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Accessing Material Culture by Following Intermediary Objects

Dominique Vinck
University of Lausanne
Switzerland

1. Introduction

In this chapter, we outline a method for describing material culture in situations where there are many interconnected places to be studied, which is the case in organisational ethnography or multi-situated ethnography (Marcus, 1995). In these kinds of setting, the aim of ethnography is to describe the linkages along the chains and paths articulating different sites. To help perform multi-situated investigations, we suggest using the concept of *intermediary object* as an ethnography-enriching tool. The key methodological idea is to take into account material objects and to follow them as they move from one site to another and from one person to another. Following these intermediary objects proves to be very useful in terms of data collection, as can be seen in studies of scientific cooperation networks (Vinck et al., 1993; Vinck, 1999) and engineering practices in design offices (Vinck & Jeantet, 1995; Vinck, 2003), but also in studies of day-to-day relations within the couple (Kaufmann, 1998). This method helps to reveal activities, actors, connections, networks and processes and contributes to providing accurate accounts of localities without losing sight of their connections. Thus, it serves the purpose of studying dynamic and contingently settled activities across organisational borders. The spaces produced are made up of flows and translations of things, people and texts.

With this suggestion to follow intermediary objects, the chapter therefore contributes to social science by taking into account material culture and the materiality of things (bodies, artefacts, etc.). Indeed, when constructivism had dissolved everything that was solid into fluid, materiality made a renewed entry into social theory (Latour, 1999). Some authors (Pels et al., 2002) pointed out that it was time to grasp the force of things and rediscover how social and material relations are entangled. They emphasised the extent to which social matters are ordered and 'set' by material things. The ethnographic suggestion to follow humans and non-humans (Latour, 1987) reflected the idea that the social world could not be sustained and achieve coherence without non-humans (Latour, 1996). The same applied to the question about what moves society and what makes up society's mobility and fluidity. The "Actor-Network Theory" agnostic approach, developed by Michel Callon, Bruno Latour and John Law (Callon, 1986; Latour, 1993; Law, 1991, 1999), with the principle of methodological symmetry between humans and non-humans, the ontological idea of the hybrid character of socio-technical collectives, the description of heterogeneous engineering (Law, 1987) and the 'interobjectivity' of social order (Latour,

1996), lead to the suppression of modernist categories separating society from technology and culture from nature.

The hypothesis that people's relationships to materiality and society are mutually dependent (Appadurai, 1986) calls for methodologies that help us to study the artefacts and technical gestures accompanying the fabrication and use of objects. Looking at intermediary objects involves focusing on artefacts and material accomplishments (acquisition of material and display of material prosperity, skill, crafts and technology). These objects are part of a culture and evolve as they interact with society. Thus Kopytoff (1986) suggests studying their biography to understand their changes in terms of status, variability and intermediary forms. Various traditions in social sciences converge towards the idea of taking into account material culture in the analysis of past and present societies. However, these traditions differ in terms of how to conceptualise the role and the meaning of artefacts. They also have very different methodological approaches to materiality: gathering the artefacts as testimony, symbols or indicators of a culture or of a stage in the evolution or dissemination of cultures; explaining their function in society; describing their interconnections and the technical system they form; following their career and biography; looking at gestures more than at the artefacts; seeing them as a coercitive force shaping the behaviour of human beings or society. We suggest using an open methodology, a methodology that allows various interpretations in order to support inductive conceptualisation.

The chapter will first trace how the concept of intermediary object emerged as part of a sociology-of-science investigation spanning more than one hundred scientific cooperation networks in the health field. We shall explore its emergence through the narrative of this investigation into scientific activity and the associated field observations. The chapter will present some of the findings and show how the concept was used.

We shall then explore how this concept can be capitalised on in the study of other practices, relations and material cultures. To do this, we shall highlight the concept's descriptive and analytical capacity when applied to a field study. This will also help us to illustrate the methodology and its importance for ethnography. We show that by describing and following intermediary objects it is possible to categorise key features of practices and relations. Among other things, we will explain how the intermediary object might be considered and theorised as a form of representation (the inscription of intentions, working habits, power relations or agreements in the very matter of an object), but also as a form of translation (uncontrolled shifts), mediation and framework.

We conclude the chapter with new developments in the concept of intermediary object and their potential application to design ethnography, as well as engineering, organisational and innovation studies. Indeed, looking at the objects being manipulated and produced, even if they are common, unspecific (e.g. a pencil) and apparently unimportant, sheds additional light on the activity under study. The hypothesis is that by following these objects and their circulation it is possible to produce another picture of human activity and organisation.

2. Networks and activities revealed through intermediary objects

In this section, we shall first retrace the emergence of the notion of intermediary object and then explore how it was initially used.

2.1 Beginnings of the notion of intermediary object

The notion of intermediary object emerged through a sociology-of-science investigation whose aim was to describe and characterise 120 scientific cooperation networks operating in the health field (Vinck, 1992, 1999; Vinck et al, 1993). These networks brought together over three thousand five hundred teams of researchers, industrialists and clinical practitioners as part of a European programme. To characterise these networks and understand what “networking” entailed, the survey identified the actors, characterised the forms of organisation and coordination, and the agreements binding the actors together. It also strove to capture the content of activity: the objectives of each network, the desired end results and the acquired or expected intermediaries. The aim was to describe the networks of relations between actors and what the research cooperative networks produced.

At the time when the investigation was performed, the network was considered a new way to organise scientific work. Promoted within the framework of public research programmes, the constitution of networks became a purposeful and collective enterprise in the 1980’s. The network was the result of a political decision to organise scientific work around projects. The European Community Commission’s involvement reflected the growing popularity of these new forms of scientific work organisation. It encouraged the setting up of cooperation between research bodies, whose political managers hoped to gain much from the collaboration. However, how these networks were formed, how they changed, what their regulation mechanisms or the difficulties they encountered were, or what their impact on research directions was, remained unknown factors. Research then began to focus on what “networking” actually meant. What forms of coordination were set up through networking? To what extent did networks make it possible to switch from a local focus on scientific practices to the universalisation and relocation of research outcomes? One main question was: what is a network and what does it produce?

