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MODELING ENGINEERING INTERFACES IN COLLABORATIVE ACTIVITIES: A TRANSACTIONAL MODEL

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ABSTRACT
In large projects such as the ATLAS detector at CERN, the complexity of organizational and decision making structures may endanger a safe management of such projects. An analysis of the ATLAS organization was conducted during several years. A map of the decision making structure of one of its sub-projects is presented in the paper. It shows that the so-called technical manager, a middle manager (most of the times an engineer) is in a position of interface and has to deal with complex socio-economic-technical problems. This paper proposes an interface model that aims to grasp the complexity of engineering management situations. Based on hologramic and recursive principles of complexity, a transactional model of the interface is proposed with the types of interfaces that derive from it. Nine types of translations are described together with six types of inward and outward transactions, as well as the exchange spaces established through the interface actor. This model is illustrated through the case study of the project introduced at the beginning of the paper. The conclusion opens towards the pooling of bilateral exchange spaces to the set up trading zones.

Keywords: interfaces, project management, collaboration, transactional model, translation

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1 INTRODUCTION

The context of large engineering projects involves very complex organization and a great number of actors from very diverse fields of expertise. Particularly in large scientific projects such as the ATLAS detector at CERN (Figure 1, right hand), the complexity of organizational and decision-making structures may endanger a safe management of such projects.

An analysis was conducted during several years on the ATLAS organization, from which a map of the decision making structure of one of its sub-projects was built. This map (Figure 1, left hand) includes all the hierarchical levels of the organization and will be explained later on in section 1.2. It shows that the so-called technical manager, a middle manager (most of the times an engineer) is in a position of interface and has to deal with complex socio-economic-technical problems. This interface position leads to the processing of information in various ways in order to communicate in both directions, not only up and down, but also laterally. This paper examines this issue and proposes an interface model that aims to grasp the complexity of engineering management situations.

