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# The management of organizational boundaries: A case study[1]

Hervé DUMEZ

Alain JEUNEMAITRE

**Hervé Dumez**
**PREG-CRG, école polytechnique, CNRS**
**herve.dumez@normalesup.org**

**Alain Jeunemaitre**
**PREG-CRG, école polytechnique, CNRS, Said Business School/CSLS, University of Oxford**
**alain.jeunemaitre@csls.ox.ac.uk**

This paper aims at understanding organizational boundaries in their different dimensions : internal and external, horizontal and vertical, static and dynamic. It first gives a definition of the phenomenon : a boundary is a potential or actual mechanism that rarefies or regulates flows between two heterogeneous spaces, and makes these flows visible.
It then formulates three propositions :

1. There are no such things as « natural boundaries ». Organizational boundaries are the result of decisions about capability units that are always debated.
2. Once established, boundaries tend to be stable and to become entrenched.
3. Even when they are entrenched, boundaries remain debatable. When controversies intensity, strategies aiming at changing the boundaries develop, and strategies aiming at maintaining them develop in response.

A case study allows a discussion of these propositions. The selected case is the Air Traffic Management industry in Europe. The authors have been working on it for more than ten years. The main points this article makes are the following:
The concept of capability unit is related to the idea that there are no such things as « natural » boundaries. When managers define a boundary, be it internal or external, they think of a capability, and this is done in a context of causal ambiguity. Boundaries are the object of a decision and are always debatable and debated. They induce a rarefaction of the financial, informational, and other flows, and this rarefaction can vary in intensity over time. Once defined, boundaries tend to sediment and become entrenched. In such a process, the asynchrony of decisions made in different areas, such as technology, human resources, and organization of sub-activities, plays a key role. As the environment evolves, controversies concerning the perimeter of the capability units may intensify and some actors may develop strategies aimed at changing the boundaries. These strategies will pertain to the boundaries of a few capability units, or to a large set of boundaries. In the latter case, the strategy, which can be characterized as “architectural”, would be developed by an actor with a particular status. This actor would belong to several organizational fields and would therefore not be constrained by the same symbolic boundaries as actors who belong to one field alone. Such a strategy entails a willingness to impose synchrony to other actors in the industry. The dynamics of displacing the boundaries relies on two processes, competition and cooperation, combined in a coopetitive approach.

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## INTRODUCTION

The notion of boundaries involves a paradox. On the one hand, it is omnipresent in the social sciences (Lamont & Molnar, 2002), and in particular in management science; on the other hand, it is rarely elaborated as such, and in its various dimensions. In management, vertical boundaries have been investigated via the study of make or buy decisions, horizontal boundaries via the study of alliances or mergers and acquisitions. At the micro level, a firm's internal boundaries have been most often studied through the idea of « spanning boundaries » in knowledge management or innovation (Nonaka, 1994 ; Brown & Duguid, 2001 ou Miller & al., 2007). More recently, what Lamont and Molnar (2002 : 168) call « symbolic boundaries » (i.e. categories actors agree upon and use to define reality) have been explored in research on boundary objects (Carlile, 2002 ; Osterlund & Carlile, 2005).

It is striking to observe that these studies are not in dialogue with each other. Thus, although the title of Araujo, Dubois and Gadde's paper (2003) is « The multiple boundaries of the firm », the authors, as they make explicit, focus exclusively on vertical boundaries. In contrast, Santos and Eisenhardt (2005) concentrate on the external boundaries of the firm, those that separate the firm from its environment, at the expense of internal boundaries. There is nevertheless a conceptual and practical link between boundaries of different kinds. An internal boundary can become an external one, for example when it is decided to transform a division into a business unit, and this unit is subsequently sold; conversely, an external boundary can become an internal one, for example when a corporation acquires a firm that is transformed into an internal division, but at the same time given autonomy within the organization. In addition, the notion of boundary refers to multiple dimensions, symbolic and social (issues of identity), as well as others involving for instance technology, power or space. The way these dimensions interact remains in great part unexplored, even though, as noted by Santos and Eisenhardt (2005 : 505), « the study of organizational boundaries is foundational ».

The present paper thus aims at exploring the multiple dimensions of boundaries and their interactions, as well as the interdependence between boundaries of different kinds. This will be done through the discussion of three propositions drawn form the scientific literature and the field research on boundaries:

1. There are no such thing as « natural boundaries ». Organizational boundaries are the result of decisions about capability units that are always debated.
2. Once established, boundaries tend to be stable and to become entrenched.
3. Even when they are entrenched, boundaries remain debatable. When controversies arise, strategies aimed at changing the boundaries develop, and strategies aimed at maintaining them develop in response.

We shall discuss these propositions on the basis of a case study on which we have worked for ten years, that of the Air Traffic Management

(ATM) industry in Europe.
In the first part of the paper, we will investigate the theoretical foundations of the notion of boundaries, relying of course on the literature related to organizational boundaries, but also to ecological, geographical and historical boundaries. We will then explain our methodology, and subsequently broach the case study itself. Finally, before the conclusions, we will discuss the propositions in the light of the case study.