The investigation rapidly revealed a diverse range of situations; each network had its own individual characteristics. Many turned out to be very different from what the science policy managers had imagined, in other words forums for discussion and trading of ideas between researchers. Instead, they reflected the collective dynamics underpinning the building of research infrastructures. Table 1 lists some examples of the scientific cooperation networks studied.

The preliminary interviews with the project leaders and network members very quickly revealed that the most active members devoted a considerable amount of time to designing, negotiating, producing and disseminating all kinds of “objects”: texts, computer files, biological samples, instruments, animals, phantoms and even patients (see table 2). Initially aiming to study relationships between researchers, the investigation began to focus on the objects that were exchanged and circulated between the network members, referred to then as “intermediary objects.” The notion was used for descriptive purposes and did not initially carry any conceptual weight. It represented additional input for the investigation. The aim was not to judge either the nature or role of these intermediary objects as they moved “between” the actors. The notion was then extended to larger objects, such as facilities or fixed pieces of equipment around which the research teams gravitated. For example, it was applied to a colony of chimpanzees suffering from AIDS or a large database.

Network theme	Type of network
Medical laser applications	Theme-based forum: bringing together a community of researchers with the aim of developing new projects + organising mutual research team visits + setting up exchanges for training
Artherosclerosis	Research infrastructure: in charge of structuring a protocol, resources (database, sample banks) and logistics to bring together clinical research teams working on a clinical trial. The idea was to be able to reuse the infrastructure for other trials.
Molecular cytogenetics of solid tumours	Research infrastructure: responsible for organising 10 cell bank lines, structuring logistics and harmonising access to equipment by other teams.
HIV genetic screening	Research infrastructure: in charge of organising a sequencing laboratory to be used by other research teams, and setting up an experiment committee responsible for harmonising equipment preparation and deciding on access to the sequencing service.
AIDS vaccine	Research infrastructure: involved in drawing up product specifications (viruses, peptides and additives) to allow for grouped orders to be placed by the entire scientific community, and distributing products to research teams with validated projects.
Biomaterials and haemocompatibility	Research infrastructure: responsible for organising a test centre network, inter-comparisons and protocol standardisation.
Congenital malformations	Central facility: in charge of organising a network of correspondents for collecting data and setting up a centralised database and a team to perform analyses.
Drug carriers	Project team: involved mobilising teams with complementary skills, each in charge of performing a specific task, and articulating intermediate outcomes prior to the development of the final products (carriers).

Table 1. Examples of scientific cooperation networks

The researchers’ focus on these objects – more than on the epistemological aspects of their research project – highlights their importance. They came to study their slightest detail, exploring them especially in terms of the action undertaken (e.g. investigation or technological development), either because they seemed to contribute something to the action, or because they extended or transformed it (introduction of a biais, cause of failure or discovery of new scientific avenues or challenges). The researchers then developed the hypothesis that the details of these intermediary objects – notably the way they were equipped, for example, with code marks (Vinck, 2011) – should also be taken into account in order to understand actions and relations, the structuring of the network and the results generated: data, publications, reference materials, best practices and health devices notably. The decision was therefore taken to follow both actors and intermediary objects and this proved to be very useful in terms of collecting data about the connections between research, clinical teams and technological teams.

Type of intermediary object	Examples
Text	Mail, intermediary reports, technical documentation, blank and completed forms, protocols, decision-making trees for diagnosis, analysis catalogues and laboratory directories, etc.
Instrument	Detectors, filters, software, digital media, etc.
Material and sample	DNA probes, HIV viral strains, brain sections, conjunctive tissue sections, lungs immersed in formalin, pancreases, peptides, reference reagents, etc.
Phantom (human substitute)	Trunk in hydroxyapatite, standard skull for hyperthermia, etc.
Animal	NUDE mice carrying a cancerous human tumour, transgenic rats, dogs, etc.
Large instrument, technological platform and instrumental device	Particle accelerators, prototype instruments, laboratories operating as open facilities for research teams, colonies of macaques or chimpanzees suffering from AIDS whose use was supervised by skilled staff, a scientific committee and an ethics committee.

Table 2. Intermediary objects encountered in the scientific cooperation networks studied

It should be pointed out that the notion of intermediary object differs significantly from the notion of boundary object (Star and Griesemer, 1989). Both notions are part of the research tradition in sociology of science but they emerged within different research frameworks. In the notion of boundary object, the situation analysed is that of the intersections between several social worlds¹ around a specific place, i.e. a museum of natural history. Furthermore, the two notions come from two leading traditions: the notion of boundary object from symbolic interactionism² and the notion of intermediary object from the actor-network theory³. Both movements take into account the heterogeneity of the social worlds of science; they follow the actors and report on their activities and effective practices, including the development of knowledge, objects and social arrangements. In both cases, the authors behind the emergence of these notions strive to account for the materiality of things that

¹ These “social worlds” are groups of activity having neither a clear border nor a formal and stable organisation. These are built up through the relation between social interactions generated by the primary activity and a suitable definition of reality. The notion stems from the symbolic interactionism movement.

² Micro-sociology movement that refuses the idea of sociological or biological determinism, preferring instead to base its explanations on the dynamics of observable interactions between individuals. It underlines the fact that the meaning of phenomena results from actors’ interpretations in a given situation. These interpretations rely on interpretive frameworks produced through interactions between actors (verbal and non-verbal symbolic interactions).

³ Sociology movement that reports on sociotechnical constructions (knowledge statements, innovation, devices, actors, etc.), in terms of networks of associations between heterogeneous entities (human and non-human) obtained following a translation operation (Callon, 1986).

actors produce and use in a given situation. However, the boundary object theory aims to understand how several social worlds are cognitively synchronised, not describe the networks of relations between research groups.

