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# Capturing Transient Knowledge in Design and Innovation Processes

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Abstract

The on-line observation and tracking of design and innovation processes in organizational settings reveal knowledge making phenomena that I have encapsulated in the notion of transient knowledge. Transient knowledge is closely connected to the practical and mundane dealings of agents involved in some kind of transformative activity, be it designing or organizational restructuring. It is knowledge that is made, used for a while and then obliterated in the process. In this paper I argue that transient knowledge plays critical functions in the dynamics of innovation and knowledge making, helping agents to carry on the activity by providing temporary structure and meaning to their actions and choices, giving direction to the process by linking the past to the future, and revealing process-related and close-to-action features of organizations and human practices that are elusive and hard to capture. The argument is based on three illustrations, drawn from close-up, participant observation of design and innovation projects. I discuss the dynamics and the main features of transient knowledge, and draw some insights and implications for our understanding of knowledge making in design and innovation processes.

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# Introduction

The close up observation and on-line tracking of design processes in organizational and professional settings reveal a set of knowledge making phenomena which, though apparently inconspicuous, turn out to be critical for developing a deeper understanding of the phenomenology of design practice and of the very nature of the designed objects - artifacts, systems and organizational arrangements. This set of phenomena I have encapsulated in the idea of transient knowledge. “Transient knowledge” I define as knowledge that emerges in a process of design and construction where some kind of transformative activity is carried out. Agents develop transient knowledge as they engage in transactions with a design situation and respond to the demands and the possibilities of the situation. This knowledge is eventually obliterated or further transformed by the same activity as the process unfolds.

Transient knowledge is associated to the practical and mundane activities of agents involved in processes of designing, learning and restructuring. In organizational and professional settings it can be observed at “construction sites”, where work is in progress for developing new products and systems, designing new work routines and organizational arrangements, and making sense of shifting events and situations. Empirically it is usually embodied in a broad array of material and symbolic repositories such as makeshift artifacts, minimal structures, recombinant routines, ephemeral practices and arrangements, beta versions, incomplete representations, all of which are the tentative components of an as yet undetermined and unstable reality. These repositories are dynamic carriers or “vehicles” of transient knowledge, being constantly revised, recombined, integrated or discarded along a main stream of activity.

Transient knowledge is made by agents in order to respond to practical problems and contingencies, and to build up some provisional coherence and meaning in a situation of practice. It originates from the urge of coping with the sudden and shifting demands of a problematic situation. Being unstable, short-lived, and seldom visible in the final outcomes of the process, transient knowledge is easily detected, therefore it has rarely hit the attention of the researcher. Its intrinsic elusiveness defies simple

conceptualization. Agents engaged in action are largely unaware of it or tend to forget it as they progress further in their designs and eventually reach the end state of an organizational transformation. Both agents and analysts have a bias, perhaps a drive, for more durable, more stable and safer forms of knowledge, searching for the forms that will last through time while discounting the more ephemeral ones. This perhaps might be one of the reasons why little research attention has been dedicated to the phenomenology of transient knowledge.

In this paper I shall argue that transient knowledge plays critical functions in many processes of design and innovation that take place in organizations, and therefore deserves to be studied in depth. First, transient knowledge helps agents to carry out the activity by providing temporary structure and meaning to their actions and choices. Second, it gives a direction to the process by linking the past to the future *via* the present state or situation. Third, it reveals process-related and close-to-action features of organizations and human practices that easily slip out of the observer's picture of the process or the situation. My claim is that a more careful empirical and theoretical focus on transient knowledge can enrich our understanding of how people try to build coherence in unstructured and shifting situations. Such inquiry can throw a new light on how *designing* happens in practice and what kind of cognitive activity is involved in it, thus allowing us to better appreciate the expanding gap between actual design practice and the formal development methodologies prescribed by management and systems engineering. In sum, transient knowledge is a relevant constitutive aspect of the process of *designing in practice*.

In the following I shall illustrate and describe the design phenomena to which I have just alluded. My illustrations will be drawn from three kinds of studies I have carried out as a participant observer and an interventionist over the past years. Observation was constantly coupled with reflective inquiry (Argyris and Schon 1996). The field research method entailed full immersion in the on-going processes: as the process unfolded I kept close track of the main events, as I perceived them, while engaging in continuing transactions and conversations with the agents involved in order to gather information, gain new insights, and help them evaluate their own design activities and choices. Each case provides a rich, "thick" description of processes whereby agents engage in building new artifacts, systems and arrangements and try to integrate them

in their practices and institutional settings. In the final discussion I draw some insights from the case analysis and illustrate some implications for our understanding of design and knowledge making processes in organizations. The overall image of design practice resulting from my studies remarkably differs from the engineering and management models in good currency.