## THEORETICAL ISSUES OF THE NOTION OF BOUNDARY

We will first attempt to define boundaries, and then draw three theoretical propositions.

### The definition of boundaries

Numerous studies dealing with boundaries do not define precisely their object. What makes the separation between two divisions of the same firm, or between this firm and its environment? A simple definition borrowed from biology can be useful: a boundary is « the regulation of flows across heterogeneous space. » (Cadenasso et alii, 2003: 757). More precisely, a boundary can be defined as a mechanism that potentially or actually rarefies or regulates flows between two heterogeneous spaces, and makes these flows visible. Inside the boundaries, authority can be exercised and flows of exchanges are less visible. Across boundaries, flows are regulated and are more visible. But a boundary can be activated at some moments, and inactivated at others. Moreover, the rarefaction and regulation of flows across a boundary, as well as their visibility, are a matter of degree and depend on the scale at which they are analyzed : « […] the perception of a boundary as abrupt or gradual will depend on the grain size at which the boundary is being measured or modeled ; a boundary that appears abrupt at a coarse grain size may appear gradual at a fine grain size. » (Strayer et al., 2003: 726).

### The determination of boundaries

Different theoretical perspectives may help understand the delineation of organizational boundaries. Transaction cost analysis emphasizes the importance of assets specificity and the frequency of transactions. Economies of scale and scope are said to define a minimum efficient size of the organization. Knowledge-based theories (Kogut & Zander, 1992) also provide insights into the structuring of organizational boundaries. These different perspectives make it possible to assess existing situations and to show that they are sub-optimal in consideration of transaction costs, scale and scope economics, or the available knowledge basis. They do not, however, illustrate with precision where organizational boundaries would and should be drawn. In practice, placing external and internal boundaries is more explicable with reference to a capability approach. When managers are told of transaction costs, they ask themselves : « what role do firm capabilities play in this ap-

proach to firm boundaries ? » As noted by Barney (1999 : 138), when they get the answer : « very little », they are puzzled. Of course, when placing a boundary, managers take into account factors of economic efficiency. But they also consider other variables, such as the control of administrative costs and the bargaining power of unions (Sako, 2006), and yet others, connected to power, competences and identity (Santos and Eisenhardt, 2005). Confronted with this diversity of factors, managers must decide on boundaries in a context of causal ambiguity (Lippman & Rumelt, 1982 ; Powell & al., 2006). They bright together different activities within a same boundary according to similarities, and « yoke » them (Abbott, 1995), creating what Jacobides and Winter (2005) call « institutional packages ». They thus try to group activities in a package superior to the sum of the activities themselves. In that sense, in line with Richardson's distinction between activities and capabilities, we speak of « capability units ». Within their boundaries, and insofar as no transaction gives rise to a monetary exchange within the unit, capability units might be seen as free transaction zones (Baldwin, 2008). In other words, transactions operate in an environment of cross-subsidization. The very unit capability, out of market transactions, favors production: « Stable clusters of connections are required for production processes, which is essentially why firms have boundaries. » (Potts, 2001 : 424).
Therefore, boundaries are decided upon by managers (the link between organization-boundaries and decision has been analysed by Ahrne & Brunsson, 2010). They are defined according to multiple and diverse variables that may act independently from each other. Hence, a decision about boundary is always subject to discussions and controversies. We can therefore formulate a first proposition:

***Proposition 1.*** *There is no such thing as a « natural » organizational boundary. Organizational boundaries derive from decisions made by managers and regarding capability units, which are always debatable.*

## Boundaries of different kinds tend to pile up and to reproduce themselves

As outcomes of decisions, boundaries tend to pile up and reproduce themselves. Geographers speak of « intrenchment » or « entrenchment » (Hartshorne, 1936 ; Minghi, 1963). Inside the boundary of a capability unit, the technology used can be different from the one used outside; an identity is shared, and the same categories employed. In the case of science, Gieryn (1999) speaks of a boundary-work relying on expulsion (a work of differentiation from outside), on expansion before the boundary is set (trying to develop new activities in the unit), and on the protection of autonomy. This entrenchment has been observed and analyzed by economists at the level of exchange flows within and across boundaries: boundaries reduce these flows (McCallum, 1995 ; Anderson & Van Wincoop, 2003).
Entrenchment has also to do with the visibility of flows and exchanges (Chevalier, 2004). Within a capability unit, a tissue of cross-subsidizations is not visible as such, even if actors have an idea of what they are.