2.2 The intermediary object as a revelation agent

Using the notion of intermediary object makes it possible to identify a large number of objects and, through these, to gain better access to actors as they engage in action. It also provides a better view of the relations, activities and practices that are otherwise difficult to pinpoint in the official and spontaneous presentations of actors where the focus is on rationales, challenges and epistemological considerations. An example of this can be drawn from a cooperative network studying pancreas B cells, which was studied during the investigation. By reconstituting the set of practices surrounding the circulation of pancreases between hospital surgeons and research laboratories, it was possible to discover an actor whose role proved to be important in the network dynamics, notably through the practical and deontological rules that it imposed. This actor was the company in charge of transferring the organs. Hence, by identifying and following intermediary objects it was possible to map and qualify the relations between actors and to document their practices within this scientific knowledge production universe.

As the researchers studied the intermediary objects, asking where they came from, how they were circulated and what the network members did with them, they discovered that the actors invested in them greatly. The actors were observed to work on and negotiate their design, packaging, accompanying logistics, transfer, inventory, conservation, use and destruction. Success and failure of scientific projects seemed to depend on these objects. If a biological sample was lost or withheld by customs for too long, if a form or a probe were badly designed, if a virus was badly packaged or the chimpanzees suffering from AIDS used improperly, then this represented a threat to the scientific project as a whole: it jeopardised the meeting of objectives, the comparison of results and the widespread, rather than local, validation of the hypotheses developed. Intermediary objects were found to be involved in the structuring of individual and collective research activities, in the harmonisation of researchers' practices and in the constitution of a knowledge circulation space (for data, hypotheses, ideas to be explored, intermediary results, etc.). Their standardisation helped to stabilise both research hypotheses and new ideas for health practices. Their appearance in the scientific cooperation networks investigated varied over time and seemed to punctuate the life of both content and social configurations.

In spite of its ability to reveal things during the investigation, the notion of intermediary object was purposefully limited from a conceptual point of view. Unlike the notion of boundary object, it remained open to interpretation in terms of the mechanisms at work. Whether the objects were subject to interpretation or not, whether they were located at the intersection of several social worlds or internal to a given social world, whether they ensured a minimum identity between heterogeneous worlds or not, were all questions left open to the ethnographic researcher. At the time, there was nothing to suggest that the notion of intermediary object would lead to the development of an interpretive framework to report on the existence of such objects and what they generated in a given situation: a reflection of technical determinism or social constructivism, the materialisation of social

relations and vectors of social forces or social neutrality, a projection screen reflecting society or social actors themselves.

2.3 Articulating the notion of intermediary object as a form of representation

We shall now explore how we might capitalise on this concept in the study of various kinds of practices, relations and material cultures. We shall therefore highlight the concept's descriptive and analytical capacity. This will also help us to illustrate the methodology and its importance for ethnography. We show that by describing and following intermediary objects it is possible to categorise key features of practices and relations. Among other things, we will explain how the intermediary object might be considered and theorised as a form of representation and a form of translation.

First, we can theorise intermediary objects as a form of representation. Representation, through intermediary objects, refers to the idea of inscribing something in the very matter of an object. Part of the meaning of the object (a data sheet, a biological sample, an instrument), together with its identity and its properties, is thus drawn from what is inscribed on it or shaped by the actors. This representation process is twofold: it concerns the processes upstream of the object's making and the projections downstream of the object. Upstream, the intermediary object represents those who designed it, the researchers who defined the kind of sample and the sampling protocol, the medical doctors qualified to do the sampling, the technicians' habits in terms of storage and transport, etc. It materialises their intentions (e.g. the research question they want to answer, the scientific hypothesis they are exploring), their working or thinking habits, the identity they defend (e.g. scientific discipline, researcher or practitioner), their relations (e.g. of power) and their interactions (e.g. negotiations), their perspectives and the compromises they have set up. Sometimes, the inscription is negotiated and conventional. It is the result of many meetings and discussions about draft protocols. The intermediary object constitutes a trace and a mark of its authors and their relations. In this respect, looking at the intermediary object tells us something about its authors and the sociotechnical conditions of their activity, about the paths they follow and the contingencies that arise.

In the case of the scientific cooperation networks observed, the intermediary object also represents the "natural phenomenon" being studied (AIDS, diseases of the conjunctive tissue, a patient's tumour, etc.). It is not therefore just a straightforward social construction. Hence, a blood sample is constructed and used by actors as a reliable spokesperson of a patient's illness. A phantom in hydroxyapatite used to calibrate instruments for measuring osteoporosis is assumed to represent a "standard" woman likely to suffer from this type of biological development. In this respect, the intermediary object is required by its authors to channel fragments of a natural phenomenon as part of a knowledge-building process. Because it has been chosen and developed, the sample is attached to an operative and interpretive framework that is often the subject of long discussions between researchers. Its material nature sometimes reflects negotiated and stabilised collective knowledge, as well as acting as a vector of knowledge yet to be explained. It is therefore a sociotechnical construction that cannot be reduced to social interpretations and intentions upstream of its making.

Finally, the intermediary object also carries some of the actors' projections and expectations in terms of future scientific results: it is a promise or a hypothesis relating to potential

scientific outcome. A sample represents a potential set of data, data represent a potential equation or a correlation between variables and the draft of an abstract represents a potential scientific paper.

Thus, whether intermediary objects are interpreted as traces, inscriptions, materialisations or carriers, they have much to say regarding actors, their projected identity, their relations and activities, their intentions and the world they are studying and shaping.

