to be processed the settlement system will transfer the securities concerned from the central securities depository (CSD) account of the seller to that of the buyer and at the same time debit the cash account of the buyer at one of a number of banks approved to provide payment services relating to the settlement system and transfer that amount to the account of the seller with that or one of the other approved banks. Finally, the system will report the conclusion of the transaction and provide an update of the positions of the two parties and their holdings to them and to any outside authorities such as regulators and tax agencies that also need to be informed of such changes.

While this sounds like quite a straightforward process, in practice, the need for simultaneity and legal certainty combined with the huge number and value of the transactions being processed make settlement a very complex and intricate affair.

The design initiative studied in this project involved the development of a single ICT platform to handle securities settlement for five settlement systems (CREST, Sicovam, Euroclear, CIK, NECIGEF) covering five different jurisdictions (UK, Ireland, France, Belgium, and the Netherlands).
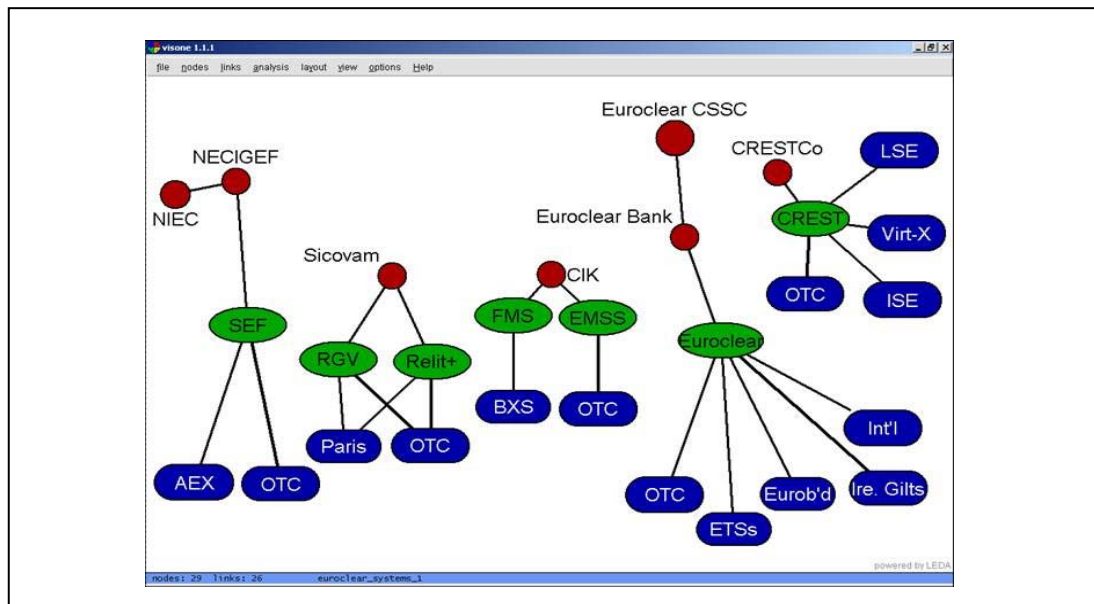
Figure 2: The situation before the Euroclear initiative

Through a succession of mergers, the operators of the separate settlement systems came under the ownership of Euroclear, the entity that up to then had owned and operated the Brussels-based Eurobond settlement system by the same name. The new ownership structure of Euroclear reflected the amount of business different market participants would bring to the consolidated entity, with the previous settlement system operators becoming its subsidiaries.
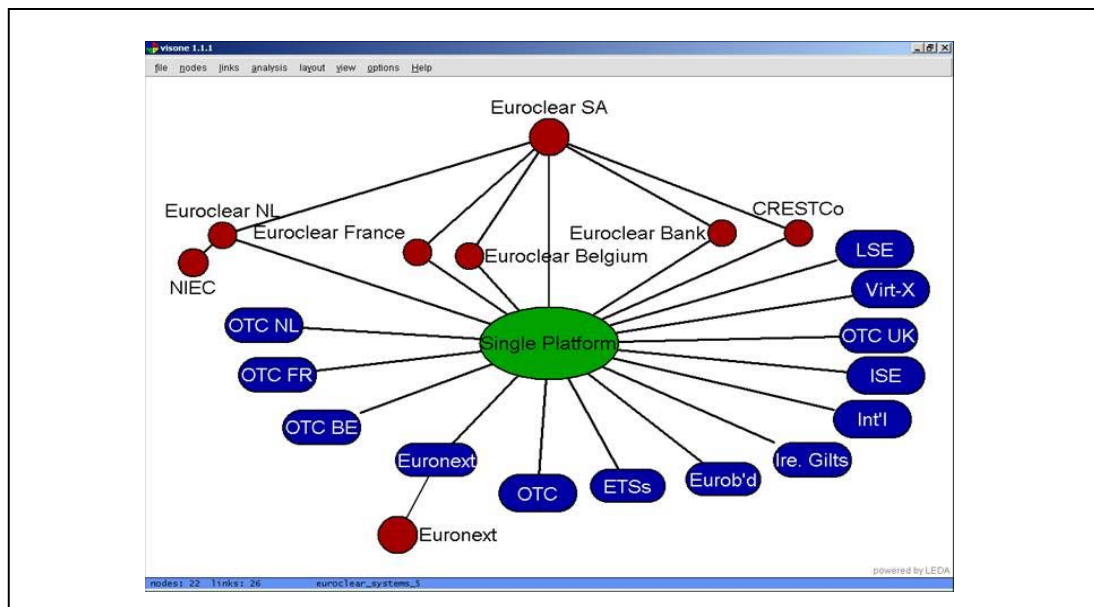