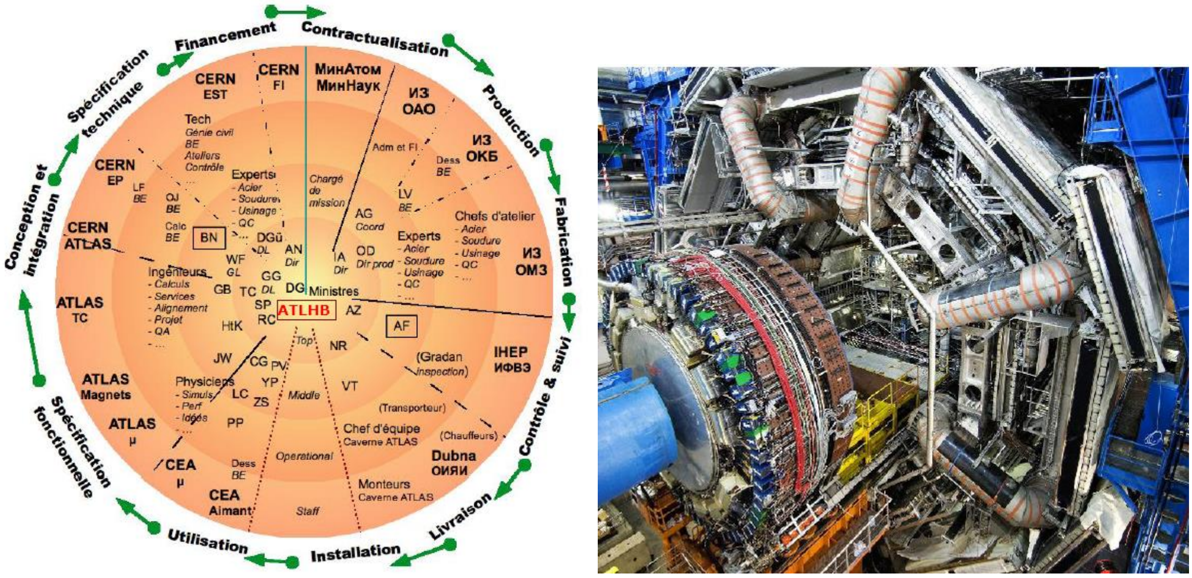


Figure 1: ATLAS organizational and technological complexity

1.1 The ATLAS Detector at LHC: Complexity at Work

The Large Hadron Collider (LHC), situated at CERN across the French-Swiss border near Geneva, is considered one of the most complex engineering endeavors at the service of science ever achieved. The complexity of this engineering system can be approached through some numbers. In order for the energy of the accelerated proton beams to reach 14 TeV, a 27 km circular accelerator was designed, made (amongst many other types of components) of large superconductor magnets at a temperature of 4K, providing the 9 Tesla magnetic field used to bend the trajectory of the particles (Bruning and Collier 2007). Two main experiments were designed: ATLAS and CMS. One of their aims was to detect the famous Higgs boson, whose discovery was announced in July 2012 (Aad et al. 2012, ATLAS 2012). The ATLAS detector is a piece of machinery (Aad et al. 2008) that consists of an impressive cylindrical structure of more than 40 meters long, 25 meters in diameter weighing approximately 7000 tons, and lays in a cavern at 100 meters below the surface. The detector is made of several sub-systems, including a magnetic system made of superconductive magnets for the muon spectrometer and the inner tracker. Each proton beam crossing provides up to 15 collisions every 25 nanoseconds, which produce a huge amount of data that requires sorting, storage and analysis.

The engineering complexity is of the same scale as the equipment. The question is not only to design the objects themselves, but also at the same time take into account their interconnections, their support, their electrical and fluids feeding, and also their handling, their maintenance, and all phases in their lifecycle. The engineering fields involved range from civil engineering to electronics and control, and include mechanics, cryogenics, magnetic, specific handling, cooling and ventilation, electrical, and geometrical survey. The requirements of the information system to support a common description of the designed CoPS (Complex Products and Sytems) (Hobday et al. 2000) are quite challenging.

ATLAS Collaboration involves over 140 laboratories, universities and research organizations from nearly 40 countries with more than 40 funding agencies contributing to the collaboration. It is organized as a kind of federation of projects. Each subsystem and each activity is represented within the Executive Board, a kind of government, which meets at least monthly with top management (spokesperson, technical coordinator and coordinator resources) to discuss and make decisions on operational issues. The Technical Coordinator also runs a Technical Management Board that consists of technical subsystems representatives (project managers or project engineers), and the Resources Coordinator prepares the quarterly meeting of representatives of "funding agencies" to deal with financial issues. The Collaboration Board, a kind of parliament, deals with relations between institutes, while the Plenary meeting brings together all collaborators as a kind of direct democracy forum.

The ATLAS top manager is neither called a President nor CEO nor even a project manager. It is very revealing of the spirit of these collaborations that the official title of the person who is elected leader of the collaboration is a "spokesperson", who has in fact no direct authority over the thousands of physicists and engineers working on the project. The role of the spokesperson is to delegate or “to guide smoothly” and, upon request of the heads of sub-systems or coordinators of activities, to arbitrate. The leadership style of the spokesperson is primarily to organize discussions and rational justifications rather than control and direct. Important decisions are always taken by consensus. In accordance with the spirit of collaboration, the leaders and managers are called project coordinators. Scientists that occupy these management positions promote horizontal coordination between the numerous institutions and the activities inside the collaboration, rather than establishing a kind of supervision leading to hierarchical relationships with their colleagues. This management style is an interesting form of coordination that rises new and challenging cooperation and decision-making issues (Boisot et al. 2011). The managers at every level of the organization need to develop interface skills for processing the information in various ways that allow their collaborators to gain common understanding, make proper decisions, execute or complement. New works within the field of strategic management (Santalainen et al., in Boisot et al. 2011, chapter 3) show that this way of management may turn out to be a very good one even for projects in more classical hierarchical organizations.

The model of the interface that is proposed later on in this paper is human-centric and starts from the elementary activities one has to accomplish when involved in such a collaboration network. In order to introduce our model we will present a more refined case study that highlights the main issues.

1.2 A Case Study: an ATLAS Sub-Project

One of the ATLAS Sub-Projects is the main supporting structure, called the “Feet and Rails” project, which was the subject of an in-depth case study (Nicquevert et al., in Boisot et al. 2011, chapter 9). This project is a large piece of mechanics consisting of 450 tons of non-magnetic stainless steel welded together, with a sub-millimetric precision over several meters, with the purpose of withstanding and guiding the movement of thousands of tons of ATLAS detectors and magnets.

Figure 1 on the left-hand side displays the various actors involved (internal and external) in this project. All the actors are positioned around a center representing the project. Each radial sector corresponds to an organizational unit working for the project. Along the radius, the disc is cut into four rings, corresponding to the hierarchical levels kept for this model (as can be seen in the bottom radial sector): that of the top management, closest to the center; that of the middle management; and that of the operational management; and finally, outside, the executors are represented with the name of their employer. The intersection between a radial sector and a ring contains an actor or a group of actors, defined both by their approximate hierarchical level and by the organizational unit they belong to.