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Every boundary displacement makes them visible, entirely or partly, and is therefore tricky. This is a reason why boundaries tend to be stable and reproduce themselves.
As Jacobides (2006 : 157) rightly noted, incentives can exacerbate the problem: decided within existing boundaries, they reinforce parochial, narrow attitudes and amplify compartmentalization.
Finally, the asynchrony of multiple decisions made within a capability unit is also part of the entrenchment dynamics. The pace of technological change is not synchronous with that of staff turnover. When deciding upon a new technology, one takes into account the inertia affecting other dimensions of the organization and one hesitates to shake existing boundaries. And once a decision has been made concerning technology, it has an effect on subsequent decisions regarding staff and organization. As a consequence, asynchrony of decisions leads to a stabilization of boundaries.
Hence proposition 2:

***Proposition 2.*** *Once a decision determining boundaries has been made, boundaries of different kinds (technological, organizational) tend to pile up, become entrenched, and reproduce themselves.*

## The displacement of boundaries

The dynamics of reproduction of boundaries is counterbalanced by a dynamics aiming at displacing them. Technology, organizational activities and capabilities, customers and suppliers are all continuously changing. Existing boundaries are progressively deinstitutionalized, i.e. their legitimacy is eroded (Oliver, 1991). A boundary misalignment can occur between actors belonging to the same organizational field; some keep operating at the national level, while others become international actors (Greenwood & Suddaby, 2006). Debates arise concerning where the boundaries are to be placed in order to define the optimal capability units. A game of strategic interactions develops. Some actors adopt strategies that destabilize existing boundaries; in response, others follow re-stabilizing strategies (Depeyre & Dumez, 2009). The actors that aim at destabilizing existing boundaries can proceed in two different ways, by trying to change either only their own boundaries, or those of the entire industry. In the latter case, they think they are in a position to play an architectural role for the whole industry (Jacobides & Billinger, 2006; Jacobides, Knudsen & Augier, 2006). To do so, they can use competition (e.g. by entering new markets or acquiring competitors), or cooperation (e.g. by establishing alliances or joint ventures), or they can attempt to combine competition and cooperation in practicing coopetition (Brandenburger & Nalebuff, 1996; Bengtsson & Kock, 1999 ; Bengtsson & al., 2010 ; Depeyre & Dumez, 1010). In response, other actors can try to defend established boundaries or displace them *a minima* to optimize the existing capability units. In such a game, the external and internal “asset orchestrations” (Helfat, 2007), i.e. the dynamics of internal and external, horizontal and vertical boundaries, are interdependent. The creation of an internal vertical boundary can help

establish a horizontal alliance between two firms, one that is vertically integrated and the other not. In such a case, the creation of a vertical boundary is a condition for the displacement of a horizontal boundary. One can thus realize how important it is to take into account the different kinds of boundaries and their multiple dimensions when analyzing the dynamics of boundaries.

***Proposition 3.*** *Even when they are entrenched, boundaries remain debatable. When controversies increase, strategies aiming at changing the boundaries develop, and strategies aiming at maintaining them develop in response.*

## METHODOLOGY

The authors of this paper have been working on the Air Traffic Management industry for twelve years (1998-2010). Their aim has been to understand the dynamics of restructuration of the European ATM. They have focused on the strategies of the different actors : European institutions, member states, service providers (be they public owned or privatized), users (airline companies), technical systems providers, aircraft manufacturers. During the period, documents have been systematically analyzed and interviews have been conducted, as shown in the following chart :

| **Interviews** | **1998-2010** |
|---|---|
| International organizations (Eurocontrol, European Commission, European parliament, etc.) | 59 |
| National Regulators | 14 |
| Service providers (controllers, control centers, etc.) | 20 |
| Users (airline companies, airlines associations) | 12 |
| Systems suppliers | 18 |
| Aircraft Manufacturers | 7 |
| **Total** | **130** |

Interviews lasted around two hours ; they were sometimes extended by the visit of an Air Traffic Control Center or the operations center of an airline company, for example. The sampling was not conceived as a statistical one. The aim was saturation in the perspective of grounded theory.
Authors also interacted with actors in the industry by taking part in technical and scientific reports for the European Commission and Eurocontrol, as shown in the following chart :

| Studies | | |
|---|---|---|
| European Commission | Study on Economic Regulation of Air Traffic Management Services | 2001 |
| Eurocontrol Experimental Center Technical and Scientific Report | Revolutionary versus Evolutionary Strategies: The Future of Air Traffic Management Service Provision | 2002 |
| Eurocontrol Experimental Center Technical and Scientific Report | Giving Substance to European Functional Airspace Blocks | 2002 |
| European Commission | Study on the Implementation Rules of Economic Regulation within The Framework of the Implementation of the Single European Sky | 2003 |
| Eurocontrol Experimental Center | Institutional Evolution of Air Traffic Management: Intergrating the Perspectives on Industrial, Organization, Economics and Law, Institutionalism | 2007 |

The scientific approach was abductive (David, 2000), and close to « systematic combining » (Dubois and Gadde, 2002: 554), « a process where theoretical framework, empirical fieldwork, and case analysis evolve simultaneously [...]. » The first series of interviews was structured by « orienting theory », which « simply tells us in the most general terms what data we are likely to need at the point of analysis » (Whyte, 1984: 118). The two elements were those identified by Whyte: « actors and their relationships » and « events », in connection with the European Air Traffic Management restructuring process. This first series of interviews (72) was treated in a grounded theory way (Locke, 2001 ; Dumez, 2004). Interviews were coded in a double, independent, manner by both authors. The coding let important themes emerge, like sedimentation of boundaries and cross-subsidization. The case study was redirected (Dubois & Gadde, 2002: 556) in accordance.