Figure 3: The reconfiguration that would result from the Euroclear initiative

It is Euroclear and its designers and engineers that conceived of and are developing the single platform to replace the seven existing platforms (represented in (Fig. 2) by green ovals) with one single entity as shown in (Fig. 3).[2]

Once this single platform is in place the trading of securities across the marketplaces and national jurisdictions involved would be no different from a domestic transaction previously.

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[2] The red circles correspond to the corporate entities that operated the settlement platforms and the blue lozenges the exchanges and marketplaces they provided settlement for.

Translating actor network theory into a concrete research project

The starting point of the analysis of this setting was MacKenzie's suggestion that marketplaces should be considered as technological black boxes and their assembling and design studied in the same way as other technological objects (MacKenzie 2005, p.555).

Seen in this light, the design of the new integrated securities system represented a rare moment when the black box of a financial marketplace was opened, disassembled, had new components added and old ones modified and then re-assembled.

Because the settlement platform at the heart of any settlement system so clearly defines a whole set of relations among a number of human and non-human entities that perform securities marketplaces, Akrich's notion of technological objects as scripts that define "a geography of responsibilities" was also adopted (Akrich 1992, p.207).

Taking this approach, the main practical objectives of the empirical investigation were to:

- Identify the actants involved and their articulations

- Understand the syntaxes, grammar, and logic of these articulations in the designers' script

- Trace the transformation of this script through time and materials

- Account for how the stabilisation and durability of the resulting relations is achieved

In other words, to "de-script" the script being written into the new settlement platform by the Euroclear designers, tracing its movement from signs to things through the tying together of laws, ICT devices, economic calculations and theories, contracts, money, obligations, geopolitical interests and worldviews.

It is by following the transformations undergone by a collective of people and things in this way that it would then be possible to identify the clusters of actants that "stay together through successive versions [of the script] without defecting" and thus become stabilised enough to be considered as black boxes (Latour, Mauguin and Teil 1992, p.41).

The empirical material

For the project as a whole, a range of evidence was utilised, including project-related documentation, operational manuals, terms and conditions and service level agreement documents, internal and external newsletters, statutes, public policy and commercial reports, interviews and ad hoc conversations with the designers and other settlement professionals, minutes from market advisory committee meetings, participation in training workshops, texts of speeches, and articles from the press.

The primary entry point, however, were the documents used by the Euroclear designers for consultation with marketplace participants that would in any way be affected by the new arrangements. Through these documents the designers informed the market participants of their proposals, inviting them to respond, comment, or object.

The consultation mechanism deployed by Euroclear stemmed from requirements in the UK for public consultation with market participants for even small changes in settlement system functionality and was similar to the UK parliamentary process using Green and White papers (CRESTCo 2005, p.9).
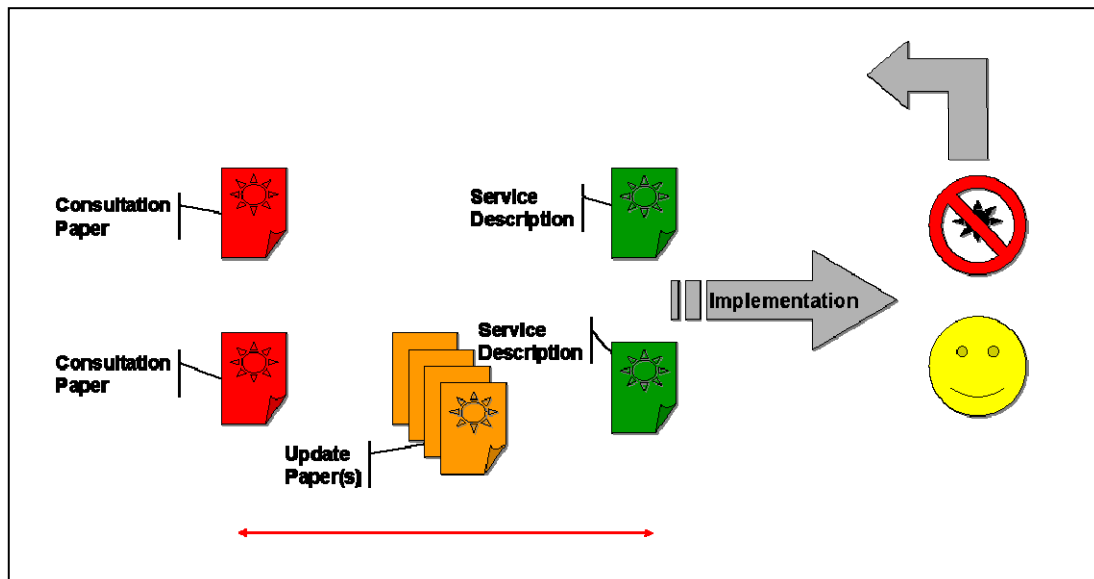
Figure 4: Document-based marketplace consultation process

