Trojan actor-networks and swift translation

Bringing actor-network theory to IT project escalation studies

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Abstract *This study investigates the potential of actor-network theory (ANT) for theory development on information technology project escalation, a pervasive problem in contemporary organizations. In so doing, the study aims to contribute to the current dialogue on the potential of ANT in the information systems field. While escalation theory has been used to study "runaway" IT projects, two distinct limitations suggest a potential of using ANT: First, there is a need for research that builds process theory on escalation of IT projects. Second, the role of technology as an important factor (or actor) in the shaping of escalation has not been examined. This paper examines a well-known case study of an IT project disaster, the computerized baggage handling system at Denver International Airport, using both escalation theory and ANT. A theory-comparative analysis then shows how each analysis contributes differently to our knowledge about dysfunctional IT projects and how the differences between the analyses mirror characteristics of the two theories. ANT is found to offer a fruitful theoretical addition to escalation research and several conceptual extensions of ANT in the context of IT project escalation are proposed: embedded actor-networks, host actor-networks, swift translation and Trojan actor-networks.*

Introduction

Escalation is a phenomenon in which an organization or other acting entity persists in pouring resources into a failing course of action (Staw, 1976). In the field of information systems, the problem of project escalation is an important issue given that escalation in software projects is quite common (Keil *et al.*, 2000), that it is often a precursor of

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failure (Ewusi-Mensah and Przasnyski, 1991; Lyytinen and Hirschheim, 1987) and that the frequency and costs of IS development failures are considerable (KPMG, 1995; Johnson, 1995). The problem of IT project escalation remains highly relevant, while the remedies are far from well known (Keil and Robey, 1999, 2001).

Notwithstanding their important insights in understanding runaway IT projects, existing escalation studies present two distinct limitations that suggest an opportunity to apply ANT. First, there is a need for research that builds process theory on the escalation of IT projects (Montealegre and Keil, 2000), a shortcoming shared with escalation theory (Ross and Staw, 1993). Second, previous escalation studies have not investigated whether the shaping and role of technology is an important factor, let alone actor, in how escalation occurs (cf. Keil, 1995a; Newman and Sabherwal, 1996; Staw and Ross, 1987).

Actor-network theory (ANT) in general (Callon, 1986; Callon and Latour, 1981; Latour, 1999), as well as in its applications within the information systems field (Holmström and Stalder, 2001; Walsham, 1997; Walsham and Sahay, 1999), addresses the role of technology in social settings and the processes by which technology influences and is influenced by social elements in a setting over time. Given this focus, ANT offers a promising theoretical approach to the understanding of IT project escalation.

In particular, the ANT view of how ideas, values and intentions of social actors become inscribed in technology (Akrich, 1992; Akrich and Latour, 1992) and how this inscription renders intentions immutable over time (Latour, 1991) suggests a possible complementary (or alternative) view of how escalation occurs. This view would specifically address the role and constitution of technology that is not expressly addressed by escalation research. It is expected that viewing technology as an actor in escalation will pose a different understanding for reversing escalation trajectories than previously suggested in escalation and de-escalation studies.

Thus, this paper investigates the potential of ANT for theory development on the subject of IT project escalation. It also contributes to the conceptual tools of ANT in this context.

To the best of our knowledge, this is the first effort to apply ANT to IT project escalation and to contrast it with escalation theory. It should be noted, however, that what this paper offers is a comparative analysis of two different theory-informed readings of the same case. We do not claim or attempt to assess and compare the complete bodies of research on escalation and ANT.

Moreover, the aim of this research is not to make unitary claims in favor, or against, either of the two theories. Instead, the aim is to identify distinctive qualities of each theory and thereby explore how the use of ANT can impact research in a specific research area within the field of information systems. This, in turn, is a way of contributing to the current dialogue within the information systems field on the use of ANT.

The methodological approach builds on a well-known and well-publicized case of IT project escalation, the computerized baggage handling system at the Denver International Airport (DIA) (Applegate, 1999; Montealegre and Keil, 2000; Montealegre *et al.*, 1996a, b). The use of an existing case study that has been analyzed from the viewpoint of escalation theory (albeit with an emphasis toward understanding de-escalation) indeed raises the bar for finding the benefits of ANT, but also

strengthens the case for the contributions that ANT brings. However, before reviewing and considering the case from two theoretical perspectives, the current state of affairs with regard to escalation theory and ANT, particularly as applied within the information systems field, is considered.

Escalation theory: factors and processual aspects

The escalation literature examines why (and how) organizations pursue failing courses of action, even over long time periods and in the face of repeated negative feedback concerning the viability of an undertaking (e.g. Brockner, 1992; Staw and Ross, 1978, 1987; Whyte, 1986).

In general, the escalation literature assumes a close interrelationship between escalation of a course of action and escalation of individual and organizational commitment to this course of action (e.g. Brockner, 1992; Staw, 1997). Escalation is seen as occurring through a series of decisions favoring persistence (Brockner, 1992; Staw and Ross, 1987) and thus, it is frequently seen as resulting from flawed decision making at the individual or group level. Additional characteristics of escalation situations include an opportunity to persist or withdraw and uncertainty about the outcomes of decisions (Staw, 1997).

Although multiple theories have been invoked to explain escalation of commitment, no single theory fully explains the phenomenon[1]. It is well-established that a wide variety of factors can promote escalation, and Staw and Ross (1987) provide a listing of these factors organized in a useful framework that distinguishes between project, psychological, social, and structural factors (as shown in Table I). Several studies that apply escalation theory to the study of information systems development and IT projects use this framework (Keil, 1995a; Newman and Sabherwal, 1996; Keil *et al.*, 2000). The Staw and Ross (1987) framework was originally proposed as a quasi-process model. The Expo86 case (Ross and Staw, 1986) provided some evidence for temporal sequencing of these different types of escalation factors, suggesting that escalation begins because of project-related factors and then is reinforced by psychological, then social, and finally structural (or organizational) factors (Ross and Staw, 1986; Staw and Ross, 1987).

However, subsequent studies (e.g. Ross and Staw, 1993; Newman and Sabherwal, 1996) have suggested that the sequencing of factors may be more complex and case-specific than previously believed. These results indicate that the framework may be weaker as a dynamic model than as a static typology. In addition, the framework has been used as a factor model (Keil, 1995a). In the escalation literature, the aim to develop knowledge on factors that promote escalation is often accompanied by an underlying purpose of halting or reversing escalation (e.g. Keil, 1995a).

Within the information systems field, Keil (1995a) applied the Staw and Ross (1987) framework to the study of IT project escalation, finding support for a majority of the factors mentioned above, as well as identifying additional factors, namely emotional attachment to the project (psychological), empire building (organizational), and slack resources and loose controls (organizational). Newman and Sabherwal (1996) also applied the Staw and Ross framework, placing emphasis on the evolution and management of commitment to an IT development project over time. Consistent with Staw and Ross (1987), they found that factors are interrelated, but contrary to the Staw and Ross framework, they found that different types of factors may occur at several

Factor types	Description	Relevant examples
Project factors	Concern the objective features of the project and how decision makers perceive these features (Ross and Staw, 1993)	Projects are more prone to escalation when they involve a large potential payoff, require a long-term investment to be profitable, and are costly to abandon and when setbacks are perceived as temporary problems that can be overcome (Staw and Ross, 1987)
Psychological factors	Cause managers to convince themselves that "things do not look so bad" (Brockner, 1992)	High personal responsibility for the project outcome, visible personal attachment to the project, prior history of success, and information-processing errors (cf. prospect theory) are psychological factors that promote escalation (Brockner, 1992; Staw and Ross, 1987)
Social factors	Stem from the social environment that can hold the decision maker(s) to a course of action even after their personal beliefs no longer justify it (Brockner, 1992; Brockner and Rubin, 1985)	A group's competitive rivalry with other groups, a group's modeling of behavior after another group, the need for external justification (resulting from leading external stakeholders' belief in project success) and behavioral norms that favor "staying the course" are all factors that increase the likelihood of escalation (Brockner, 1992; Ross and Staw, 1993; Staw and Ross, 1987)
Structural factors	Concern the political and organizational context of the project	These include political support for the project, and administrative inertia and tie-in with organizational objectives and values (Goodman *et al.*, 1980; Pfeffer, 1981; Staw and Ross, 1987; Ross and Staw, 1993). They also include external political support and external pressure to persist (Ross and Staw, 1993)

Table I.
Types of factors that can promote escalation

stages of a project and that factors may disappear and reappear during the course of a project.