2.4 The intermediary object as a form of translation

Intermediary objects can also be theorised as a form of translation, i.e. of intentional moves and uncontrolled shifts. Translation refers to the idea that when there is a shift from intention to realisation or from one register to another (e.g. from a sample to a set of data), there is some kind of transformation involved (Latour, 1995), such as the construction of coherence or the creation of new possibilities. The intermediary object cannot be reduced to its author's intention. When it is materialised, something new is introduced. The shift, which is not necessarily desired or controlled, may even lead the investigator astray. For example, when coloured, biological tissue may react in unexpected ways or produce an interesting artefact. In other words, following translation, the resulting object may generate something different from what was originally aimed at. Similarly, objects do not simply materialise the social relations (e.g. power struggles between physicists and physicians when defining a nuclear beam for cancer treatment) presiding over their making. This is because the matter (or the formalism used) introduces something new to the action (Almklov, 2008). This sometimes creates opaqueness and, in the case of scientific cooperation networks, leads to discussions between members as to how to interpret the intermediary object they have produced. Along the same lines, while an intermediary object can represent a fragment of a natural phenomenon or a disease, it is also the place where nature is transformed and socialised (Knorr, 1995) through technical and conceptual developments within a research community. In the case of a network working on osteoporosis, the researchers can be seen to enter into discussions about what the intermediary objects constructed and circulated really show. The material nature of objects (written traces, samples, technical artefacts or manipulated living beings) is seen as a source of opaqueness in the action. Such objects cannot therefore be reduced to initial intentions as these are overridden by other factors entering into the situation (Latour, 1996).

The development of the notion of intermediary object stems from work on and thinking about a series of other notions: especially the notions of inscription (Latour and Woolgar, 1979) and immutable and combinable mobiles (Latour, 1987) used in the analysis of scientific fact construction, the notion of boundary object (Star and Griesemer, 1989) and Callon's notion of intermediaries (1989). Latour and Woolgar (1979) and Latour (1987), in particular, showed that when inscriptions are followed (e.g. plots from analysis instruments, tables of figures, diagrams and texts) it is possible to analyse scientific practices differently and to deflate some of the abusive questions arising in epistemology. These inscriptions are not just pieces of information, they are also material entities, which may or may not be difficult to produce, keep and use. Similarly, our investigations into scientific and technological practices show how strongly actors invest in intermediary objects. They do this in order to control what they are doing and control the objects' meanings, partly because they know how risky the translation process can be. They also invest in the

manipulation and interpretation of these objects. The objects are sometimes explored further in investigation work because their opaqueness is a source of new knowledge.

For the social scientist studying cooperative networks, taking a closer look at what is going on and around these intermediary objects makes it possible to uncover and characterise the exchanges and relations between actors, define the organisation and cooperation networks involved, and access investments and activities before, during and after these exchanges. Studying the processes of representation and translation as the story of an intermediary object unfolds can thus be of great benefit to the social scientist.

2.5 The intermediary object as a mediator

In scientific cooperation networks, researchers have many opportunities to meet up through workshops, coordination meetings and conferences, for example. During one such meeting where researchers are seated around a table discussing and exploring possible solutions, one of them finds it difficult to express his idea in words. He therefore produces a diagram and places it in front of his colleagues to explain it. However, before pursuing his explanation, he stops, surprised to discover in his diagram something he has not previously thought of. The act of drawing, and then looking at the result, produces a different effect from the one he has in mind. It is as if, during the research process, the intermediary object is able to introduce something new to the action. This “new” element partly escapes the control of the actors. In this way, it can be compared to a mediator that interacts with the actors present. In such situations, the intermediary object provides support during the discussion as it offers each person involved something to hold on to (each researcher, clinician or engineer can grasp the object from his/her usual point of view). In another working discussion, the joint completion of a table of design criteria and solutions lead the researchers to discover a new solution. This is because the table allows them to draw parallels between otherwise disassociated aspects. In others situations, like discussions between mathematicians, intermediary objects might appear when the participants do not understand each other, such as a drawing on the blackboard. These objects then disappear once a level of mutual understanding has been achieved (Lefebvre, 2003). Thus, following the activity surrounding an intermediary object helps to describe the emergence of a solution. More generally, during a meeting, researchers will produce and mobilise several objects (e.g. pictures and diagrams). Moving from one to another, they will reconstruct the objects and hence generate new ideas, interpretations, data and solutions. This demonstrates that the materiality of the movements acts as a form of mediation. During the mediation process, the movement occurs partly unbeknownst to the participants. Materiality builds and restricts the dynamics at work. Thus, following the intermediary objects produced and mobilised during interactions between actors helps to describe how these objects facilitate, foster or complicate the building of compromises and the sharing of knowledge. Depending on the details of these objects, they displace the actors’ viewpoints, act as a memory support and contribute to the setting up of a work collective.

Some intermediary objects, e.g. roughs, diagrams, protocols, X ray pictures or data tables have a low level of codification. This sometimes facilitates the integration of knowledge and viewpoints during cooperative action. Others, on the other hand, are highly codified and use high level conventions, e.g. a formal, detailed protocol or software with a black-box algorithm. However, such objects offer medical data collectors little scope for acting on the

research. They are closed objects, operating within a prescriptive register. Roughts, on the other hand, only actively support research action when they are developed jointly, and as long as they remain within the framework of the collective having built them. This local characteristic comes from the fact that they are not systematically attached to highly general representational conventions. By following the activities surrounding a series of roughs, we can see the relative stability of these objects as memory back-ups.

Finally, the notion of intermediary object teaches us that during research activity the materiality of objects, roughs, writings, samples or probes influences the emergence of knowledge. The gradual construction of such knowledge can be tracked through these objects and the activity surrounding them. The research process cannot be reduced to the application of methods. Something (a new idea, a shift in viewpoint, different connections, etc.) occurs in the research process through the materiality of the action. The socio-cognitive processes mediated by the objects depend on this something. Looking at these objects thus provides access to these processes.

2.6 The intermediary object as an operator of change and a temporal marker

Objects can act as temporal markers and operators of change. The history of scientific cooperation networks is punctuated by the production of intermediary objects: the first version of a protocol to be discussed, the final version of a protocol based on a consensus, a standard phantom that is mass-produced and distributed to network members, the standardised analysis procedures of different laboratories, etc. They mark the stages of work performed and render its evolution less reversible. Once a common research protocol has been approved by participants, the network is no longer the same. Before this stage is reached, the participants seek to set up a common denominator. Once the denominator has been found, they are ready to align their work. They go from a situation where, in spite of the wish to work on something common, each participant gives a specific slant to their work and, to varying degrees, attempts to modify that of other participants, to a situation where the teams agree to act according to the joint protocol. In theory, they can still question this protocol, but may find themselves excluded from the network when it is already following a certain direction and is unlikely to swerve from it.