Adapting the Green and White Book terminology of the UK to a cross-jurisdictional setting, consultative documentation for the project was classified instead as either a Consultation Paper, an Update Paper, or a Service Description. As (Fig. 4) shows, according to the amount and importance of the comments and feedback received from the publication of a Consultation Paper, either an Update Paper would be issued taking into account the comments received or explaining why these would not be acted upon initiating a second iteration of the consultation process, or, if little or no feedback or comment was received, the original Consultation Paper would form the basis for the Service Description.

Through this mechanism, these documents – once stabilised – would then form the high-level specification for the software coders and computer engineers to work from when developing the actual ICT platform. If at some point for technical or other reasons the resulting functionality during implementation differed from that outlined in the Service Description, the whole consultative process for that particular aspect of the system would have to start afresh.

The consultative documentation was seen as particularly important to this empirical investigation because it provided an unambiguous, public, and easy to read outline of the associations of human and non-human entities proposed by the designers of the platform.

Furthermore, the documentation and the consultation process it was at the centre of provided a good way of identifying the "consensual" and "controversial" zones of the technical object being investigated here. When a Consultation Paper moves, with hardly any change, to being a Service Description, the actants specified in it, the relations and articulations that are proposed for them, and the roles they are expected to perform can be considered as non-controversial and thus as having achieved a degree of stabilisation. If, on the other hand, after a Consultation Paper is published many Update Papers are issued and a Service Description proves illusive, it is fair to assume that some issue or controversy is persisting and investigative attention should be directed there. The progression of a controversy through the various documents generated was thus followed and problems in terms of the enrolment of actants identified.

In this way, the progression of the arrangement proposed by the designers was mapped and tracked using network visualisation software from business plan, through consultation documentation, to actual ICT platform.

Texts and documentation: an ally in the study of technological design

The central role that the consultative documentation played in the design initiative studied here chimed with a number of other research approaches that have given texts and documents a central position in their investigations and go beyond traditional concerns with content and discourse.

For example, research located in the social studies of finance field that counts the material practices found in finance among its central research interests have sought to study documents and texts in a way that goes beyond concerns with business efficiency, communication, content, and productivity (Preda 2002, p.208). These approaches see documents not just in terms of the organising, transmitting, and storing of information, but as participating in the assembling of the sociotechnical networks of finance.

Similar arguments have been pursued by Cooren (Cooren 2004) in organisational studies, who writes:

> Texts participate in the channelling of behaviours, constitute and stabilise organisational pathways and broadcast information. By remaining, [they] fabricate relatively fixed spaces and times, define objectives and invite humans to follow specific organisational paths.[3]

In relation to the study of technosciences Latour also makes the point in *"Pasteur on Lactic Acid Yeast: A Partial Semiotic Analysis"* that scientific texts and documents are as much part of scientific practices and the making of science as laboratories, instruments, controversies, disciplines, and institutions and as such should be considered as important actors in the building of actor networks (Latour 1993, p.129).

In this research the consultative documentation that formed an important part of the empirical evidence used as well as a number of other project-related documents, were found to have an important role as an early, word-based, outline of the sociotechnical network being assembled. The malleability and recombinability of words and language make such documents a low-cost and low-risk way to make and present a mental model of a machine that is to be developed. They can be seen as the bare bones of a sociotechnical network to be gradually fleshed-out, in this case using ICTs.

They are not just networks of letters, words, and sentences linked by the grammar, syntax, and semantics of language and restricted to connections with other texts and literary inscriptions (Callon 1991). They are a crucial part of the path of the proposed sociotechnical network as it moves from the realm of thoughts and concepts, through words, to stable material entity. They have to be read, therefore, as maps rather than just conveyors of meaning and information and as such can be conceptualised as a kind of technology of enrolment.

For researchers documents and texts considered in this way open-up a source of previously underutilised empirical evidence and provide a way of overcoming epistemological problems encountered in research approaches that are dependent overly on the interpretation of accounts of human informants. For those involved in technological design it is hoped that the rationalisation of many of the techniques they already deploy in this article, will enable them to see more clearly the centrality of processes of textualisation, inscription, and enrolment to their projects and to come up with ways of using, analysing, and improving these techniques in a more conscious way in order to advance their work as assemblers of sociotechnical networks.

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[3] In (Cooren 2004, p.388)

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