In this paper, the choice of the Staw and Ross framework to analyze escalation of the selected case means that the analysis tool consists of a framework that summarizes a substantial part of escalation research and that has been used in several studies on IT project escalation. We adopt a similar strategy in our use of ANT.

ANT: underlying ideas and central concepts

Pioneered by Michel Callon and Bruno Latour (Callon and Latour, 1981; Callon, 1986), and later extended and further developed by the original authors and other researchers (Latour, 1999; Law, 1991; Law, 1994; Law and Hassard, 1999), ANT provides a rich approach for understanding the creation of networks of aligned interests. The theory outlines how actors form alliances and enroll other actors, and use non-human actors (artifacts) to strengthen such alliances and to secure their interests, thus creating

actor-networks made up of humans as well as of artifacts (Callon, 1986; Callon and Latour, 1981; Latour, 1996). In the field of information systems, ANT has been recognized as having a potential for understanding the complex social interactions associated with IT (Walsham, 1997), and has specifically been used to interpret the political processes of IT implementation (e.g. Holmström and Stalder, 2001; Monteiro and Hepsø, 2000; Walsham and Sahay, 1999).

According to Callon (1986), the creation of an actor-network, also referred to as translation, consists of four major stages: problematization, interessement, enrollment, and mobilization. Before discussing the details of each stage it should be noted that all translation processes do not pass through all these stages and that translation processes may fail and halt at any stage. The choice of the word "translation" derives from Callon (1985), who defines it as "the methods by which an actor enrolls others" (Callon, 1985, p. xvii).

During the problematization stage, an actor initiating the process defines identities and interests of other actors that are consistent with the interests of the initiating actor. In this initial stage in building an actor-network certain actors position themselves as indispensable resources in the solution of the problems they have defined. They define the problems and solutions and also establish roles and identities for other actors in the network. As a consequence, initiators establish themselves as an "obligatory passage point" (Callon, 1986) for problem solution.

The second translation stage is interessement, which involves convincing other actors that the interests defined by the initiator(s) are in fact well in line with their own interests. This also involves, if necessary, creating incentives for actors such that they are willing to overcome obstacles in the way of becoming a part of the actor-network. As Callon puts it, successful interessement "confirms (more or less completely) the validity of the problematization and the alliances it implies" (Callon, 1986, pp. 209-10). Interessement thus includes locking new allies into place and cornering entities not yet co-opted.

If interessement is successful, enrollment occurs. Enrollment involves a definition of roles of each of the actors in the newly created actor-network. It also involves a set of strategies through which initiators seek to convince other actors to embrace the underlying ideas of the growing actor-network, and to be an active part of the whole project. In other words, it is "the group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed" (Callon, 1986, p. 211).

The fourth and final stage of translation, mobilization, includes initiators' use of a set of methods to ensure that allied spokespersons act according to the agreement and do not betray the initiators' interests. Building on a set of enrolled actors, initiators seek to secure continued support to the underlying ideas from the enrolled actors. With allies mobilized, an actor network achieves stability. This stability would mean that the actor-network and its underlying ideas have become institutionalized and are no longer seen as controversial.

The translation stages are often found to be more fluid and interrelated than Callon's analytical translation model might suggest. Recent ANT research paints a picture of a fluid translation process where the order of things is created and maintained through actors' strategic efforts to negotiate and maneuver one another into networks of aligned allies (Latour, 1999; Law and Hassard, 1999; Scott and

Wagner, 2003). Bearing this in mind, the four translation stages still provide a suitable vehicle for analysis and for communication of results.

In addition to the four stages of translation, the process of inscription is critical to building networks, as most artifacts within a social system embody inscriptions of some interests. As ideas are inscribed in technology and as these technologies diffuse in contexts where they are assigned relevance, they help achieve socio-technical stability (Latour, 1987). While technologies are, in part, open for interpretation, there are some features that are in practice "beyond" (re)interpretation and that increase stability in the networks in which technologies are encompassed (Latour, 1991). Inscription takes place in the formation of a technology and in the placement of this technology in an actor-network. This means that the technology does not have to be "implemented" for it to exist. It has to be conceived, but once it is conceived it is a force to be reckoned with: it is an actor (Latour, 1996, 1999). Inscriptions prescribe a program of action for other actors, which the latter may or may not follow, depending on the strength of the inscription (e.g. Latour, 1992). In relation to translation, inscription to a large extent takes place simultaneously and interrelatedly; it starts as soon as a technology enters the picture and is beginning to be formed by its "creators" (Akrich, 1992; Latour, 1992).

Another important phenomenon and concept of ANT is irreversibility. Irreversibility refers to the degree to which in a certain situation it is impossible to go back to a point where alternative possibilities exist (Callon, 1991). Irreversibility is often the result of the inscription of interests into technological artifacts, whereby those interests become increasingly difficult to change (Hanseth and Monteiro, 1998).

Hanseth and Monteiro (1998) also point out that there is often more than one relevant network in relation to complex IT-related change efforts. In the context of changing irreversible networks, they proposed three actor-network configurations involving more than one network: disconnected networks (networks that are unrelated and unaligned), gateways (links between two actor-networks that are unable to establish direct interaction), and polyvalent networks (distinct but partly overlapping actor-networks joined through certain multi-attaching, or "polyvalent", nodes)[2]. The decomposition of an actor-network into smaller units (creating disconnected networks, or networks connected through gateways or polyvalent nodes) might enable change of a previously irreversible network (Hanseth and Monteiro, 1998).

Method

While the overall interest underlying this article concerns the potential of ANT in the field of IS, we pursue this interest by focusing on the particular area of IT project escalation. In order to assess the potential of ANT to this research area, a vehicle for carrying out a theory-comparative analysis was needed. For this, a single case study was used.

This research approach is well supported by methodology on the use of case studies for theory-building and theory-testing (Eisenhardt, 1989; Lee, 1989), as well as by two influential articles by Markus (1983) and by Lee (1994). There is also an example of this research design within IT project escalation studies (Keil, 1995b).

Markus' (1983) research, which used a case study to compare three theories, incorporated an original case study. Lee (1994) instead used secondary data from a study on electronic mail (by Markus, 1991) to perform an analysis that differed from

the original author's in several ways. In particular, it varies in its epistemological and ontological stance and in the theoretical approach employed, thus illustrating how positivist and interpretive approaches to organizational research can be integrated or combined (Lee, 1991).

Compared to Markus (1983) and Lee (1994), this study employs a combined strategy in which a case based on secondary data is analyzed from two different theoretical perspectives with differing basic assumptions: Escalation studies frequently employ a positivist stance (e.g. Brockner, 1992; Keil *et al.*, 1995; Whyte, 1986), whereas actor-network studies are predominantly interpretive or critical (e.g. Hansen and Mouritsen, 1999; Walsham and Sahay, 1999). We thus employ two different epistemologies within one article with the purpose of comparing and contrasting two theory-based analyses, but not with the aim of combining these theories. This aim is well within the boundaries for how positivist and interpretive research can be combined and opens the door for further cross-fertilization between research traditions over time (Lee, 1991).

The strengths in applying multiple theoretical perspectives on a single case have to do not only with being able to understand more facets of the case, but also with being able to better understand the distinctive strengths of the perspectives involved. This aim might essentially be seen as interpretive (uncovering multiple meanings) rather than positivist (explaining causes and effects of events in the case) (cf. Alvesson and Sköldberg, 2000). However, the purpose of the analyses is primarily to contrast and compare theories and to let each analysis reflect the theory used. Thus, our goal is primarily to contribute to an emerging discourse, rather than to find either the objective truth about the case (cf. Rorty, 1979, p. 377) or even the most meaningful interpretation of it.