Around the disc, a series of arrows indicate the schematic lifecycle of the project, starting from bottom left with the specification of the need and ending at the same place with the phase of utilization by the ATLAS physicists. These scientists (in our simplified model) are partly at CERN and partly in other scientific organizations such the French CEA (*Commissariat à l’Énergie Atomique*), where the team in charge of the toroidal magnet that is supported by the Feet was working. The technical specification is then the basis of the design performed by the CERN Design Office (BE – *Bureau d’études*). The financing comes from CERN as well as from Russian ministers who delegate the manufacturing to a Russian company, Izhora (IZ). This manufacturing is followed up mainly by a Russian scientific institute (IHEP), a member of the ATLAS Collaboration and responsible for successful completion of the production. Installation is then supervised by the ATLAS Technical Coordination.

This concentric model illustrates the ability of these technical managers to move and circulate between all the actors on the whole surface of the disc, in particular the project leader and the Russian mediator. They interface with their peers of the middle managers' ring, as well as with those in the top management ring in order to establish and regulate the organizational context within which the project evolves, and also on the operational management ring when actions on the field have to be supervised and followed up, be it in the design offices, in the various workshops, for quality control or still for the data management of the documents or in the ATLAS cavern.
The aim of the transactional model proposed in the paper is to provide a tool to better characterize and represent how this organizational web works, and to offer a way to pilot the project by getting an overall picture of the dynamic exchanges between all the actors during the lifetime of the project.

2 THE TRANSACTIONAL MODEL

2.1 The Interface Actor

Fleurance and Pérez (2009) developed an approach of management in action, which is built in a dual institutional space (between the organization and the individual) and searches for the right distance between a center and a periphery in the context of a collective network of actors. It is a complex management due to the structure, the diversity of interactions and interventions, and the coupling between processes and different time scales. "This perspective then places the actors and their subjectivities at the center of the organizational dynamics" in which knowledge is negotiated.

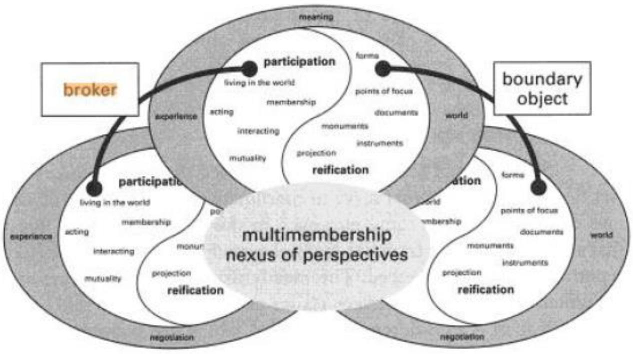


Figure 2: The broker, an interface between communities of practice (Wenger 1998)

Figure 2 is the image of the manager at the center of a network of actors that inspired the figure of the interface actor, precisely at the interface between communities of practice introduced by Wenger (1998). The term he uses is that of broker: "people who can introduce elements of one practice into another". Chanal (2000) prefers the term of *interface actor*, introduced by Moisdon and Weil (1992) to highlight, in the car makers' projects, these "new actors more worried by the interface issues between correlated techniques or between actors intervening at various times. They intervene as mediators able to offer marginal concessions to one or the other stakeholders". Chanal stated that this position is "both complex and difficult to achieve [...] and involves translation skills, coordination and coherence of different perspectives". The use of this translation metaphor explicitly refers to Latour (1987): "Translation is the interpretation given by those who build the facts, their interests and those of the people they recruit". With transaction, translation is one of the two components of the mediation work of the interface actors that will be used to define our interfaces and interface model.

2.2 The Hologramic Principle

The hologramic principle proposed by Morin is based on an analogy with the physical hologram: each point of such an image contains the whole information of the object represented "not only the part is inside the whole, but the whole is inside the part". He further clarifies that "the whole is inscribed in a certain way into the part" (Morin 2008a). He cites the example of the biological world, where every cell in our body contains all the genetic information of the organism. This is also the case in the sociological world where each individual carries the knowledge of the society (mostly unconsciously), while being shaped by it. In the hologramic idea, the knowledge of all the parts is enriched by the whole, and of the whole by all the parts, in the same knowledge-producing move. This is the idea behind our model: it can equally apply at any scale, and thus efficiently describes multi-scale effects.