Subsequently, interviews were structured in two parts. The first one remained open, and followed primitive orienting theory (actors, relationships, events of the European ATM industry restructuring process). The second one was used to test propositions that derived from the coding. Piore (2006) shows that interviews can be used to test ideas coming from previous steps of the research development. The aim was to « generate surprises » and to identify « patterns », or what Hedstrøm and Swedberg (1998 ; see also Depeyre & Dumez, 2007) call « social mechanisms ». These mechanisms were related to the establishment and dynamics of boundaries.

The paper as it stands is the result of « matching », i.e. « going back and forth between framework, data sources, and analysis » (Dubois & Gadde, 2002: 556). This led to the formulation of propositions that were discussed throughout the case study development. Locke (2001) has highlighted the fact that the classic structure of papers (review of literature, presentation of the data, discussion) does not give a good account of the way grounded theory and abduction develop. Yin (2003) has in turn suggested that a case study that leads to theoretical propo-

sitions can be written the other way around : such rewriting is a good test for the consistency of the way the study was conducted. That is precisely what we did in this paper.

The theory of boundaries being the starting point of the writing, a case-study approach appears to be appropriate approach to understand the various dimensions of the dynamics of boundaries for three main reasons (Ragin & Becker, 1992 ; Yin, 2003) : first, observed changes are complex, and causal dynamics and the actors' motives are difficult to specify ; second, the analysis includes an historical dimension ; and third, what is looked for is theory development, i.e. a process by which a theoretical framework is discussed through the use of data and extended by means of such a discussion (Greenwood & Suddaby, 2006). The case is an instrumental one, in the sense of Stake (1994).

The choice of the case was directed towards an industry rather than towards a single organization. Indeed, only an industry can demonstrate a complete set of boundaries of different kinds. Air Traffic Management is particularly interesting from this perspective for at last two reasons. First, insofar as national boundaries actually play an important role in ATM, boundaries are not only metaphoric. Second, the ATM industry exhibits the entire set of boundaries : national, organizational, technical, jurisdictional, symbolic (Beyer, 2008 ; Dumez & Jeunemaître, 2001; Grushka-Cockayne, De Reyck & Degraeve, 2008).

Let us now turn to the presentation of the case.

## THE CASE STUDY: BOUNDARIES AND CAPABILITY UNITS

When commercial aviation was developed, a decision was made at the international level and on the basis of Grotius's theory on the freedom of the seas: the sky would be free; except in time of war or crisis, no country would be able to prohibit access or set up a toll. A priori, national boundaries should not play any role in that industry. The Chicago Convention, signed in 1944, establishes nevertheless that each state is in charge of guaranteeing the safety of the sky over its territory, especially to avoid collisions (Mendes de Leon, 2007). Moreover, each state has the right to let aircraft pay for the cost of this essential service. In the US, passengers pay a tax that is explicitly added to the ticket price. In Europe, airline companies pay route charges calculated on the basis of the weight of the aircraft and the route followed. Each country has organized its own control system. Each has designed a network of beacons that allow pilots and controllers to draw routes and know exactly where the aircraft is at certain times, a radar system that allows controllers to follow the aircraft, a telecom system between pilots and controllers, a weather information system, a rescue system for cases of a crash or other problems, and control centers. When an aircraft crosses a national boundary, it generally leaves one control system and enters another. The pilot takes leave of the controller of the country she is leaving and greets that of the country she is entering. Since VHF frequencies are saturated, and since it takes time to leave and to signal

entry in a new airspace, national boundaries rarefy flows. The traffic flow is therefore rarefied by boundaries that are in no way natural, but result from the organization of capability units decided at the national level.

As mentioned before, routes have been designed through a network of beacons, and sectors have been established on the basis of these routes and their crossings, so as to balance the work of the controllers. When aircraft fly up and down on crossing routes, sectors are small. This is for example the case with the very complicated Chartres sector in France: North/South routes cross West/East (transatlantic) routes as aircraft fly down and up approaching or leaving the Paris airports. When aircraft follow simple routes at high altitude, sectors can be much wider. At night, when the traffic is light, different sectors might be regrouped. During the day, they are progressively degrouped as the traffic increases. Sectors cannot be too small. As already observed, when an aircraft leaves a sector, it must signal that to the corresponding controller, and it must signal its entry to the controller of the new sector. That takes time. The sector is thus the basic capability unit and the boundaries separating these units rarefy flows and operate as a constraint for the growth of traffic.