An essential aspect of the research design is that case studies are well suited to both interpretive and positivist positions (cf. Lee, 1989; Lee, 1991; Walsham, 1993; Yin, 1994). Furthermore, case studies have been repeatedly used in both IT escalation studies (Keil, 1995a; Montealegre and Keil, 2000; Newman and Sabherwal, 1996) and IT ANT studies (Holmström and Stalder, 2001; Walsham and Sahay, 1999).

The use of an existing case study also had the advantage of providing a data set that was manageable and fixed in its content. Furthermore, the original case study (Montealegre *et al.*, 1996a, b) was not originally geared towards either of the two theories, although it has later been used to investigate de-escalation (Montealegre and Keil, 2000).

While the chosen case has been used in research that employed basic assumptions and methodological positions common in escalation research, only the de-escalation side of the case was addressed (Montealegre and Keil, 2000; Keil and Montealegre, 2000). The escalation process of the case has not been previously analyzed. Choosing a case study that has been used in escalation research certainly raises the bar for finding the benefits of ANT, but also strengthens the argument for identified contributions of ANT.

As can be concluded from the above, several efforts have been made to design and carry out a theory-comparison that is fair towards both escalation theory and ANT. The division of responsibilities within the author team was also used to further this aim. Of the four authors, one author is highly knowledgeable about escalation theory,

one author has expertise in ANT, and two authors are familiar with both theories, albeit with more substantial research experience within escalation theory.

The division of responsibilities was designed so that each author with expertise in a specific theory performed the first analysis using that theory independently from the other analysis. Each "expert", however, did this in collaboration with the first author, who was responsible for balancing or "arbitration" of the analyses. This author was responsible for triangulating the emerging analyses against each other and the case and for securing the integration of the separate analyses into the discourse of the paper. The fourth author, who had extensive knowledge of the events at DIA and direct access to data of the case, corroborated the case description as well as the two case analyses. This provided further tests of the quality of the analyses. Subsequent developments of the separate analyses and the theory-comparative analysis were carried out in iterations involving all authors. Through the sequence of steps in this process, a dialectical process (cf. Klein and Myers, 1999) was built into the writing of the article.

IT project escalation: a case and two theoretical lenses

In this section the case of the computerized baggage handling system (CBHS) escalation at DIA is presented. Two distinctively different analyses of the case using escalation theory and ANT as analytical lenses are then presented and subsequently discussed.

The computerized baggage handling system at the Denver International Airport

In 1987, the City of Denver, including the mayor, the mayor's office and members of the city council, completed a master plan (with input from the airport users, airlines, pilots and Federal Aviation Administration (FAA)) that called for building the world's most efficient and the nation's largest airport[3]. Construction was to begin in late 1989 and completion was to occur by October 1993. The need for a new airport had been discussed and investigated since the mid-1970s, involving the above actors as well as the media, the general public and the regional business community (often represented by the local Chamber of Commerce). It had even been a key issue in the 1983 mayoral election and was often described as a technologically advanced project that would attract federal capital, create jobs and attract new business to the region.

The 1987 master plan for the new airport presumed that airline tenants would install their own baggage handling systems, thus excluding construction of baggage handling systems from the overall DIA project. This was customary in earlier airport construction projects.

In December 1991, as a result of its relatively early commitment to DIA as a major hub, United was the first to start work on a baggage handling system, commissioning BAE Automated Systems Inc. to build a CBHS at the new airport. BAE was a leading manufacturer of material handling systems with a solid track record for installing airport baggage handling systems. Since United planned to use DIA as a major hub, the airline placed high demands on the prospective system, aiming for an advanced solution. The main reason was the customer convenience and service level an advanced CBHS could bring, particularly in reducing transfer times for passengers (less than 30 minutes was the goal).

Phase 1: conceptualization of the airport-wide CBHS. At the end of 1991, two years into the construction of the new airport and with BAE already working on United's baggage system, the DIA project's top managers began to recognize the potential benefits of an airport-wide CBHS. At that time, United and Continental were the only carriers that had committed as leaseholders of the new airport. Moreover, as one DIA senior manager explained, "airlines other than United simply were not coming forward with plans to develop their own baggage systems". As a result, airport planners and consultants began to develop specifications for an airport-wide CBHS and the City sent out a request for bids. While sixteen companies (both domestic and foreign) were contacted, only three responded; and a consulting firm recommended against all three submitted designs on the grounds that the configurations would not meet the airport's needs. A member of the DIA management team commented, "All had the same response: 'there was not enough time to build such a system'".

While BAE was one of the companies contacted, it elected not to bid on the airport-wide system. A United project manager explained: "BAE told them from the beginning that they were going to need at least one more year to get the system up and running, but no one wanted to hear that". The City of Denver was getting the same story from the technical advisers to the Franz Josef Strauss Airport in Munich. The Munich Airport had a CBHS far less complex than the one proposed for DIA, yet its technical advisors had been testing the system for two years before the airport opened.

Phase 2: emergence of a solution and a supplier. The fact that BAE had already begun constructing United's CBHS, together with their international reputation, convinced the DIA project management team to approach the company about designing an airport-wide system. BAE was asked by the City of Denver to study how the United concept could be expanded into an integrated airport system that could serve the other carriers in the various concourses. The City of Denver had two major concerns, recalled Di Fonso, president of BAE:

> First, they had no acceptable proposal. Second, United was probably going to go ahead and build what it needed and the rest of the airport would have been equipped with something else.

BAE presented a proposal to develop the "most complex baggage-handling system ever built", explained Di Fonso. The proposed CBHS was to route bags (including suitcases of all sizes, skis, and golf clubs) from the main terminal through a tunnel into a remote concourse and directly to the gate. It was to include 3,100 independent "telecars" to route and deliver luggage among the counters, gates, and claim areas of 20 different airlines. Although this system would be more expensive initially than simple tugs and baggage carts, it was expected to reduce the labor required to distribute bags to the correct locations (Bouton, 1993). Bags unloaded from aircraft arriving at a particular concourse would barely be touched by human hands. To prove the capability of the system's mechanical aspects, and demonstrate the proposed system to the airlines and politicians, BAE built a prototype CBHS in a 50,000 square foot warehouse near its manufacturing plant in Carrollton, Texas. The prototype system convinced Chief Airport Engineer Walter Slinger that the computerized system would work.

In April 1992, BAE was awarded the $175.6 million contract to build the entire airport system. According to Di Fonso, company executives and City officials

hammered out a deal in three intense working sessions. "We placed a number of conditions on accepting the job", he observed. "The design was not to be changed beyond a given date and there would be a number of freeze dates for mechanical design, software design, permanent power requirements and the like".

The design of the United baggage system was frozen on May 15, 1992, when the DIA management team took over managerial responsibility for the integrated CHBS. Because of the tight deadlines, Denver officials committed to unrestricted access for BAE. In addition, substantial changes had to be made to the overall design of the terminal, and some construction already completed had to be taken out and reinstalled.

Phase 3: turmoil in the governance of the project. In October 1992, six months after BAE had been awarded the contract to build the CBHS, the chief airport engineer, Walter Slinger, died. Slinger, who had been a strong proponent of the baggage system and closely involved in the negotiations with BAE, exerted a significant impact on the project. His management style was autocratic, and he was detail-oriented. Gail Edmond, who was selected as Slinger's replacement because she had worked closely with him, had a managerial style quite different from Slinger's. Her style was more consensus-oriented and she preferred to follow a hands-off approach, allowing different parties to work out differences among themselves. A Public Works manager recalled his first reaction to the change: "[The airport] is not going to be open on time". A United Airlines project manager explained the significance of replacing Slinger with Edmond:

> Slinger … was controversial because of his attitude, but he was never afraid to address problems. He had a lot of autonomy and could get things done. Gail … had a good understanding of how the project was organized and who the key players were, but the City council didn't give her anywhere near the autonomy and the authority that Slinger had.