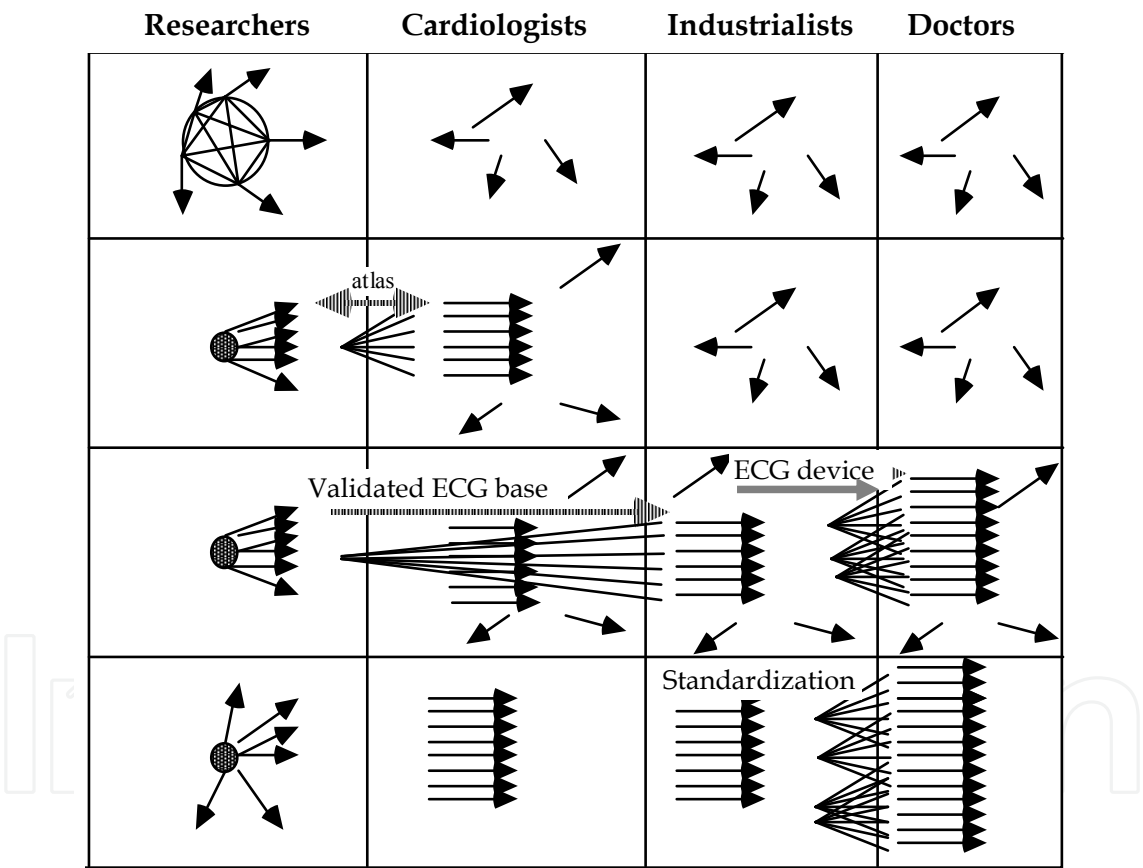


Fig. 1. The network before and after agreement regarding a common protocol has been reached. Each arrow represents a research team and the direction followed by its action. The lines represent the relations inside the network.

Intermediary objects progressively consolidate networks while at the same time they act as time arrows heralding a change in phase. They thus embody two complementary dimensions:

- They reflect the agreement that is gradually built up between the teams having constructed them. In turn, this agreement reflects two simultaneous types of effect: the links the teams develop to obtain a result (structuring effect) and the common references they must embrace in order to be able to work together (alignment effect: languages, experimental practices, etc.).
- They serve as back-up to the widening of the network. A result can only exist if it is taken up and used by others. Intermediary objects are therefore operators of the network's transformation depending on the degree of involvement of the actors who are already in the network or on the enrolment of new actors. Both situations follow different action paths: in the first case, the action deepens the scientific and technical work while, in the other, it broadens its scope to the extent that what has been acquired becomes universal.

Let us take the example of a network in charge of standardising the recording and automatic analysis of electrocardiograms (ECG's). The development of this network might be described in the diagram below (figure 2). The diagram shows the structuring of a core of



The columns represent the different categories of actors that the network progressively wishes to reach and mobilise. The lines correspond to the different action phases (structuring implemented and transfer). The boxes reflect the intermediary objects and their effects on the teams producing them and the teams then taking them up. The arrows represent the actors. The direction of the arrows reflects the alignment or the non-alignment of the actors' practices. The lines represent the exchanges. The direction and content of the exchanges is indicated by the hatched arrows (except the relations between researchers where the interactions are many and varied). The dark dot indicates that the researchers interact with each other to such an extent that they can be considered by the other actors involved as a single entity.

Fig. 2. Dynamics of the ECG network.

teams and the progressive alignment of an increasing number of actors. The end result is the standardisation of ECG recording and automatic analysis equipment. If we go down the “researchers” column, we can see that one group of research teams regularly discusses messages, ECG measurement and analysis algorithms, working documents, data, records, etc. The exchanges between these teams are such that this network can quickly be treated as a single actor. At the same time, the research directions of the teams in this network notably come together around a few common themes. Once the work is complete, and the common objectives achieved, it is likely that the different teams will explore new research directions while maintaining close links with the others, even if these are not as close as before.