## Transient and durable knowledge in designing

In the recent literature a number of authors have taken issue with a static view of knowledge as a finished product or established asset, focusing on more dynamic aspects of knowledge making (Nonaka and Takeuchi 1995; Tsoukas 1996, Orlikowski 2002; Patriotta 2003). In contrast to a view of knowledge as a stock of discrete packages, or a definable set of accepted facts, the close-to-action, evolutionary and process-related features of knowledge making have been explored. Interest in formal representations and established capabilities has been replaced by an interest in knowing in practice (Orlikowski 2002). This shift of focus has been fed with several research streams. First, I should like to mention Argyris and Schon's work on the theory of action and organizational learning (Argyris and Schon 1978; Argyris and Schon 1996) and Schon's pioneering studies on reflective practice and designing in action (Schon 1987; Schon 1992). A further contribution comes from Weick's ideas on *bricolage*, design as improvisation, and the role of minimal structures in structuring and sensemaking processes (Weick 1993a; Weick 1993b; Weick 1995; Weick 1998). An important but often neglected antecedent is the developmental psychology of Vigotsky (1962; 1978) and Scribner (1986), who have emphasized the critical role of material artifacts in the process of knowledge making, thus helping us appreciate knowledge as a dynamic "functional complex" (Vigotsky 1978). Studies on practice (Sternberg and Wagner 1986; Brown and Duguid 1991), everyday cognition (Lave and Wenger 1991) and the cognitive anthropology of Hutchins (1991; 1993) applied to work teams have raised our awareness of situated cognition and learning, leading us to conceptualise practices as delicate cognitive ecologies. Feldman and Pentland (2003), on their part, have shown that even knowledge stocked in structured repertoires of apparently stable routines is subject to subtle and continuous change. Finally Brown and Eisenhardt (1997) in their study of relentlessly

shifting organizations have captured properties that enable organizations to keep a balance between order and chaos and engage in ongoing continuous innovation. Although working in different fields and using varied theoretical lenses, all these scholars have appreciated the situated and dynamic aspects of knowledge making and have explored the close association of knowledge to practice and "doing". Their work has shifted the focus of attention from knowledge as a product to knowing as an ongoing accomplishment; at the same time it has contributed to re-conceptualizing change and innovation as an ongoing, pervasive phenomenon in organizational life (Tsoukas and Chia 2002; Chia 2002).

Yet, transient knowledge has never been taken seriously as a distinct object of analysis. Perhaps the reason for this is that durable knowledge is generally considered to be more valuable. Knowledge that can be stabilized, reproduced and exploited through long stretches of time is perceived to be of higher economic value, as it yields increasing returns to investment and cognitive economies. It can be organized into standard packages and codified bodies, so that it can be more easily communicated and learned across time and space. Indeed, only if it gains some resilience and durability, knowledge becomes an exploitable asset, giving stability and certainty to human affairs. For these reasons individuals and organizations always search and strive to build durable knowledge. What is transient or shaky is perceived as cognitively uninteresting and economically unrewarding, therefore it is not regarded as something worth pursuing.

However, although they are predicated as distinct, transient and durable knowledge need not be in opposition. On the contrary, they can be thought of as co-existing within the very same process of making, mutually supporting one another, the one turning into the other in an endless dialectic. Transient and durable forms of knowledge may play complementary roles in situations of transformation, when a pre-existing design or arrangement must be relinquished and a new one needs to be built. More durable states of knowledge are achieved through transient states, and transient states emerge when established knowledge is subject to doubt, revision and reframing. If change must be obtained, on the one hand the durability of old practices and structures has to be suspended, although they are still necessary to hold on to something solid and reliable; on the other hand new tentative arrangements are being

designed and tried out for the purpose of innovation, thereby inducing instability. Therefore, on the one hand durability is rejected and transiency is produced by a variety of designs, experiments and explorative moves; on the other hand, and at the same time, transiency is contrasted and durability is searched for by tentatively casting some kind of structure on indeterminate, shifting situations. Both fear and fascination simultaneously drive our behavior in front of novelty and ambiguity, thus enacting a complex dynamics and pushing us into dilemmas of action (Schon, The Fear of Innovation, 199 ).