To further complicate matters, the airlines began requesting changes to the system's design, although the mechanical and software designs were supposedly frozen. "Six months prior to opening the airport", a senior vice-president of BAE recalled, "we were still moving equipment around, changing controls, changing software design". Di Fonso also recalled his frustration at that time: "we kept asking the City to take prompt action to assure BAE the ability to continue its work in an uninterrupted manner. Without the City's help, the delays to BAE's work quickly became unrecoverable".

Phase 4: mounting problems and repeated delays. Initially, construction problems kept the new airport from opening on the originally scheduled date in October 1993. In February 1993 Mayor Wellington Webb delayed the scheduled October 1993 airport opening to December 19, 1993. Later, this December date was changed to March 9, 1994. Then, in September 1993, problems with the CBHS forced a further postponement – this time until May 15, 1994.

In late April 1994, as BAE was preparing the first test of the system, the City of Denver invited reporters to observe the test. So many problems were discovered that testing had to be halted. Reporters saw piles of discarded clothes and other personal items lying beneath the Telecar's tracks. After the test, Mayor Webb delayed the airport's opening once again – for an indefinite period of time. "Clearly, the automated baggage system now underway at DIA is not yet at a level that meets the requirements of the City, the airlines, or the traveling public", the mayor stated. "There is only one thing worse than not opening DIA … [and] that is opening the airport and then having to shut it down because the [CBHS] doesn't work".

Two days after the failed tests, city leaders met with United and Continental Airlines executives to discuss the pending delay and financing plans. United Airlines agreed to front $8.8 million per month over the next three months to pay for the delay. The other airlines were to be assessed their share of delay costs once DIA was open (Svaldi, 1994).

Epilogue: abandonment of the CBHS project. Shortly after Webb's decision to delay the opening of the airport until the CBHS was fully operational, external pressure mounted as DIA came under the investigation of a federal grand jury as well as multiple federal agencies (including the Securities and Exchange Commission (SEC) and the FAA). Mayor Webb eventually succumbed to the pressure and withdrew his commitment to the CBHS project. Dealing with the costs of further delays had become untenable, and an effort was made to find the most expedient way of getting the airport operational. To accomplish this, a manual baggage handling system based on propane-powered tugs and carts was implemented. Webb positioned this as a "back-up" system that would enhance the value of the airport, but for all practical purposes, it became a substitute system.

When the airport finally opened in late February 1995 (16 months behind schedule and close to $2 billion over budget), the CBHS project had essentially been abandoned, leaving two concourses served by a manual baggage system and one concourse served by a scaled-down semi-automated system, serving only United Airlines outbound passengers.

The CBHS project from an escalation theory perspective

This section presents an analysis of the CBHS project based on the Staw and Ross (1987) framework[4]. In the escalation literature, escalation is viewed as resulting from a sequence of distinct decisions occurring over time (Brockner, 1992; Staw and Ross, 1987). In order to facilitate an analysis of processual aspects of escalation, key decisions that contributed to escalation were identified and factors were identified in relation to each key decision (cf. Staw and Ross, 1987).

Table II provides an overview of the escalation process according to the escalation theory analysis, showing the timeframe in which each key decision occurred, the situation that gave rise to the decision, what the key decision concerned and the consequences of each decision.

Table III then shows what factors were identified in each phase, thus providing an overview of how different factors and types of factors were present at different points in the escalation process. This analysis suggests that both project and psychological factors were quite salient in the initial phases and remained strong throughout most of the project. The presence of 5-6 project-related factors and 2-3 psychological factors was noted in all phases of the escalation process.

Structural (or organizational) factors were also present throughout the process, while social factors were not detectable in the first and third phases. Factors of the latter two types increased in number in late phases (two to four factors present for each type). The analysis supports Newman and Sabherwal's (1996) finding that different types of factors may occur at several stages of a project and that factors may disappear and reappear during the course of a project.

In the following, each identified factor will be discussed in more detail. This discussion is structured in accordance with the Staw and Ross (1987) framework.

Timeframe (phase)	Situation that gives rise to decision	Escalation decision	Decision consequences
December 1991 (phase 1)	Growing recognition of potential benefits of airport-wide CBHS Airlines other than United had not come forward with plans to develop their own baggage handling systems	Build airport-wide computerized baggage handling system	Specifications are developed for airport-wide CBHS request for proposal process is initiated (16 companies contacted) Proposals are received from three companies – all judged to be inadequate
April 1992 (phase 2)	BAE had a history of success in building airport-wide CBHSs BAE was already working under contract with United to create such a system BAE was willing to enlarge the project from handling United's needs to creating a system that would handle the needs of the entire airport, on certain conditions	Award contract to BAE	BAE's contract with United is frozen BAE is promised that it will have priority over other contractors in terms of site access and that the design will not be changed beyond a given date Though construction has already begun, substantial changes must be made on the terminal and concourses in order to accommodate the computerized system
October 1992 (phase 3)	Chief Airport Engineer Slinger had died Edmond was DIA's chief of construction and acting director of aviation, and had worked very closely with Slinger	Appoint Edmond new Chief Airport Engineer and continue with the project	Edmond becomes the new chief airport engineer, while keeping her previous responsibilities Project management style changes Project governance structure becomes ambiguous Mayor's office exercises tight control over Edmond, who also has considerably less credibility within the DIA project Problems with the computerized baggage handling project begin to emerge
April 1994 (phase 4)	Mayor Webb had reconfirmed his commitment to the airport-wide CBHS	Delay DIA opening until CBHS is operational	City of Denver approaches tenant airlines for financial support Tenant airlines agree to participate in covering costs of delay Pressures from external parties increase

Table II.
Key decisions that led to escalation of the CBHS project at DIA

Factor types	Factors	Phase 1	Phase 2	Phase 3	Phase 4
Project factors	Investment character of the project	✓	✓	✓	✓
	Efficacious resources	✓	✓		
	Large size of payoff	✓	✓	✓	✓
	Long-term payoff	✓	✓	✓	✓
	Infeasibility of alternatives	✓	✓	✓	✓
	Temporary cause of setback		✓	✓	✓
Psychological factors	Personal responsibility for failure	✓	✓	✓	✓
	Ego importance of failure	✓	✓		
	Prior success/reinforcement		✓	✓	
	Prior expenditures irrevocable		✓	✓	✓
Social factors	Responsibility for failure		✓		✓
	Norms for consistency and hero effect				✓
	Public identification with course of action				✓
	Job insecurity				✓
Structural factors	Political support	✓	✓	✓	✓
	Institutionalization			✓	✓

Table III.
Factors identified as contributing to escalation in different phases of the CHBS project at DIA

Table IV summarizes all the factors identified in the CBHS case, categorized according to the framework and listed in the order discussed below.