The other actors who are progressively involved are not, in theory, linked up. They are involved in a network via the central network. Relations with the cardiologists consist of exchanges of ECG traces: these are blank traces on which the cardiologists indicate segment cuts (p, q, r, s or t) (figure 3). Once the segment cuts have been marked by the cardiologists, the traces are then submitted for a second, and sometimes third, opinion. The only time the cardiologists interact is when they meet to come to a consensus about how to segment the 3% of traces for which a consensus has not been previously reached. The industrialists are aligned to the network via the validated ECG trace database that they buy from the network. They compare, test and ensure their instruments comply with this reference base. However, compliance with the reference base is not compulsory (it is based on factual standardisation), which means that some may continue to distribute and interpret the traces differently. The alignment of all the industrialists and all the doctors can only occur via the specifications imposed by, for example, a standardisation body.

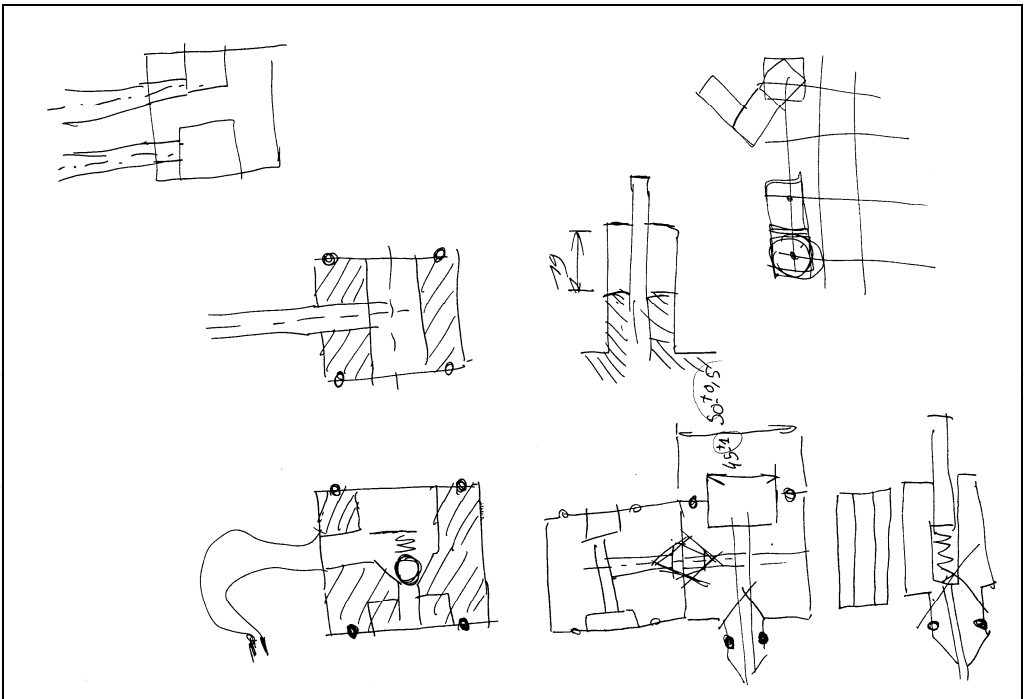


Fig. 3. Sketches of 1st overall plan

These actors’ use of intermediary objects reveals the temporal structure of the socio-cognitive process: understanding of the problem, exploration of possible solutions and their evaluation, sharing of knowledge, design of a protocol, settling of agreements regarding this

protocol, collection of data, definition of a standard, etc. These socio-cognitive activities are developed through material activity. Thus, looking at this materiality helps to grasp the cognitive process.

The intermediary objects are produced and used according to a process of succession and substitution. When one object is taken up, others sometimes disappear from the workspace.

Objects previously left to one side may make a come-back. Some of these intermediary objects also play a specific role in the temporal dynamics. They correspond to breaks or transitions between distinct phases of the activity. They define the boundary between design phases. They can be considered as phase change markers. The change of objects corresponds to a change in action. Their completion contributes to irreversibility in the process. They accompany the process and reveal the temporal organisation and changes at work.

However, it is not enough to look at these objects and their inventory alone. Indeed, they cannot be dissociated from the actions and interactions taking place. They are surrounded by diverse activities.

3. Accessing material culture in engineering work

Following this short account of how the notion of intermediary objects has been used in the study of scientific cooperation networks, we shall now turn our attention to some of the ways in which the notion has been further developed and its potential application to ethnography, mainly in engineering and innovation studies. Indeed, studying objects as they are handled and produced, even apparently common, unspecific (e.g. a pencil) and unimportant objects, sheds additional light on activity. As previously suggested, by following these objects and their circulation it is possible to produce another picture of human activity and organisation. This section will thus review some of the findings relating to intermediary objects in engineering design activity.

Based on the observation and monitoring of intermediary objects, ethnographic studies of design activities in the manufacturing industry have also borne their fruit. They have produced a very different picture from the one presented in engineering literature where reference is made to methods, tools and organisation, the potential benefits of these and the (best) way to work. Unlike this normative and idealistic vision of engineering activities, a description based on following actors and intermediary objects has helped to capture real practices and organisation (Vinck & Jeantet, 1995; Vinck *et al*, 1996; Grégori *et al*, 1998; Brassac & Grégori, 2001; Boujut & Blanco, 2002; Godjo *et al*, 2003; Lécaillon, 2003; Vinck, 2003; Ruffier, 2008). Their research work has led these authors to discover quantities of sketches, drawings, prototypes, listings and screen shots in the offices visited. Many of these objects are textual documents (Anomaly Sheets, Open-ended Specifications, Technical Instructions, Forecast Cost Price Documents, Detailed Methods, Operation Plans, Summary Documents, etc.) or graphic documents (Sketches, Manufacturing Plans, Block Diagrams, etc.). They are also physical objects (Prototypes, Broken Parts, Models made of Cardboard or Modelling Clay).