2.3 The Tripolar Interface Model

The suggested tripolar mesh model also comes from an extended observation and case studies that can be found in Nicquevert (2012): whatever point of view, regardless of the focus on any of the actors or the groups of actors considered, whether human, socio-technical, organizational or otherwise, this actor may, according to our hypothesis, *act in only three ways* (Figure 3, left): “what I am asked to do” (up); “what I actually do” (middle); and “what I ask to be done” (down). These terms correspond to the three categories of identified stakeholders: those who ask me to do (e.g. superiors, superordinates, supervisors, project managers or clients); those whom I work with (e.g. peer companies or organizations, peers, colleagues, or partners); and those to whom I ask to do (e.g. subcontractor, operational subordinate, performers or suppliers).

It is precisely these interface relationships that we seek to characterize through our model: what should be done in order for two sequential bilateral arrows (in yellow on Figure 3 left) to become one interface arrow (in dark green)? Can we treat the three interface directions (up, down, middle) in a generic way, and how? We propose to define the two interface components, translation and transaction, and to implement them in a structured way.

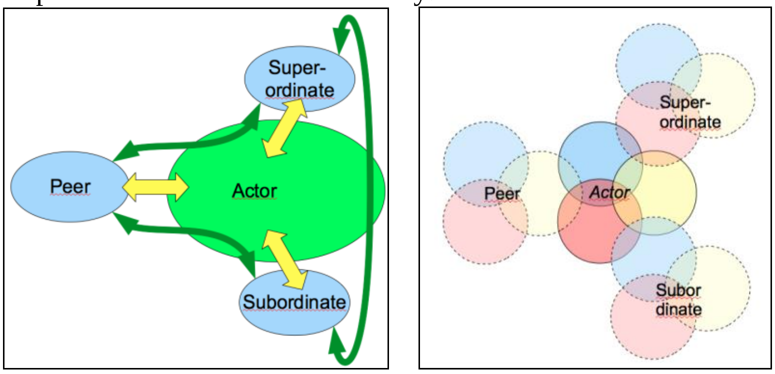
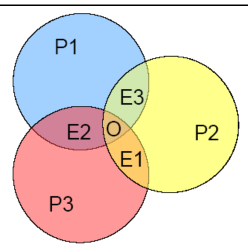


Figure 3: The three ways of interface: up, down,and middle in/out (left); and their representation with the tripolar interface model (right)

The proposed tripolar mesh model is a general model of an interface actor, inspired by transactional analysis (Berne, 1961) and by multi-agent systems. It follows a dual interface mode, both translation and transaction. This model, according to the hologramic principle presented in section 2.2, is composed of an elementary cell which has the basic topological form displayed in Figure 4. The mesh consists of seven distinct areas created by the topology of three superimposed circles: a central triangle with convex sides O, which is what we call the *core* of the actor; three *poles* P_1 to P_3; and three (bilateral) *exchange spaces* E_1 to E_3. As such, the core of every actor can be put in relation with another actor along one of the P_i poles through one exchange space E_i.



O: the core, the actor
E_i: bilateral exchange space
P_i: interface poles (interaction modes)
P_1: what I ask to be done
P_2: what I do
P_3: what I am asked to do

Figure 4: The elementary tripolar cell of the interface model

The network of interconnected actors is thus represented by a continuous web of interconnected circles (Figure 5, Figure 8). As the organization constantly evolves, this network is also dynamic.

2.4 A Typical Case: the Interface between a Superordinate and a Subordinate

Let us illustrate one of these types of interfaces with the case of a superordinate A and a subordinate C through an interface actor O (Figure 5). This case is very common in projects and can be illustrated by each position of Figure 1 along the radial axis, when a technical manager has to connect an actor from the outer circle to another one from the inner circle, at any point of the circle. This interface operates in the two directions, describing the flow of the top-down instructions (orders, specifications, requests) that the superordinate sends to the subordinate, and bottom-up information feedback (reports, indicators, results, questions, remarks) that the superordinate receives from the subordinate. In this section, our tripolar model will help us catch what happens at the interface to ensure a correct transmission.