Sectors are managed at the level of a control center for the management of both human resources (controllers work in teams) and technical resources (maintenance of computer systems). When centers are big, they are usually divided into two rooms. Small countries have set up one control center, large countries several. A few centers could probably manage the entire European upper airspace and be footloose (a center set up in Ireland could manage the German airspace). Large countries, however, have chosen to build several centers in the interest of safety. Indeed, if one center shuts down for a technical reason or because of a controllers' strike, another one can manage at least part of the traffic. What Americans call « pork barrel » issues have also played a role, since local politicians have strongly lobbied to have and keep centers in their area. Boundaries have also been superposed and entrenched because of public procurement: each country has defined its own requirements for the technological system it needed, and has acquired or developed it for its centers. These systems have to compute the flight data in order to support the controllers' work.

Each airline company announces its flight plans. Flight plans are then analyzed by the system, which must be able to forecast when a flight will enter a sector at a certain altitude, ascending or descending. Systems include a safety net whereby the risk of collision between two flights is signaled to the controller. France, for example, has developed its own system with teams of engineers who belong to the national administration. At the same time, Thales, a French firm, developed a system for other countries (Danemark, Eire, Sweden). A specific system being developed for each country, interoperability in Europe has been a big problem, dealt with by Eurocontrol and the European Commission so that the boundaries between systems do not excessively rarefy flows (Dumez & Jeunemaître, 2001).

To sum up, the Air Traffic Management industry cumulates boundaries.

At the lowest level, the smallest capability unit, boundaries separate the sectors controllers are in charge of. Then there are the boundaries that define control centers and yoke a series of sectors, each with its teams of controllers and maintenance. Since, with very few exceptions, sectors are defined and control centers built at the national level, national boundaries superpose themselves to those of sectors, while at the same time determining them. Public procurement of technical systems and the recruitment of controllers are decided asynchronously on a national basis and thus reinforce the entrenchment of boundaries on a national basis.

## THE DEBATE ABOUT THE BOUNDARIES

At the end of the 1990s, the deregulation of commercial aviation and the development of the hubs and spokes system induced a traffic growth and the ATM system reached a state of saturation; flight delays exploded and their cost increased considerably. Airline companies tried to contain their costs and asked for a decrease in route charges. The ensuing debate concerned the organization of capability units and the fragmentation of the European ATM. As stated in the theoretical section, organizational boundaries are primarily capability unit boundaries. They are determined through a balancing between economies of scale and scope, on the one hand, and diseconomies (costs of control, safety, etc.) on the other. This is confirmed by our case study. As regards for example the technology, it is clearly sub-optimal that each country asks for the development of a specific system (or, like France, develops its own). At the same time, the development of a unique system at the European level entails a risk. The optimal situation would probably be a competition between a maximum of two or three systems. The same could be said of the route design and the setting up of control centers at a national level. The probability for that level to provide the optimal balancing of economies and diseconomies is low. A comparison with the United States is always difficult, but gives nevertheless a broad idea: the traffic there is far higher than in Europe, yet the number of control centers is far lower, and the cost of a controlled flight hour is 62% inferior to that in Europe. For historical reasons, national boundaries as sedimentation of political, organizational and technological boundaries have been entrenched around sectors and control centers. Although the optimum cannot be determined with precision, the capability units are clearly sub-optimal.

This entrenchment has also to do with the visibilization and opacification of financial flows (cross-subsidization within the boundaries). Organizational boundaries opacify some money transfers (within boundaries, some activities invisibly finance others), while at the boundary itself flows are made visible[2]. Cross-subsidization is the second element of the economics of boundaries, the first being the design of capability units. Innovation can be promoted by a certain opacity of the financial transfers between traditional and new activities within a capability unit, but cross-subsidization can also strongly inhibit change. In the ATM

**2.** « Accounting is an aspect of all legal, formal organizations and the organizations' accounts maintain boundaries by measuring financial flows across these boundaries and by establishing which resources do or do not belong to the organization. » (Brunsson, 2006, p. 18)

industry, the same organization (the national service provider) usually manages upper and lower airspace. It would, however, be more efficient to specialize control centers for the upper and the lower airspace, and to reduce the number of control centers managing the upper airspace (one or two big centers could probably suffice for the whole European upper airspace).
Controlling the upper airspace is far less costly than controlling the lower one. Thus, when Denmark, Finland, Norway and Sweden decided to explore the creation of a private company to manage a common center to control their merged upper airspace, it turned out that its cost would be substantially inferior to that of centers specialized in lower airspace control. The new boundary stemming from the creation of the private company would have prohibited the cross-subsidization of lower airspace control by upper airspace control. The « yoking » (Abbott, 1995) of both controls in the same organization conceals the cross-subsidization. The same phenomenon is common in Europe. The flights by American airlines over Europe in the upper airspace without landing there partly cross-subsidize the control of lower airspace used by European airlines. Cross-subsidization induced by existing boundaries is a factor of stability. Hence, as soon as a boundary is discussed, the actors benefiting from the cross-subsidization mobilize themselves in order to maintain the status quo. In contrast, other actors can at the same time have a direct interest in change.