Project factors. Project factors included:

- *Investment character of the project.* The CBHS was perceived as an investment rather than an expense. Staw and Ross (1987) suggest that cognitively treating a project as an investment is likely to set up expectations of future gain, which can engender escalation behavior. Investing in an airport-wide CBHS was seen as something that would pay off in the future because it would make the airport more attractive to both carriers and the traveling public. In addition to saving carriers the time and expense of creating their own baggage handling solutions, the CBHS would also reduce turnaround times on the ground, allowing more effective use of airplanes. Moreover, quick delivery of bags would also make the airport more attractive to travelers, especially those who needed to make tight connections.
- *Efficacious resources.* In retrospect, the decision to add an airport-wide CBHS two years into the construction of the airport was a risky undertaking, especially since it would require undoing portions of the airport that had just been constructed. On the other hand, a solution for baggage handling had to be found and Slinger's and other actors' actions indicate that resources were seen as available and efficacious. If decision makers believe that additional "investment is likely to be efficacious or turn the situation around" (Staw and Ross, 1987, p. 45), they may be prone to take on risky projects and to escalate their commitment to such courses of action even in the presence of negative feedback.
- *Large size of payoff.* The CBHS represented a large potential payoff in two respects. First, a functioning airport-wide CBHS could help to entice other carriers to set up operations at DIA. Second, getting the CBHS up and running by January 1, 1994, would allow the airport to open before the city would need to

Factor types	Factors	How factors promote escalation
Project factors	Investment character of the project	Expectations of future gain can engender escalation behavior
	Efficacious resources	Assessments that additional investment is likely to be efficacious or turn the situation around promotes escalation
	Large size of payoff	Large projected payoff makes decision makers more inclined toward escalation behavior
	Long-term payoff	Expectations of long-term (rather than short-term) rewards promote escalation
	Infeasibility of alternatives	Perceived lack of feasible alternatives contributes to escalating commitment
	Temporary cause of setback	Viewing problems as temporary and manageable engenders escalation
Psychological factors	Personal responsibility for failure	High perceived personal responsibility for failure contributes to escalation of commitment
	Ego importance of failure	Concern with personal reputation and ego will increase the perceived costs of withdrawal
	Prior success/reinforcement	History of prior success reinforces belief in possibility of success, thus promoting escalation
	Prior expenditures irrevocable	Expenditures that cannot be recovered contribute to escalation
Social factors	Responsibility for failure	The social aspect of responsibility pertains to the need to save face, which contributes to escalation
	Norms for consistency and hero effect	Social norms that favor consistent behavior and norms that find the successful turnaround of failing projects heroic promote escalation behavior
	Public identification with course of action	Public identification contributes to the binding of decision makers to that course of action
	Job insecurity	If being associated with a failing course of action threatens a person's job security, there is incentive to persist in the hope of achieving a turnaround
Structural factors	Political support	When advocates for a project are also governing and overseeing this project, the risk for escalation increases
	Institutionalization	When the existence of a project and the necessity of its deliverables are taken for granted and become embedded in the organization, escalation is more likely

Source: Based on Staw and Ross (1987)

Table IV.
Factors contributing to escalation in the CHBS project at DIA

begin paying interest to the bondholders who had helped fund the construction of the airport. Thus, there was a large potential payoff if the CBHS could be completed successfully within a certain time frame and this appears to have contributed to the escalation of commitment.

- *Long-term payoff.* The baggage handling system was embedded in the context of the airport construction itself, which was viewed as a long-term public works project that would bring job growth and economic recovery to the region. As

suggested by Staw and Ross (1987), initiatives that are perceived to have a long-term payoff structure are more likely to engender escalation because there is no expectation of an immediate reward. There is also less of an impulse to reexamine such a course of action when things begin to go awry.

- *Infeasibility of alternatives.* The initial design for the airport did not incorporate an airport-wide CBHS, because it was assumed that individual airlines would develop their own baggage systems since this was the norm in most other American airports. By 1992, however, the project's top managers began to see the benefits of an airport-wide CBHS. The idea for such a system and its perceived benefits were largely the result of the original plan being perceived as infeasible in light of the fact that no airlines other than United had come forward with plans to develop their own baggage handling systems. As Staw and Ross (1987) suggest, the infeasibility of alternatives appears to have influenced the decision to commit resources to a risky endeavor.
- *Temporary cause of setback.* Escalation theory suggests that setbacks that are viewed as temporary are likely to promote escalation because they will be seen as minor obstacles that can easily be overcome. In the case of DIA, when airline carriers other than United were not planning their own baggage handling systems, it was relatively easy for Slinger and others to perceive this as a temporary setback that could be overcome with the application of additional resources. Indeed, viewing setbacks as temporary became a common response pattern as the airport encountered a series of construction delays followed by problems that surfaced with the baggage handling system.

With the exception of efficacious resources, all project factors remained present throughout all phases of the de-escalation process.

Psychological factors. Psychological factors included:

- *Personal responsibility for failure.* Individuals with a high degree of personal responsibility will have a tendency to escalate their commitment (Staw and Ross, 1987). In this case, Chief Airport Engineer Walter Slinger was a strong proponent of the airport-wide CBHS and later became closely involved in negotiations with BAE. The airport's initial sponsor, Mayor Peña, as well as his successor, Mayor Webb, also had high levels of personal responsibility for the outcome of the project, as the CBHS came to be seen as an integral part of the airport. Thus, the high degree of personal responsibility on the part of key decision makers encouraged them to escalate their commitment to the CBHS.
- *Ego importance of failure.* The "ego implications of failure will increase the perceived costs of withdrawal" (Staw and Ross, 1987, p. 51). Again, if the CBHS is viewed within the broader context of the entire airport construction project, it can be seen that the executives linked to DIA had staked not only their jobs but also their reputations on the success of the project. Webb's election and his re-election prospects were tied to DIA. Slinger had staked his reputation on the successful completion of DIA and undoubtedly spent considerable political capital in pushing for the construction of the CBHS. Thus, the ego implications of failure can be seen as being relatively high.

- *Prior success/reinforcement.* Escalation theory suggests that a prior history of success can reinforce behavior patterns that have previously been successful, thus promoting escalation. BAE had significant experience implementing this technology, albeit on a smaller scale (and with lower complexity) than would be required for DIA. BAE's reputation and success history, however, meant that city officials did not tend to question whether the job could be done successfully. The aviation director, for example, told a luncheon forum at the Denver Press Club, "No one [in the DIA management team] realized the complexity of the technology as it relates to this baggage system" (O'Driscoll, 1994). The impact of prior success history was reinforced when the project management team visited different airports and learned that there had never been an instance of an airport opening being delayed by a faulty baggage system. As one member of the DIA management team recalled, "what we heard was that BAE had a culture of always making it work on the last day". Thus, it is likely that BAE's prior history of success gave city officials a false sense of confidence in what could be accomplished.
- *Prior expenditures irrevocable.* Staw and Ross (1987) suggest that when prior expenditures are irrevocable, this can promote escalation. After the decision was made to build an airport-wide CBHS, funds were allocated and spent. Thus, it stands to reason that decision makers would view these prior expenditures as irrevocable.

Social factors. Social factors did not begin to emerge until it had become clear that that the airport construction was running behind schedule and that decision makers bound to the project would need to manage the expectations of various stakeholders:

- *Responsibility for failure.* The social aspect of escalation comes into play when decision makers are seen as being bound to a certain course of action and begin to engage in escalation behavior in order to save face. Since the entire DIA project was constantly under public scrutiny, the key decision makers could not help but be publicly identified with the project. This public identification carried over to the CBHS as well, which became an integral part of the overall project. Staw and Ross (1987) suggest that when prior expenditure commitments are irrevocable, public, and freely chosen, the tendency toward escalation increases. Once the CBHS contract was signed between the City and BAE, all these conditions existed and appeared to promote escalation behavior.
- *Norms for consistency and hero effect.* Staw and Ross (1987) suggest that social norms that favor consistent behavior can bind individuals to failing courses of action. Moreover, leaders who can successfully orchestrate turnarounds are often especially revered and regarded as heroes. These norms help explain why Mayor Webb "stayed the course" even in the face of the very unsuccessful public demonstration in April 1994 of the CBHS. Thus, while reporters saw mangled suitcases and piles of discarded clothes and other personal items lying on the floor, Mayor Webb pledged that he would not open the airport until the problems with the CBHS were resolved.
- *Public identification with course of action*. By vowing to delay the opening of the airport until the CBHS was up and running, Webb became publicly identified

with pursuing a course of action that escalated the city's commitment to the CBHS. Many individuals who saw the results of the failed baggage system test began to seriously question whether BAE would be able to get the system operating. But Mayor Webb reconfirmed his commitment to the system both publicly and in direct communication with the vendor, insisting that the airport would open when the CBHS operated successfully.