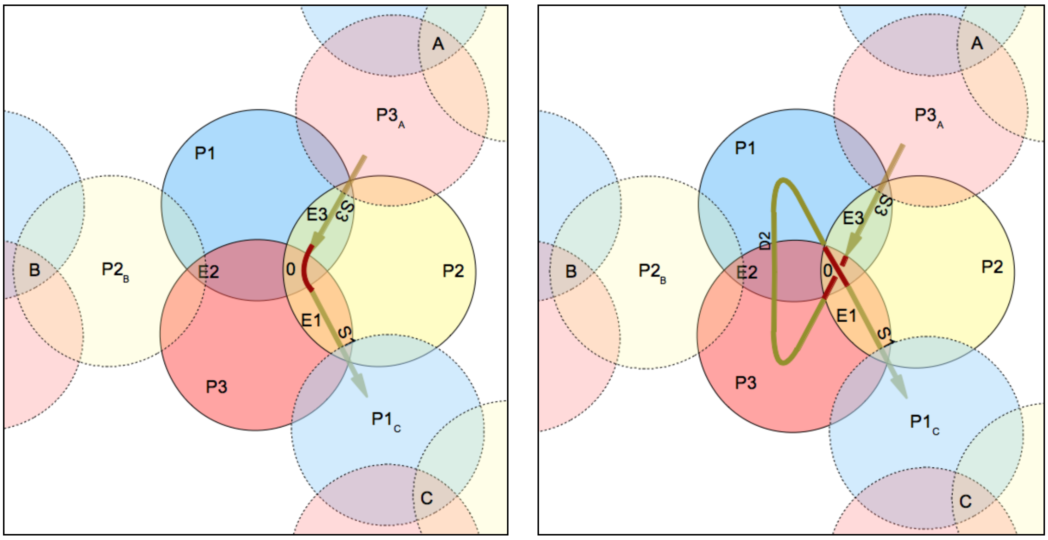


Figure 5: The actor O acting as an interface between actors A and C
Left: direct interface (commissioning role). Right : composite interface (mediating role)

Let us specify how the connection is established between *A* and *C*, and the role of *O* in the interface thus formed: a commissioning role in the first direct mode (Figure 5 left) and a mediating one in the second composite (indirect) mode (Figure 5 right). We are mainly interested in the latter mode, in which the interface actor adds value and which constitutes the major interaction mode in engineering design. The former, the direct mode is however also of interest, and complements the picture.

2.4.1 Commissioning interactions

Consider the case of a statement coming from *A* to *C*. In our tripolar mesh model, the interactions will take a path which takes into account the various areas traversed from core *A*, namely the pole P_{3A} and the (bilateral) exchange space E_3, until it reaches the core of the interface actor *O*. The path then exits through exchange space E_1, before joining the core *C* through the pole P_{1C}, giving him instructions or an initiation (in the etymological sense: “order to start”). The interface is then composed of a first transaction between *A* and *O*, and a second transaction between *O* and *C*. These two transactions are represented in Figure 6 (centre) by the arrows S_i: the arrow S_3 models the transaction between *A* and *O* from the pole 3 of *A* to *O* core (through exchange space E_3), and the arrow S_1 models the transaction between *O* and *C*, from *O* core to the pole 1 of *C* (through exchange space E_1). The interface thus formed is made of two successive transactions, without additional treatment inside the actor *O*. This first mode is called “direct mode” because it does not bring additional value to the interface. By analogy to Vinck and Jeantet’s work (1995) we call it a “commissioning” interface mode.

2.4.2 Mediating interactions

The second mode is that in which an additional internal operation at the level of the interface actor *O* occurs, i.e. a *translation* operation. According to the terminology of the intermediary objects (Vinck and Jeantet 1995; Vinck, 2011), this composite translation mode is called a “mediating” translation mode. In order to represent topologically this translation operation and realize the passage from a P_3 type pole (“what I am asked to do”) to a P_1 type pole (“what I actually do”), the inflow (specification or order, in our case) from the first protagonist *A* will not pass directly from E_3 to E_1: as in the direct mode, it will travel through the *internal* poles of the interface actor *O*, forming a loop as shown in Figure 5 (right side), in order to be converted before reaching the P_{3C} pole of the other protagonist of the interaction. The incoming object of the transaction S_3 will benefit from the adding-value treatment provided by the interface actor *O*: for that, it enters into the P_{3O} internal pole of the interface actor *O*, and then reaches its P_{1O} pole by crossing the exchange space E_2 *transversely*, and not longitudinally (as is the case for the two arrows S_1 and S_3 modelling a transaction): this transverse crossing models a translation operation. This path is represented by the alpha-shaped arrow D_2 (translation of P_3 to P_1).

The interface thus formed is composed of one incoming transaction S_3, followed by a translation D_2, then an outgoing transaction S_1. This composition applies to all types of interfaces as explained in section 3. The interface being moreover bidirectional, it must understood that incoming and outgoing transactions exchange regularly and dynamically their role during the process.