## THE DYNAMICS OF BOUNDARIES

Some actors try to change boundaries when they think new ones would be more efficient. In the ATM industry, two actors, Boeing and the European Commission, attempted to play an architectural role.
Since the 1990s, Boeing has been exploring the systems that could be integrated in the cockpits to improve ATM. Now, ATM is not an industry Boeing is part of, except in connection with the embarked systems, which constitute their only common boundary. Boeing's problem is to sell aircraft, and ATM can be a bottleneck for this activity. The diagnosis made by Boeing is that actors within the industry are not able to innovate radically, even though radical innovation is what is needed. Suppliers of systems and hardware such as radars and control centers (e.g. Lockheed Martin, Thales or Raytheon) try to sell the systems they have on the shelf, and are reluctant to work on a radical innovation which, for example, would be based on the massive use of satellite technology. In other words, the actors in the industry are locked in entrenched boundaries, and tend to consider the future with the eyes of the past. Only an external actor – an outsider – can help introduce new solutions. As one such actor, Boeing has stressed two dimensions: technological and operational boundaries and organizational boundaries. Concerning the former, it considers that sectors represent the main bottleneck. Thus, Boeing's engineers have been working on the concept of a « seamless space » that would break down the boundaries. Concerning the latter,

organizational dimension, Boeing has tried to group all the actors of the industry to define the requirements of the needed technological and operational system. It created a Working Together Team (WTT)[3] with the goal of spanning present boundaries between aircraft manufactures, service providers, systems suppliers, controllers, and airlines. Boeing had in mind not only the American, but also the European situation: aircraft fly over both continents and the embarked systems and procedures had to be the same on both sides of the Atlantic. European actors like Eurocontrol or Thales took part in the WTT.

Two points must be highlighted in this connection. Boeing introduced itself as an outsider operating outside the traditional boundaries defining the industry, and therefore in a position to redesign more efficiently these boundaries. To the extent that it does not compete with the actors of the industry, it can stimulate among them the cooperation that is needed. Nevertheless, the project failed and, in 2004, Boeing closed down the ATM subsidiary it had set up four years earlier (half of the engineers were nevertheless appointed to Boeing's R&D unit, Phantom Works, and went on working on ATM, as if Boeing had become a semi-dormant company in the industry).

The European Commission is the other actor that has been trying to play an architectural role in the industry, by attempting to change the existing boundaries. The official role of the Commission is to conceive and propose integrative policies between the Union member states. The Commission took an initiative for the ATM in 2000 with the Single European Sky. At the time the project was launched, competition was identified as the main factor for changing boundaries. The idea was to draw a separation between the upper airspace and the lower airspace, and to merge all national upper airspace into a single European one. Then a competitive bid would have been organized for the service provision in this unique upper airspace. There would not have been competition in the market (since it is not thinkable that an aircraft could choose between two air traffic control systems), but rather competition for the market (the contract would be awarded to the service provider that made the best offer according to specified requirements, and the provider would be given a monopoly position for a limited period of time). Progressively, the approach evolved, and cooperation supplanted competition.

One of the Single European Sky elements focused on interoperability, to make certain that the different systems used in Europe could communicate with each other. Another element created the concept of Functional Airspace Blocks (FABs), aimed at promoting cooperation between countries in order to define capability units spanning boundaries. United Kingdom and Eire, France and Switzerland, Spain and Portugal, for example, have entered into talks to create such blocks.

Thus, an actor that plays an architectural role, the European Commission (jointly with the Council and Parliament) created a framework to make possible the transformation of boundaries. Subsequently, actors belonging to the industry developed cooperative strategies that effectively modified the boundaries. These strategies have been offensive

**3.** This form of organization had been used to develop the 777, one of the biggest successes in the history of the commercial aviation. The Working Together Team grouped the customers, Boeing's engineers and the future suppliers, and mobilized computer aided design (Benson 1994 ; 1995 ; 1996).

and defensive. For example, when Denmark, Finland, Norway and Sweden tried to elaborate a joint project, they did so feeling threatened by the offensive projects of the German service provider. Similarly, controllers themselves have presented a project called MOSAIC, which groups different service providers in central Europe (Benelux, France, Germany), with the goal of responding to the threat of privatization or of grouping by pairs. In short, cooperative projects are stimulated by a climate of actual or potential competition.

## DISCUSSION

The present discussion will be structured in two parts. First, we will return to the three propositions. Second, we will present four methodological principles for the study of organizational boundaries.

The first proposition states that organizational boundaries are never "natural", but that they are determined by decisions that take into account transaction costs, and economies of scale and scope on the one hand, and, on the other hand, diseconomies of different kinds, non economic factors such as power or identity, as well as the benefits and costs of opacity and transparency in designing the best practical capability unit. Our case study substantiates such proposition. The displacement of boundaries in the ATM industry with the goal of widening the scope of the capability units clearly seems to improve the functioning of the industry, inducing economies in maintenance and the development of large technological systems, as well as a better operational efficiency.