- *Job insecurity*. Another social factor that binds decision makers to failing courses of action is job insecurity. If being associated with a failing course of action threatens one's job security, there is an incentive to escalate commitment in the hopes of turning around the failing endeavor. In the case of the baggage handling system at DIA, one can argue that Mayor Webb as well as other public employees faced considerable exposure on this project. Indeed, in the case of Webb, realizing his future political aspirations depended on successfully navigating through the maelstrom that threatened to consume him.

Structural factors. Structural factors included:

- *Political support*. When advocates for a project are "represented on governing bodies and budget committees charged with the fate of a venture, one may expect substantial persistence in the course of action" (Staw and Ross, 1987, p. 61). In the case of DIA and the baggage handling system, one cannot easily imagine having more political support than the mayor's endorsement of the project.
- *Institutionalization*. Projects can become institutionalized in an organization when "actions are taken for granted" because they have become deeply embedded (Staw and Ross, 1987, p. 62). In the case of DIA, the baggage handling system had necessitated changes in the airport plans that were reflected in the actual concrete and steel that formed the structure of the new facility. This level of physical "embeddedness" probably made it difficult to visualize an airport without the airport-wide CBHS. Indeed, the evidence suggests that construction of the baggage system was already "taken for granted". Even after the system's primary champion died, there was no evidence of any serious discussion about whether or not to continue with the CBHS project. This suggests that some level of institutionalization had occurred by the time that Edmond took over as the new chief airport engineer.

The CBHS project from an ANT perspective

In analyzing the case from the point of view of ANT[5], the emphasis was placed on the efforts to create a sufficiently powerful consortium of actors to support and push forward the underlying ideas behind the project. Thus, understanding the escalation of the CBHS project from an ANT perspective is based to a large extent on the particular way in which a durable actor-network and its inscriptions were created.

It should be noted that there were two interrelated translation processes at DIA: one concerning the airport project *per se*, the other concerning the CBHS. It should also be noted that when the idea of an airport-wide CBHS was introduced, there was already an existing, stable, and far-reaching actor-network for the DIA airport. Among the actors in that network were the public, the regional business community, the City of Denver and its mayor, federal grant-providing agencies, prospective and present airline tenants, vendor tenants, bond investors, etc. Understanding the character of

these two actor-networks, and how they are interrelated, is central to the ANT reading of the case.

In the first stage of the translation process, problematization, problems, solutions and key roles are defined (Callon, 1986). At the time when the airport-wide CBHS idea came into the picture, the airport project was already well under way, with construction having been started two years earlier. At a certain point, the looming crisis brought about by the non-existence of baggage handling systems and the inaction of airlines (United exempted) prompted the DIA project team, particularly Slinger, to address the problem. When airlines were thought responsible, baggage-handling was practically a non-issue for the DIA project. When the situation was redefined as a problem for the DIA project, a solution had to be found. Slinger found a solution with very attractive characteristics: there was already a baggage handling system being built, which "only" had to be expanded to serve the whole airport. Conceptually, this was a short leap. Furthermore, this system happened (for reasons of passenger turn-around time) to exhibit characteristics that matched the grandeur of the new airport. It was a state-of-the-art baggage handling system for a state-of-the-art airport.

A key to establishing the CBHS actor-network was addressing how to define the roles of new actors and how to redefine the roles of actors within the DIA network to enable the airport-wide CBHS project. At this point, Slinger's problematization included redefinition of the role of United Airlines (buy-in to airport-wide system instead of commissioning construction of a proprietary system), definition of a new role (supplier of airport-wide system), and/or redefinition of BAE's role (no role or assuming the new role of airport-wide supplier). In addition, problematization built upon the inheritance of actors and roles from the DIA actor-network in which the emerging CBHS actor-network was embedded. The negotiation and casting of these and other roles was addressed in the interessement phase of the translation process.

In the interessement stage, actors commit to the problematization offered (Callon, 1986), accommodating to the proposed identity and future of the actor-network and approaching the roles to be played by actors in the network. Similar to the processes identified in the problematization stage, interessement was largely given by the actors and their roles and positions in the DIA actor-network. In some cases, these actors were not actively engaged in the CBHS project (vendor tenants, federal grant-providing agencies), whereas other existing actors were key in the interessement stage (Mayor Webb and the mayor's office, United Airlines, and in the latter stage BAE). Important, however, is that actors were inherited from the host actor-network and that even "silent" or passive actors in the host network would eventually become important in the abandonment of the CBHS project.

Slinger's main arguments for the proposed solution in the interessement stage was that the CBHS would provide a solution to the problem that the absence of baggage handling systems (present or under construction) posed for two out of three airport concourses. An airport-wide CHBS would also improve the overall service quality of DIA. Slinger also managed to frame the CBHS as a feature that would enhance the level of technological advancement of DIA and thus raise the stature of DIA even further above its competitors (i.e. other major airport hubs).

Through these maneuvers, Slinger reinforced and supplemented a coalition of interests involving significant actors and thus established a network of interest in the

deployment of the CBHS. Slinger worked at drawing these actors into a coherent coalition by establishing a common interest in the proposed solution – the adoption and re-development of the CBHS to the whole airport.

Early on, Slinger secured support for the new solution from the mayor. Next, United Airlines was persuaded that they would be served as well, or perhaps even better, by the overall CBHS as they would have been by their own system. Finally, a vendor for the airport-wide system had to be found and/or persuaded to come onboard. It is unclear whether Slinger had only BAE in mind from the beginning. However, as the incoming bids had been rejected, BAE was again approached and incentives were offered that were instrumental in persuading it to enter the emerging actor-network and assume its goals.

The successful interessement is demonstrated by the declaration from BAE that they would build "the most complex baggage handling system ever built". Not only had they agreed to take on the task, BAE had also assumed the challenge of building a CHBS that reflected the inscriptions being made into the emerging artifacts of the DIA.

Enrollment concerns the negotiation of roles between actors in the actor-network under formation (Callon, 1986). Closely interlinked with interessement, enrollment was partly expressed through the negotiations and agreements about terms and conditions of DIA's deal with BAE and similarly through mutual agreement about the redefined role of United Airlines with regard to the baggage handling system. The formalization of contracts was part of this process, and the resulting contracts were important as guarantees for what was agreed.

Translation processes are dynamic and emergent processes; a single actor does not hold a privileged position over – or control of – the development of events. Rather, different groups of actors compete in "trials of strength" (Latour, 1987) in order to establish their interests. As can be seen in the CBHS case, one actor will attempt to enlist the support of others and others may submit, but they may also refuse and attempt to forge alliances of their own to resist the plan (Holmström and Stalder, 2001, Latour, 1996). Here, Slinger's persuasion of United Airlines and BAE over their verbal (United's concerns about how their needs would be met) and non-verbal (e.g. BAE's decision not to bid) objections to the proposed solution bears evidence of Slinger's – and the mayor's – strength in these negotiations.

Enrollment took place in a small context, partly because many of the actors in the DIA actor-network saw the signing of the contract with BAE only as an extension of the existing actor-network. However, as the drama played out, it would become increasingly clear that the actions taking place within the CBHS actor-network, while embedded in the DIA actor-network, would not automatically benefit the intentions of members of its host actor-network.

Evidence of enrollment is found in actions such as the realignment of BAE's development work to the new project and its goals and United's acceptance of its new role in the expanded baggage handling system.

The basis for mobilization is the existence of enrolled actors. These actors may well retain their own specific agendas; they need only find it worthwhile to be part of the network on the basis of alliances concerning one or a few specific issues. Once the web of alliances is in place, it becomes possible for some actors to speak on behalf of a whole cause (i.e. to mobilize the action of an entire network) (Callon, 1986). Thus, mobilization

is largely about keeping actors aligned over some period of time, acting in agreement with the interests of the initiators.

After the initial actions that indicate successful enrollment, BAE's activities became increasingly frantic as they strived to deliver in accordance with a plan and an ambition level that from the very beginning – according to experience from various sources and several similar projects – was judged as having very slim chances of succeeding. How did BAE come to act so consistently in accordance with the inscribed interests of the initiators, even over mounting difficulties?