2.5 Impedance Matching

Let us pay attention to the particular internal translation (named D_2) between P_1 and P_3, called *impedance matching*. This term comes from an analogy with acoustics. In a nutshell, the acoustic impedance is the ratio between the pressure and the velocity of the air, representing a kind of resistance or inertia to the sound propagation. By analogy, this impedance matching represents the adaptation of a language type to another one, from one type of sensitivity to another, from one cognitive level to another (Galison 1997, Wenger 1998, Jung 2006).
During the case study on the ATLAS Feet and Rails Project, it was often noticed how it was common that the terms and mindsets of physicists were not directly understandable for engineers, and conversely, the engineering constraints were not perceived in the physicists' world. As a result, more or less explicit requests from the Technical Coordination had to be interpreted and adapted, in order to be handled either by the design office or by the Russian manufacturer. It is therefore a question or translating and adapting the message to the sensitivity and cognitive ability of the stakeholders. What will be clear to someone will be awkward for another if not equipped with the necessary keys to decrypt the message. Such is the purpose of this impedance matching.

3 THE INTERFACE MODEL

By analogy and extension to what has been presented above, it is possible to model the two other types of interfaces set up by the interface actor *O*: between a superordinate *A* and a peer *B*, or an interface between a peer *B* and a subordinate *C*. Modeling interfaces can also be extended to these cases (rather frequent in practice) of interfaces called "looping", that is to say between two instances of the same level, e.g. between superordinates *A*' and *A''*, between two peers *B'* and *B''*, or between two subordinates *C'* and *C''*. Each oriented interface is composed as follows:

Oriented interface = incoming transaction + internal translation + outgoing transaction

In order to define the six types of possible interfaces created by an interface actor that connects two other actors of a network, it is necessary to introduce other modular components in terms of translation and transactions: internal loops translation. We first present the different types of interfaces, and these additional components, before synthesizing the composition.

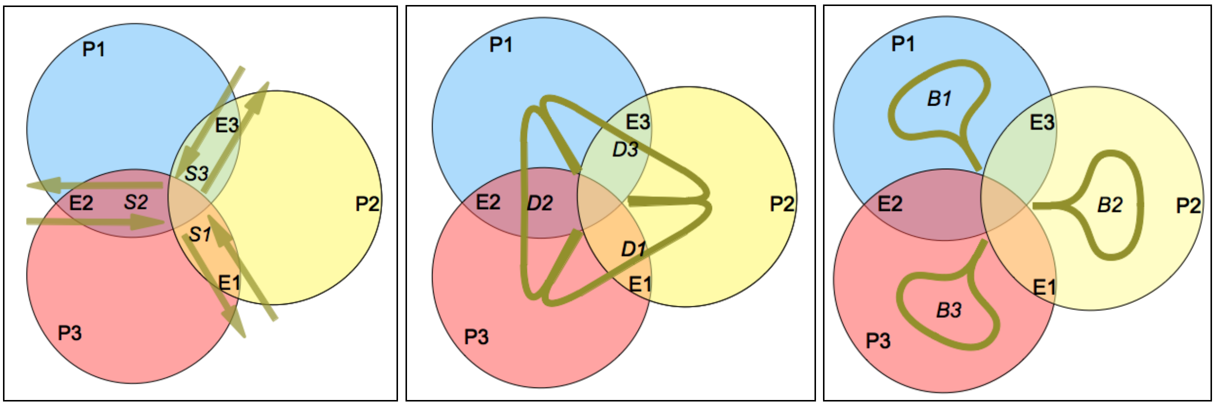


Figure 6: Interface modular components
From left to right: Transactions, translations, and looping translations

In the previous case of section 2.4, the top-down oriented interface is coupled with the bottom-up oriented interface that forms a vertical interface, connecting *A* and *C* through *O* (Figure 5). These interfaces are bilateral, that is to say, they both operate on directions and are complex. With Morin (2008a, 2008b) we are able to describe these interfaces in terms of *dialogic loops*: interfaces operate in recursive loops between the two interfaced actors. The technical manager, as an interface actor, fuels this connection that becomes a complex relationship. Let us detail the modular components that are used to build these interfaces, both transactions and translations.