When the focus of a study is on these intermediary objects, each design office appears to be very different, presenting a specific type of material culture. One might be observed to have

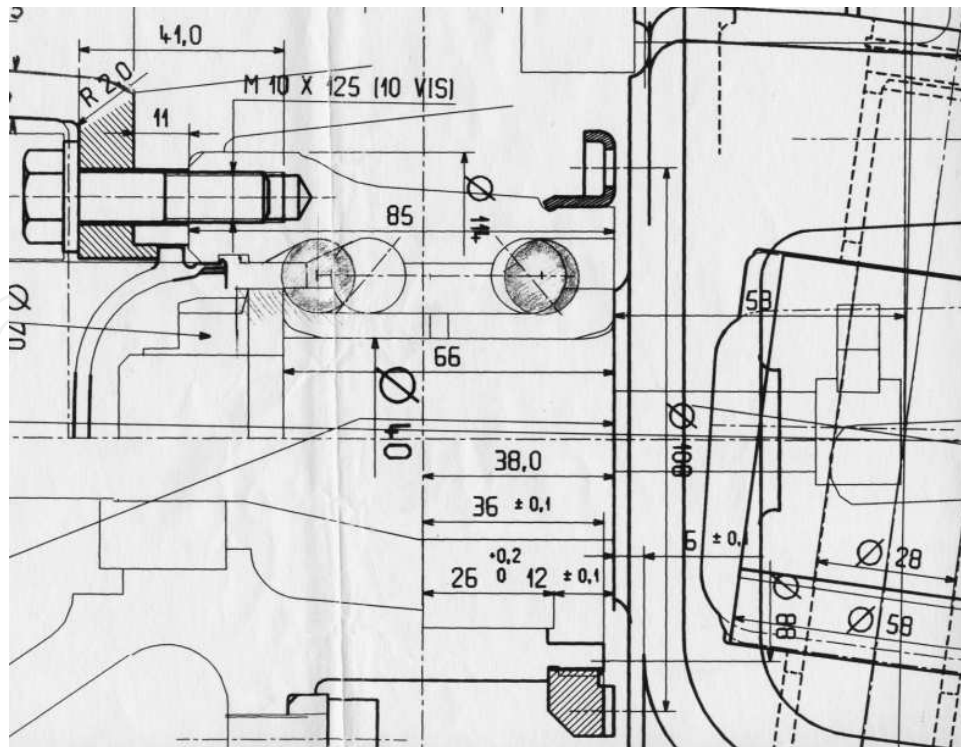


Fig. 4. A 2-D overall plan

well-ordered stacks of folded sheets, which are apparently not used very often. Another might present a disorganised mass of large sheets portraying industrial drawings and manual annotations, with people touching them and talking around them. Another design office may be full of lists of data and equations, while a fourth might display a mass of prototypes and broken parts, which people are looking at, picking up and moving from their desk to a test bench. Some objects and activities also appear to be somewhat clandestine (e.g. the use of modelling clay in a firm whose management insists on the use of digital modelling only).

By following these intermediary objects, in addition to performing interviews and observing what people do and say, it is possible to capture ethnomethods and map design processes, thereby uncovering relations between people that are not in the description of the official working process. As the ethnographer follows the activity as it unfolds, s/he also discovers a mutual cross-referencing, built by design office members, as various drawings and series of movements are pieced together. As they talk, designers point to different documents, sometimes making annotations on one drawing, explaining its relation to another drawing or using bodily gestures to show how the mechanism represented on the drawing works.

Reconstituting this activity reveals task-sharing, process sequencing and regulation points as different opinions are compared and contrasted and explanations requested. As with the description of the design office, following the moves of people and intermediary objects brings to light contrasting dynamics, cultures and socio-cognitive processes from one organisation to another, even when they perform very similar technical activities (Ravaille & Vinck, 2003). Observing the in situ activity (as Hutchins (1995) did on planes and boats), and looking at intermediary objects, are effective ways of gaining access to collective activities.

This method helps to shed light on cultural and cognitive aspects, social networks inside organisations and the effective practices of engineers.

3.1 Revealing representation and translation processes in technical practices

In design offices, it is also within the intermediary object that the representation process unfolds. The object reflects the designers' intentions (i.e. the desire, purpose and initial demand of the customer and the way designers expect to satisfy that demand), their working habits (e.g. technical culture reflecting the social milieu specific to various engineering fields like mechanics, hydrodynamics, electricity, aesthetics, but also organisational restrictions relating to cost, deadline and reputation), their interactions (e.g. more than 1000 technicians and engineers might be involved in the car design process), and the compromises they introduce (e.g. between designers and marketers on what to propose to the customer). Sometimes designers put their names or signatures on the intermediary objects that serve as the basis for the final future product to be sold to the customer. By following such intermediary objects (which are like various versions of both the customer's desire and the solution proposed), it is possible to trace the design journey and how the designers shape the demand. Upstream in the design process, intermediary objects represent the actors involved while, downstream, they reflect the emerging new object supposed to satisfy the initial demand. They are like pieces of society shaping the future of that society.

As in scientific cooperation networks, the design environment intermediary object is also where the translation takes place. When the intended solution is materialised, something new is introduced owing to the materiality or to the formalism used. For instance, the formalism pertaining to an industrial drawing requires the designer to define all surfaces, including unspecified features that the customer may consider to be unimportant. The designer might take it upon himself to specify these unimportant surfaces. This may lead to a solution that is difficult and costly because the operator in charge of making the product is bound to follow the indications on the drawing. The operator does not necessarily realise that the surface is unimportant and can therefore be manufactured differently to avoid complications. Following intermediary objects thus makes it possible to describe the wanted or unwanted translation processes unfolding through the design process, and how constraints are introduced to the design. The material nature of objects and the formalism and tools used to produce intermediary objects are sources of opaqueness. The resulting objects do not simply reflect social relations and intentions; they also inherit something from the materiality, abilities and tools used to make them. This material culture cannot therefore be reduced to social interactions and inscriptions. This becomes much clearer when the ethnographer follows the intermediary objects.