For a period, Slinger's management style and persuasion skills were probably enough to supplement the stability created through the earlier stages of the translation process, including the contracts created within that process. After the death of Slinger, the new airport manager, Edmond, did not fully assume this role, but rather acted on the order of Mayor Webb. The mayor and the City of Denver thus took over as guardians of the agreements that were embodied in the CBHS actor-network, and their roles grew to resemble that of initiators, particularly for the mayor.

In sum, key actors Slinger and Webb, together with the mayor's office and through successive co-optation of other actors, had succeeded with the translation process in spite of the initial objections from United Airlines and the initial refusal of BAE to take on the larger project. What had been created was an actor-network that pursued the dream of the most advanced CHBS ever built.

The roots of escalation existed from the very beginning of the CBHS project, and the successful translation process served to create a stable actor-network that would reinforce escalation behavior and monitor that actors did not deviate from the intentions and goals of the network. As a consequence of the successful translation and of the ongoing inscription, the emerging technological artifact embodied the intentions, goals, values, and dreams of the initiators.

The translation process during which the idea of the CBHS was established was quite rapid. It did not involve extensive negotiations with a multitude of actors. Moreover, it met limited resistance and opposition in the process of defining the problem and the proposed solution. The underlying condition for what we call swift translation was the embeddedness of the CBHS actor-network within the DIA actor-network. This condition meant that the embedded network inherited actors, roles, relationships and statements from its host network.

The notion of swift translation should not be construed as a weak translation: translation in the CBHS case was very strong until the point where central actors in the host network, the mayor and the airport itself, were threatened by the embedded network. However, since swift translation is enabled by and dependent on particular circumstances, in this case the embeddedness of the CBHS actor-network, the durability of the resulting actor-network may be fleeting if the enabling circumstances change.

From the beginning, a majority of actors in the DIA actor-network most likely viewed the emerging CBHS project as an integrated and subordinated part of the DIA project, aligned with the overall vision of DIA as a modern and efficient airport. In contrast, the CBHS project emerged into an actor-network in its own right, embedded but distinct, dependent but intentional – even willful. The problems mounting during 1993, with the CBHS seemingly out of control, became increasingly difficult to handle

for the DIA project management. At this time, the embedded network had developed into a Trojan actor-network – a threat potentially fatal for its host. Over time the host actor-network grew weaker, as a result of its inability to control developments in the embedded CBHS actor-network.

In spite of these developments, the inscriptions and network relations were still stable enough to hold actors in the determined roles and action patterns of the CBHS project well beyond the initial opening date of the airport and even through a publicly experienced and reported test disaster in April 1994. At this point, however, as previously passive actors in the host actor-network sprang into action (federal grant-providing agencies, FAA), fueled by other actors (the media) and outside entities entering the host network (the SEC), the CBHS actor-network began to unravel.

Just as the embeddedness of the CBHS actor-network influenced the form and the velocity of the translation process, this embeddedness also helps explain why CBHS was ultimately abandoned, namely to save the host network and central, individual actors in the host network.

The CBHS had up until this point been seen as a crucial part without which the host actor-network could not realize its full potential. Under pressure from new and newly vocal actors in the host actor-network, the intentions with regard to the CBHS changed from realization of DIA's full potential to putting an end to the delays in opening DIA and to the increasing scrutiny of the mayor, the City of Denver and DIA itself. This meant forsaking all but the basic ambitions concerning baggage handling services and settling for run-of-the-mill service levels in this area.

The redirection of what had been the CBHS project at DIA involved establishing two distinct but overlapping networks – polyvalent networks – in the form of separate, overlapping baggage handling systems[6]. One of the systems was based on familiar technology and procedures – on the "installed base" (Hanseth and Monteiro, 1998) – and the other system was the scaled-down version of the CBHS that served United Airlines' departures. The original CBHS was now treated as a dysfunctional part of the DIA actor-network, and the Trojan actor-network was separated from its host.

It should be noted that while the translation process that led to the acceptance of the CBHS was swift, the process of abandonment was not. It took some time to identify the CBHS project as a Trojan and abandon it. Furthermore, the swift translation process set the stage for making the Trojan possible, as so much of the actor-network (actors, goals, and intentions) was inherited from the DIA host actor-network.

Discussion

The understanding of escalation from an ANT perspective is directly related to the processes of translation and inscription: the creation of a durable actor-network with intentions, goals, and beliefs is a basis for whatever trajectory a development process has, whether resulting in an artifact that performs a role in a social setting or resulting in eventual abandonment of a project as the actor-network ultimately fails. It should be noted, however, that escalation occurs because translation is strong during a time period, although geared toward goals that are ultimately found to be unrealizable. Weak translation that fails at early stages would in terms of escalation theory be a "functional" or "correct" abandonment of a failing (or "dysfunctional") course of action at an early stage.

The ANT view of translation, however, is neutral with regard to what is formed; it deals primarily with the formation process and its characteristics. A faithful application of ANT is not concerned with assessing what is dysfunctional behavior and what is not. Rather, the concern is with understanding in some detail how and why translation processes evolve in certain ways. The concern is not with judging development trajectories or actions (decisions). In applying ANT to the study of IT project escalation, however, it follows that there is a focus on projects that display one or several prolonged periods of hardships. During these periods, the projects are in peril (i.e. questioned by actors, or experiencing problems related to resource consumption) and approach "failure" (however that term is defined in a particular social context). The difference is thus not in the phenomenon studied, but rather in how this phenomenon is viewed and assessed.

Seen from an ANT view, escalation also stems from the process of inscription of technological systems. Inscriptions have to do with ideas and assumptions about the role of the technology; what it is supposed to do, what relationships it is to have with other actors in the network. As these ideas and assumptions are formed at a relatively early stage of a project, they will be difficult to change as the project evolves. Thus, it becomes difficult to redirect the project.

There are several distinct differences between the two readings of the case. The ANT reading focuses on the creation of the project and how actors and goals were locked into a pattern of action. In so doing, it helps us understand escalation as something that is partly created by the very conditions and conjectures that are present even before a project is started. The escalation reading, on the other hand, focuses more on the successive build-up of escalation through a series of distinct decisions by decision makers who fail to identify, acknowledge and break a failing course of action. Escalation theory suggests that a set of factors helps explain why the failing course of action is not terminated. ANT, on the other hand, seems to view escalation as considerably more systemic. As a stable actor-network is being formed, actors increasingly hold each other in the "locked" positions assigned to and by them. As a result of these differences, ANT is arguably less informative about – and less concerned with – the personal and social psychology that holds even influential actors in fixed patterns of action, unable to break away from a failing course.

In spite of these differences in emphasis, the embodiment of ideas in artifacts somewhat surprisingly constitutes a point of contact between our analyses. Specifically, the escalation factor institutionalization implies that ideas and solutions are taken for granted and that physical structures or artifacts reinforce those ideas. This is remarkably similar to the ANT view of translation and inscription. The fundamental difference, however, is that the focus of the process-oriented ANT analysis is in the escalation analysis relegated to one factor within the Staw and Ross framework.

Another striking difference between our two readings of the case concerns the difference in language, which reflects the differences in language of the reference theories. Whereas escalation theory talks about "objective features" and "incorrect decisions" (Keil, 1995a; Ross and Staw, 1993), ANT talks about the "love of technology" (Latour, 1996) and about how artifacts inscribe behavior (Hanseth and Monteiro, 1997).

These differences are partly differences in views of rationality and objectivity, and partly attributable to epistemological and ontological assumptions of the two theories.

For the purposes of this research, it is also important to point out that ANT provides a coherent and integrated set of conceptual analysis tools that can be used for studying escalation processes. Given the earlier referred criticism of the Staw and Ross (1987) framework as quasi-process model, and given the herein demonstrated applicability of translation stages (cf. Callon, 1986), it seems highly likely that translation stages will provide considerably better guidance for the study of escalation as process, than does the Staw and Ross framework. The main differences between the ANT and the escalation theory analyses of this case are outlined in Table V.