3.1 Transaction Types

During the previous case of the vertical top-down interface, two types of transactions were described: the transaction between the interface actor and a subordinate, and the transaction between a superordinate and an interface actor. The third type of possible transaction is the transaction between the interface actor and one of his peers. In that case a *lateral* transaction occurs. This transaction type is somewhat neglected in literature in favor of vertical relationships. It is sometimes called middle-out (Kinchla and Wolfe 1979). By extrapolation, we will call a centripetal (inward) transaction a middle-in transaction. This transaction with a peer typically consists of the synchronization task of the action of one actor with that of his peers (middle-in), or sharing of information sent to his peers so that they synchronize with his action (middle-out). These six possible transactions are summarized and defined in Figure 6 (left-hand side).

3.2 Translation Types

We introduced in section 2.6 the translation of type D_2 called *impedance matching* between the P_1 pole "what I ask to be done" and the P_3 pole "what I am asked to do". The other two types of translations between the other two pairs of poles are respectively the translation type D_3 *dispatching / gathering* between pole 1 and pole 2 "what I do", and the translation type D_1 *sorting / reconstitution* between poles 2 and 3. Figure 6 (middle) graphically summarizes these three types of translation.
Strictly speaking, these translations are not symmetrical (that is to say, they should also depend on the direction in which they traveled). The model, however, offers the possibility of simplifying this hypothesis by introducing this dialogical relation. It is indeed difficult to distinguish these different types of translations but we used dialogic pairs of words in order to point out the asymmetry of the translations. The use of the model will allow the stabilization of denominations.
Each unidirectional translation operates simultaneously and dialogically with its counterpart. The impedance matching translation D_2 is a term that contains its own dialogic, so to say. The other translations will be written more easily in the form of an equation, where the omega symbol Ω represents the dialogic loop (see also Table 1 below):

$D_1 = \Omega$ *(sorting, reconstitution) → cooperation,*

$D_3 = \Omega$ *(dispatching, gathering) → coordination.*

Let us explain these definitions. The translation D_1 occurs between the P_2 pole "what I do" and the P_3 pole "what I am asked to do". Between these two poles, among what we are asked to do (my colleagues and me) it is to sort between what I will do myself on the one hand and, on the other hand, what my colleagues will do. It is then to ensure (that is the subject of the outgoing transaction that complements the corresponding interface) that the sorting is shared with my colleagues. In return, it is to reconstitute the entire task. Verification of completeness in accordance with the initial request is the subject of the transaction that completes this interface. Therefore the operation $D_1 = \Omega$ *(sorting, reconstitution)* is a translation between a global task and its sub-tasks, that we consider as a preparatory translation to *cooperation*.
Similarly, D_3 is the operation that takes place between the poles P_2 and P_1. It is fairly similar to the previously described translation, except that this time it is to share resources, to define the boundaries within a group of subordinates, and then collect what was shared to verify consistency (which is subject of the outgoing transaction). The translation process is therefore: $D_3 = \Omega$ *(dispatching, gathering),* and we can consider this operation as a prerequisite to translation type *coordination*.

3.3 Looping Translations

The case of looping interfaces implies internal translations inside one pole of the interface actor. It is shown in Figure 6 (right-hand side). We call these translation loops: a *conciliation* loop within P_1 "what I ask to be done"; a *mediation* loop within P_2 "what I do"; and *arbitration* loop within P_3 "what I am asked to do". These terms highlight the subtle differences between these three loops and require some further refinements. It would indeed be appropriate to consider that each translation loop is simultaneously made of the three possible ways, the main modality giving its name to such a triad. For example, conciliation requires both mediation and arbitration in order to be achieved.

3.4 Summary

The different types of transactions and translations that make up an interface between two actors through a third one are summarized in Table 1. The considered poles are those of the two actors put in interface that are connected to the ones of the interface actor. The transactions S_i are shown in the first row and first column of the matrix, that is to say in the cells linking the pole of an external actor with the pole of the same nature of the considered interface actor. Looping translations B_i fulfill the diagonal, when the off-diagonal terms D_i (between two internal poles of the interface actor) are the other remaining types of translation. We thus obtain fifteen types of relationship. By introducing the dialogic loops D_1 and D_3, the direction in which translations are scanned does not change the fundamental nature of these dynamic interfaces. Their number is reduced to twelve, the sub-matrix 3x3 of translations between internal poles of the interface actor then being symmetrical.