3.2 Framing the action

In a functional sizing meeting, five designers are gathered around a square table. One of them acts as the facilitator. It is assumed he will play this role before the start of the meeting owing to his central role in the project. The intermediary object is an A1 format drawing. This is placed on the table opposite the facilitator. The other designers have a side view of the drawing. Each therefore has a different viewpoint. Although there are no rules telling the designers to stay put, nobody gets up to move around to see the drawing from a

different viewpoint at any time. Similarly, the drawing is never moved or turned around. Throughout the observation of this scene, each thing and each person seems to have a set, immutable place. The designers seem to be enrolled within a framework defined by the configuration of the objects and which is never called into question.

This framework is set by the intermediary objects, such as the drawing on the table and other surrounding objects like the furniture. It is sometimes desired, perceived and accepted by the designers present but, in other working situations, it can be unwanted and subject to negotiation. It seems to define and delimit a space for action. It structures the space by differentiating it: the places around the table are not all equivalent. The viewpoints of the actors present are thus necessarily different. If they act as though they share the same point of view, this is either because they are building a collective illusion (they do not realise they have different viewpoints) or attempting to cognitively offset the differences introduced by their respective points of view.

The intermediary object, in the form of the drawing placed on the table, helps to set the framework for this engineering activity by focusing views in a certain way. Everything happens around the table with almost constant reference to the drawing through words, gestures, inscriptions and looks. The drawing and its physical limits also help to define and outline a space for action around the table. There is a strong differentiation between the public space (the drawing), common to the five designers, and the private spaces in which each designer is surrounded by his or her own pencils, mementos and notebooks. Some actions take place within the collective space, such as when an item is pointed out on the drawing and a collectively defined line is added to it. Others belong to the private space, such as when the objects surrounding a person are readjusted, or when somebody consults the drawing analysis grid or jots down notes in their private notebook. There are sometimes shifts between one space and another. Actions performed on personal objects might prepare the way for actions performed in the common space, such as a chair being moved before an actor speaks, a pencil being picked up before something is said, the pencil being put down again to mark the end of the designer's engagement on the collective stage or to mark their withdrawal.

The objects help to frame the action, notably by outlining, structuring and differentiating the spaces. They bring something to the action, even if their effects are not those of technical determination – insofar as the effects depend on the way in which the framework is reviewed, modified or left unchanged over the course of the ensuing action. Given that they can contribute to setting the action framework for the various actors present, intermediary objects constitute a form of implicit structure.

3.3 Equipping intermediary objects and spaces of exchange

Recent developments in the notion of intermediary object have extended its use in new ways. The controversies observed between design technicians and engineers regarding some of the details of intermediary objects underline the need for these objects to be equipped with marks or codes (Vinck, 2011). These details seem to be central to the actors because they appear to structure their activity and relations, as well as the social and technical world. The actors will talk about requirements, technical problems and solutions, but also about the details of drawings. They invest highly in these objects in terms of their

preparation and realisation, but also in terms of checking who will receive them, who might explain a drawing and who should have control over the use of such objects. Many of these discussions concern the circulation of both people and drawings. One of the topics of major concern is the signatures, codes and dates appearing on drawings. A project seems to depend on these details. Improperly numbered, a drawing can even jeopardise the integration of each designer's results.

Our following of actors and intermediary objects has also revealed the importance of the place occupied by the exchange of data and information between designers. These actors are constantly searching for information (calling up other designers, looking inside shared databases or walking around a colleague's desktop). They strive to recover information associated with drawings (authors and holders, location and access, existence of new versions, etc.). Their search for information also encompasses the quality of technical data and the degree of trust they can have in them with respect to their origin, the identity of the author and the history of their construction. Their concern about whether information should be circulated highlights the importance of information exchange. Careful examination of the forms of exchange shows that what is at stake in this passing on of technical data has to do with the anthropological issue of gift exchange; the technical data given is a gift carrying with it something of the person offering it. There is a close relationship between the anthropological conditions of the information exchange and the elements equipping the objects being circulated.

4. Conclusion

Since the end of the 1980's, the social sciences have given increasing consideration to the materiality of things (bodies, artefacts, etc.). The Actor-Network Theory (ANT) and a number of other social sciences (sociology of consumption, anthropology of material culture, science and technology studies, and sociology of the risk society) have called attention to the importance of materiality, among other aspects in the study of science, technology, engineering and innovation. ANT has played a major role in this respect. It reports on sociotechnical constructions of knowledge, devices, actors and institutions, in terms of networks of associations between heterogeneous entities (human and non-human) obtained following a translation operation (Callon, 1986).

Providing a short overview of some of the discoveries made through the use of the notion of intermediary object, this chapter contributes to sociological considerations of materiality. The methodological approach underlying the notion reveals actors and relations, practices and activities, real organisations, and processes and networks. The chapter is based on investigations performed in the field of scientific cooperation networks and design activities. However, various authors have also used the concept in the field of organisational studies (e.g. Reverdy (2003) on quality insurance or Bazet & de Terssac (2001) on industrial planning), political sciences focusing on public policies (e.g. Mélard (2008) on ecology), geography (e.g. Laron et al, 2001), and technology transfer (e.g. Ruffier (2008) on trucks).

The chapter provides a summary of some of the conceptual developments surrounding the notion: mainly representation, translation and mediation processes, the marking of changes and temporality and action framing. It concludes with a new development of the notion in the field of design activity ethnography. This development shows the importance of two

things: the circulation spaces between actors and the equipping of intermediary objects. Through the process of equipping, new properties are conferred on the intermediary object and this contributes to the shaping of collective dynamics.

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An Ethnography of Global Landscapes and Corridors

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The chapters presented in this book draw on ethnography as a methodology in a variety of disciplines, including education, management, design, marketing, ecology and scientific contexts, illustrating the value of a qualitative approach to research design. The chapters discuss the use of traditional ethnographic methods, such as immersion, observation and interview, as well as innovative ethnographical methods which have been influenced by the new digital culture. The latter challenges notions of identity, field and traditional culture such that people are able to represent themselves in the research process rather than be represented. New approaches to ethnography also examine the use and implication of images in representation as well as critically examining the role and impact of the researcher in the process.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
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