In practice, however, the optimum in placing the boundaries is difficult to determine. This difficulty illustrates the notion of causal ambiguity developed by Resource-Based View theorists (Barney, 1999). Should Europe go in the direction of a unique service provider, akin to the Federal Aviation Authority in the Unites States ATM system? Or should it include a few big service providers that would both compete and cooperate with each other? In the absence of a "natural" path to follow, decisions have to be made in order to restructure the industry.

According to the second proposition, once the decisions have been made, boundaries tend to sediment and become entrenched. This phenomenon can be explained by the multiple dimensions of the activities and dimensions involved (technological, organizational, relational, and so forth), combined with the asynchrony of the decisions related to them. The fact that the French and the German air traffic controls decided to develop a new technological system at different times reinforced the boundary separating the two capability units. As boundaries are not natural and tend to be entrenched, they are debatable and even controversial. This can lead to a change in boundaries (third proposition). Periodically, controversies become increasingly intense. Regarding the European ATM, the end of the 1990s was such a period because of a growing number of delayed flights. A change in the status of some actors (as when DFS in Germany, NATS in the

United Kingdom, and Swisscontrol in Switzerland were corporatized or privatized; Button & McDougall, 2006) triggered a shift in symbolic boundaries (Lamont et Molnar, 2002). Other actors (Boeing, the European Commission) thought they could play an architectural role; such a role consisted partly in changing their own boundaries, but more deeply in defining a framework that would allow other actors in the industry to transform theirs.

Our analysis does not result in a general theory of boundaries. Rather, it leads to the formulation of three propositions, which are (in line with our abductive approach) at the same time a result and a starting point for new studies. Four methodological principles can be formulated to conduct new research programmes on organizational boundaries.

## When analyzing boundaries, all types have to be taken into account.

Araujo, Dubois & Gadde (2003) or de Santos and Eisenhardt (2005) give precious insights on boundaries but they focus on only one type. They thus cannot demonstrate how boundaries can transform themselves in dynamics. For example, the French ATM organization is vertically integrated, with a unit of engineers specialized in designing and building technological systems for France. If a vertical boundary is established (by transforming this unit into a subsidiary), the vertical internal boundary would easily become an external one (if the subsidiary is eventually sold to a private firm such as Thales or Lockheed Martin). If the unit is maintained relatively autonomous after the acquisition by a private firm, the boundary becomes an horizontal internal one. When studying boundaries, it is necessary to examine various types at the same time: internal and external, horizontal and vertical, technical and symbolic.

## When analyzing the dynamics of boundaries, the coopetitive dimension must be taken into account.

Our case study illustrates the fact that the study of the dynamics of boundaries must be put in relation with the literature on coopetition (Yami, Castaldo, Dagnino & Le Roy, 2010), since the dynamics of boundaries entails complex combinations of cooperation and competition. In our case, the European Commission evolved from a competitive approach to a cooperative one. At the very beginning, the idea was to promote competition between national service providers to make the boundaries change more efficiently. Later, cooperation was favored in the form of interoperability of technical systems, and of FABs for the operational dimension. In fact, the Commission used a coopetitive approach; cooperation among small players, small and big players, and big players develops in a climate of potential competition. It is because competition looks credible in the future that cooperation develops. And the development of cooperation can be a precondition of the development of competition.

At the organizational level, moving a boundary can favor cooperation and competition. The privatization of public organizations has often

led to this kind of evolution: former internal units have been vertically separated, and have experienced competition afterwards (Cox, Harris & Parker, 1999). The creation of a vertical separation can also have an impact on horizontal boundaries, and make alliances possible. If, for example, the French ATM wants to enter into an alliance with its German counterpart, its vertically integrated structure is an obstacle, as the French technological system is designed by teams belonging to the French organization, while the German organization turns to the market to acquire its own system. The creation of a vertical boundary within the French organization makes the alliance easier, since the establishment of such boundaries can favor the abolition of horizontal ones.

## When analyzing boundaries, two dimensions are important : the rarefaction of flows (financial, informational, material, etc.) and their visibilization.

Within boundaries, flows are invisible. They become visible when they cross boundaries and when transactions occur (as seen by Baldwin, 2008). Within boundaries, cross-subsidization is general (Chevalier, 2004). Every establishment or displacement of a boundary visibilizes certain flows and opacifies others. In our case, the condition for the Europeanization of the sky would be the establishment of a boundary separating the upper and the lower airspace. This separation would make visible the current cross-subsidization between both, a situation in which flights in the upper airspace finance landings and take-offs.