Table 1: Composition of interfaces

From/to	External pole	P_1	P_2	P_3
External pole	(Non applicable)	S_1, bottom-up *Verification*	S_2, middle-in *Synchronization*	S_3, top-down *Specification*
P_1 (*what I ask to be done*)	S_1, top-down *Initiation*	B_1 *Arbitration*	D_3 *Coordination*	D_2 *Impedance matching*
P_2 (*what I do*)	S_2, middle-out *Exchange*	D_3 Coordination	B_2 Mediation	D_1 Cooperation
P_3 (*what I am asked to do*)	S_3, bottom-up *Orientation* (global view)	D_2 Impedance matching	D_1 Cooperation	B_3 Conciliation

4 THE CASE STUDY

For illustration, we take the case of the Feet and Rails of the ATLAS project, represented by the concentric model shown in Figure 1. The elementary cell of Figure 4 can be seen with different levels of refinement in a fractal decomposition or aggregation, shown in Figure 7 (right part illustrates the superposition of, and interconnection between tripolar cells). At the level of human actors, the tripole furthest left represents an actor; three poles are three internal bodies in line with the other concentric upper, lower level, and equivalent levels of the model shown in Figure 1. This is the way the technical manager moves inside the concentric model, and sets up interfaces inside the real project.

At a higher level, is the organization *team*, the design office BE for example, where the relationship between the head of the office, the designer and the simulation engineer can be observed. At an even higher level, CERN wide for example, are the interactions between the ATLAS Technical Coordination, the Design office belonging to the Physics Division and the direction of this division. During the case study, the latter acted as an interface between ATLAS and the Technical Office, and also on behalf of third counterparts ATLAS, CMS sister-like experience, for sharing resources. At the ATLAS Collaboration level, we focus on the relationships between CERN design office, the project organization of the Feet project (code ATLHB) and Technical Coordination (TC), whose mission is to monitor the successful completion of the projects the fund on behalf of the whole of the Collaboration.

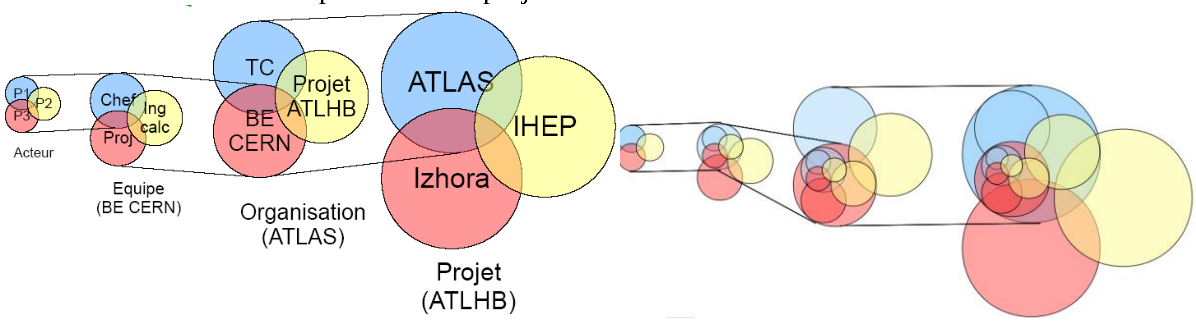


Figure 7: Tripolar model of the network within the ATLAS Feet and Rails project

At the global and inter-organizational level, we can also use the network as a representation of the overall project in its implementation phase. The three players are then three organizations: ATLAS Collaboration as specifying entity, Izhora executing the work, and IHEP responsible for monitoring implementation. It is interesting to identify who within these organizations is holding which pole. For ATLAS it could be suggested that the Technical Coordinator takes pole 3, the head of CERN research department being in pole 1, and the project manager in pole 2. Inside Izhora stands the project manager in pole 3, the manufacturing foreman in pole 1, and the design office in 2. For IHEP we would have: Chief Physicist in pole 3, the verification office in pole 1, and an engineer-physicist in pole 2. Reality is more complex, of course, and this relationship between human actors as representatives of the legal entity deserves further development.

5 CONCLUSION: TOWARDS THE DESCRIPTION OF TRADING ZONES

This paper presented an approach for modeling interactions in an engineering context. The concept of interface was used to describe the position of a middle manager in the dynamics of these interactions. This model is generic and captures all types of possible interactions between actors. It is obviously a human centric approach starting from the interface, considering that every actor is potentially at the centre of this interface. This proposal needs to be refined and worked out in the context of industrial cases. Theoretical work also needs to be carried out in order to root the operators and dialogic operations in sound foundations. The present work is a first step toward the operational set up of trading zones (Galison 1997), by pooling a series of bilateral exchange spaces between several collaborating actors belonging to different communities of practice.

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