Regarding the ANT analysis of the case, the embeddedness of the CBHS actor-network and how it turned into a Trojan actor-network in relation to its host actor-network was discussed earlier. Embeddedness was also found to enable swift translation, through the inheritance of actors, roles, goals, and intentions. It should be noted that a swift translation process does not necessarily imply that abandonment is swift. The ANT analysis suggests that the process of abandonment may still be complex and possibly lengthy. Indeed, our ANT analysis concurs with the escalation analysis in terms of how a trajectory is "locked", although the two analyses differ distinctly, but not completely, in their views of how this originally comes about and how escalation is brought to a halt.

The relation between Trojan actor-networks and their host therefore presents a problem situation different from the situations proposed by Hanseth and Monteiro (1998). The processes of abandonment may be similar (e.g. through the formation of several networks connected through gateways or polyvalent nodes – see section 3), but in the case of an embedded actor-network, an essential and probably very early aspect of the abandonment process is the disentangling of the Trojan from its host and thus the disruption of embeddedness.

While Hanseth and Monteiro (1998) identified three types of network relations (disconnected networks, gateways, and polyvalent networks), they did not identify the configuration that we found so important for the understanding of our case from an ANT perspective. We therefore propose embedded/host networks as a new network configuration in Hanseth's and Monteiro's typology. While their discussion on the change of "irreversible" networks (resembling de-escalation) is not the focus of this paper, our ANT analysis strongly suggests that the embeddedness of the CBHS actor-network influenced not only the escalation, but also the abandonment of the CBHS project.

Conclusions

In this paper, the case of the Denver International Airport CBHS was analyzed from two theoretical perspectives, escalation theory and ANT. Since the aim was to contribute to the current discourse on the application of ANT to the field of information systems, the concluding sections of the paper discuss not only the two different analyses, but also delves into specific aspects of how ANT can be applied and introduces several new ANT-related concepts.

When comparing and contrasting the ANT perspective to the escalation theory analysis, it can be seen how the two theories can help us make sense of a single case in two very different ways. Central differences between the employed theories were

Characteristics of the theories as illustrated by the case analyses	Escalation theory/IS escalation studies	ANT/ANT applied to IS escalation
Factor-oriented vs. process-oriented	Predominantly factor-oriented	Process-oriented
Focus on decision vs. action	Focus on decisions	Focus on socio-technical action
Focused actors	Decision makers	Multitude of human and non-human actors – and the relations, actions and mechanisms that hold them together
Focused levels	Individual, limited group	Network (i.e. systemic level beyond/above social group)
Epistemological and ontological stance	Predominantly positivist	Interpretive or interpretive/critical
Purposes of generated knowledge	Provide knowledge that help real-world decision makers make better decisions on runaway IT projects by accurately depicting organizational phenomena and identifying factors that promote escalation	Contribute to our understanding of how we create society through technology by providing meaningful stories and interpretations about socio-technical projects
Overall conceptualization of escalation as phenomenon	Escalation occurs through a series of decisions by organizational decision makers	Escalation takes place as a consequence of how the processes of translation and inscription occur in the evolution and stabilization of an actor-network.
Overall explanation of the CBHS escalation scenario	Factors promoting escalation were present and consequently escalation occurred. These factors included all categories, project, psychological, social and organizational. Escalation occurred as a result of influence of these factors over time and because counterforce were not present	The translation process led to the creating of a durable actor-network that embodied goals and intentions, which under the circumstances had little if any chance to succeed. However, the achieved stability of the actor-network held actors in position for an extended time period, thus causing escalation
Overall explanation of the abandonment of the CBHS project	Ultimately, there came a point where feedback on the viability of the CBHS project was devoid of any uncertainty and where external forces strongly pushed for abandonment. At this point, Mayor Webb extricated himself and the City of Denver through a sequence of steps that provided an alternative solution (based on Montealegre and Keil, 2000)	The CBHS actor-network was embedded within a host actor-network. Over time, the evolution of the embedded network led to a threat to its host. On the initiative of actors in (and entering) the host network, the embedded Trojan actor-network was ultimately sacrificed to save its host

Table V.
Escalation of CBHS: two theoretical views

summarized in Table V. The main differences can be viewed both in terms of how each theory informs us about IT project escalation and in terms of a choice regarding research approach for the study of this phenomenon. In our theory-comparative analysis, the escalation theory analysis was found to be factor-oriented, partly as a

result of applying the Staw and Ross (1987) framework, whereas the ANT analysis, using Callon's translation phases, was geared toward processes. These differences are reflected in a broader set of studies within the two theory areas (see, for example, Brockner, 1992; Keil *et al.*, 1995; Monteiro and Hepsø, 2000; Walsham and Sahay, 1999).

The differences in terms of analytical focus, ontological and epistemological assumptions, and purpose of generated knowledge all point to two different ways of understanding IT project escalation. A researcher using escalation theory understands escalation as something that occurs through a series of distinct decisions by organizational decision makers, whereas an ANT perspective on IT project escalation frames escalation as something that takes place as a consequence of how the processes of translation and inscription occur in the evolution and stabilization of an actor-network.

This difference was evident in the two explanations of the CBHS escalation scenario: From an escalation theory perspective it can be seen how factors promoting escalation were present, including project, psychological, social, and organizational categories. Escalation occurred as a result of the combined effect of factors within these categories, manifested in consecutive decisions to persist. In contrast, the ANT reading of the case makes sense of the IT project escalation as a process of translation and inscription, where the translation process led to the creation of a durable actor-network that embodied goals and intentions, which under the circumstances had little, if any, chance to succeed. However, the achieved stability of the actor-network held actors in position for an extended time period, thus causing escalation.

Overarching differences between the theories (as reflected in our analyses) in views, values and goals concerning research (epistemology and ontology) were also found. These differences illustrate that the choice of theory to employ in analyzing a study is not merely a choice of a tool, but also a choice of philosophy, of perspective on greater things than a specific IT project. In line with Lee (1991), our current position is that IT project escalation studies would benefit from coexistence and cross-fertilization between studies of both theory traditions.

Since only one theory tradition currently populates this research area, it is particularly important to address the conceptual tools that ANT can bring to IT project escalation studies. Specifically, this study found embeddedness and swift translation to be central to the ANT reading of the case and thus to the understanding of how events unfolded. Our analysis also indicated that the specific character of an embedded actor-network emerging within a host actor-network potentially impacts the basis and character of the actor relationships, how the network is constituted, and how translation plays out. In particular, embeddedness facilitates inheritance of actors, goals, values, and intentions from a host actor-network to the embedded actor-network, thus enabling a rapid translation process, or swift translation.

This entanglement of two actor-networks – the embedded Trojan actor-network and the host actor-network – presents a complex situation that poses a special challenge both to real-world actors enmeshed in these networks and to researchers trying to make sense of them. In sum, ANT provides the foundation for a rich understanding of the complexities involved in escalation processes, particularly through its focus on complex socio-technical and political processes, and its view of technology. Through this, ANT offers a fruitful alternative, or complementary, approach to the study of IT project escalation.

Notes

1. Keil *et al.* (2000) summarize these theories and how they relate to escalation behavior.
2. Hanseth and Monteiro (1998) also use the term backwards-compatible network, but to denote a stable actor-network to which small additions are made over time (i.e. there is only one, slowly evolving, network).
3. This section builds on published accounts, primarily Montealegre *et al.* (1996a, b) and Montealegre and Keil (2000). If not otherwise stated, all quotes are from these sources. Newspaper articles and other official sources have been used to corroborate and supplement these accounts.
4. While this analysis was largely carried out "from scratch" as part of this study, it has benefited from insights gained during an earlier study using the same case (Montealegre and Keil, 2000).
5. To avoid repetition, this section recapitulates case facts more sparingly, with the assumption that the reader is by now familiar with the case.
6. Both of these networks were embedded in the DIA actor-network.

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