## When analyzing boundaries, the asynchrony of decisions must be taken into account.

Within organizations, which are defined by their boundaries, numerous types of decisions are made, and they are related to many dimensions. Each type of decision has its own clock. And clockspeeds (Fine, 1998) are different. Existing boundaries constitue a frame for decision-making and, in return, the asynchrony of the decisions reinforces existing boundaries. In order to change boundaries, decisions must be resynchronized. This resynchronization power is one dimension of the architectural power of some actors (Jacobides & Billinger, 2006; Jacobides, Knudsen & Augier, 2006). Our case illustrates that point. In 2004, the Single European Sky was adopted for four years, and was assessed in 2008, at the end of this period. A new step (Single European Sky II) was voted in 2009, and will be assessed in 2013. Actors are obliged to elaborate their decisions within this synchronized framework. The European Commission has launched in parallel a project, SESAR, which prepares the technological shift twenty years ahead (a very similar project to the one Boeing was working on between 2001 and 2004 ; not surprisingly, Boeing's teams of Phanton Works have got contracts with SESAR). Such long term horizon is a means to make boundaries evolve.

The chart below presents the methodology proposed to analyze the dynamics of boundaries :

| | | |
|---|---|---|
| Determining the capability units | Economic analysis | Economies of scale and scope, diseconomies |
| | | Visibilization/opacification of the flows and exchanges (especially financial) |
| | Decision | A hierarchical actor determines the perimeter of the capability unit in a context of causal ambiguity, taking also into account non economic factors |
| Dynamics of boundary stabilization | sedimentation | Sedimentation of different kinds of boundaries |
| | asynchrony | Asynchrony of the decisions affecting the multiple dimensions of boundaries (technology, human resources, etc.) |
| Dynamics of boundary change | controversies | Being not « natural », boundaries are debatable |
| | Architectural actors | Strategy of imposed synchrony and of designing coopetition |
| | Actors of the industry | Coopetitive game and redesigning of the capability units |

## CONCLUSION

Our case study has shown how fruitful it is to analyze different types of boundaries (internal, external, horizontal, vertical) and their different dimensions (technology, organization, etc.) in a synoptic way.
We would first like to highlight some notions our analysis of boundaries has put forth. The concept of capability unit is related to the idea that there are no such things as « natural » boundaries that could be determined, for example, by transaction costs or economies of scale and scope. When managers place an internal or an external boundary, they think of a capability, and this is done in a context of causal ambiguity. Boundaries are the object of a decision, and are as such always debatable and debated. Moreover, they induce a rarefaction of the flows (financial, informational, and others), and the intensity of this rarefaction can itself evolve over time. Once determined, the boundaries tend to sediment and become entrenched. In that process, they asynchrony of decisions made in multiple dimensions (touching for example on technology, human resources, or the organization of sub-activities) plays a key role. As the environment evolves, controversies concerning the perimeter of the capability units may intensify, and some actors may develop strategies aimed at changing the boundaries. These strategies may pertain to the boundaries of a few capability units, or to a large set of boundaries. In the latter case, the strategy for transforming boundaries may be described as “architectural,” and is developed by an actor with a particular status. Such an actor, for example Boeing, belongs simultaneously to several organizational fields, and is not constrained by the same symbolic boundaries as the actors only belonging to one field. The architectural strategy entails a will to impose synchrony to other actors in the industry. The dynamics of displacing the boundaries relies on two processes, competition and cooperation, that may come together in a coopetitive approach.
The chart above illustrates these different points.
In our view, the case of the European ATM industry shows the necessity of considering an extended set of boundaries (external, internal, hori-

zontal, vertical, symbolic), as well as their dynamics (e.g. a vertical internal boundary may become an external one, thus allowing for a modification of horizontal boundaries). The richness of the case satisfies the condition of "conceptual variety" (Weick, 2007). Yet it also presents some limitations. One of them is the absence of price competition in the industry, which prevents us from more fully examining the usual link between the market and the boundaries. Another is the fact that ATM is a network industry where capability units are deeply interdependent. The boundary issue is partly determined by these particular features of the case, and any generalization has to be made with caution. Other studies are therefore required to test and enrich the approach (multidimensional and dynamic). In particular, situations in which a capability unit is designed should be studied with an ethnographic methodology. This methodology would throw light on the processes through which managers define the boundaries of capability units in a context of causal ambiguity, and would thereby help elucidate and flesh out the third proposition, according to which, even when entrenched, boundaries remain debatable, and implicated in strategies aimed at changing and maintaining them.

**Hervé Dumez** is a ENS-Ulm alumnus and research director at CNRS in economics and management science with visiting position at MIT. He carries out his research at PREG Ecole polytechnique. His fields of interest cover business strategies, market dynamics and regulation. His research has focused on industry such as cement, beer, air traffic services, defence, and on strategic concepts in particular coopetition. He has published a number of books and articles on his own or jointly with Alain Jeunemaitre. He is editor of the Aegis Libellio.

**Alain Jeunemaitre** is a Sorbonne alumnus and director at CNRS in economics and management science. He carries out his research at PREG Ecole polytechnique and the University of Oxford (CSLS and Said Business School). He is member of SESAR scientific committee, European Commission and Eurocontrol joint undertaking for the definition of the future European air traffic control system. His fields of interest cover business strategies, market dynamics and regulation. His research has focused on industry such as cement, beer, air traffic services, defence, and on strategic concepts in particular coopetition. He has published a number of books and articles on his own or jointly with Hervé Dumez.

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