When studied as an empirical phenomenon, knowledge may exhibit different degrees of stability and durability. We may find established forms of knowledge embodied in a variety of cognitive and material entities that are used as unquestioned premises and tools in designing new systems. And we may also find less established and more transient forms emerging along the design process before the process reaches some kind of closure; to paraphrase Latour: *before the box actually gets closed* (Latour 1987; Lanzara 1999*)*. This transient knowledge surfaces in the concrete moves enacted by the agents. It is highly contextual and situated, and extremely sensitive to local moves. Although it is necessary for the advancement of the process, it is not tightly connected to the end state, nor is necessarily reflected in the final outcomes. Transient knowledge conveys a sense of movement, direction and instability, stimulating search and exploration. Its dynamics reflect the activity of knowing and the process of knowledge-in-the-making (Orlikowsky 2002; Patriotta 2003).

In the following section I shall provide some illustrations of such an elusive phenomenon. Empirical access to phenomena and events that are highly volatile, intrinsically unstable, and often "obliterated" in the process is not easy at all. The challenge is to capture and record transient knowledge in a process *while it actually unfolds*. Sometimes such knowledge comes about in flashes, or rather in "snippets", and we can only catch glimpses of it. Yet, taking the challenge of "catching reality on flight" (Pettigrew ) may be of crucial practical interest in the analysis of large-scale design and innovation processes, where agents need to rely on constantly updated descriptions and quick understandings of the process in which they are engaged.

## Snippets of designing

The material presented below is drawn from fieldwork on design and innovation projects in which the author of this paper worked as an observer and a facilitator in a variety of organizational settings (Lanzara 1990; Lanzara 1999; Lanzara and Patriotta 2001). The processes observed are:

- the laboratory development of a computer music language for educational purposes; (software development)
- the innovation of the music curriculum in a major academic and research institution; (curriculum design)
- the introduction and testing of a computer-controlled video-recording system into the courtroom for criminal trials. (organizational re-design)

All cases focus on the processes through which agents, in their re-designing efforts, come to develop new practical knowledge about artifacts and tools, roles and routines, the work setting and the overall organization in which they work.

**First illustration: Designing software by 'for instances'**

My first case is about product development, namely the design of a computer software for music education named Music LOGO. In the developers' intentions the new educational software would help undergraduate students of a major university to experiment with basic musical structures so that they could develop musical understanding and hands-on compositional skills. In my fieldwork I sat in the lab for long hours with the project leader (a music teacher) and the software programmer, who jointly engaged in developing the new system. As I helped them with observations, descriptions and ongoing assessment of project activities, I was struck by the way they proceeded in designing, that resembled an apparently undirected navigation.

At the outset they frame the development problem as one of upgrading the existing Apple II-based prototype of Music LOGO and developing a new version of it for the Macintosh computer. In their early moves they stick to the old core of the system and try to design a new version of the software. In their activity the two developers swing back and forth between the preexisting system which they are familiar with and the

new software tools and facilities that the advancement of computer technology has made available. They keep updating old features and at the same time add new features to the system. In their designing they seem to be tacitly guided by what they already know about the old system and its operations, so that in developing the new features they inadvertently bring to the new system many of the features of the old system. Consequently what they happen to design is dependent on the old system's features in much deeper ways than they are aware of. But at the same time the music teacher has an idea of what she wants to be available for the students, although the idea is still vague and underspecified, and with the help of the programmer she is trying to overcome the limitations of the old system and design something different.

When I start my observations the two developers are confronting a procedure called GTUNEBLOCK that comes from the old system. The procedure allows the composition of simple tunes by using a numerical notation. Numbers are typed in and manipulated to fix pitches and durations, and the proportions between them. The procedure makes the creation of even a simple melody extremely laborious for the students, and the music teacher is unhappy with it. She wants to "get rid of all these numbers" and asks the programmer to try out some simpler graphics interface. But she doesn't really know what she wants or has only a faint idea of it. So the programmer provides what they (and I) call a 'for instance', that is, a version of the new graphics procedure, an embodied and enacted response to the musician's *desiderata*, as the programmer understands them.

The 'for instance' the programmer works out is a tentative procedure called TUNEBLOCK GRAPHICS, which does not use a numerical notation to write melodies but is based on windows that contain icons. Icons are associated to little motives called 'tuneblocks' that can be arranged into more complex musical sequences by selecting and ordering the windows by mouse clicking. The graphics procedure is embedded in a medium of a different kind, which allows a more direct linkage between the music and the graphics on the computer screen. The musician immediately engages in "doing things" with the TUNEBLOCK GRAPHICS. She plays with it in order to explore its potential, but she often discovers that the 'new entity' does not behave as she expected. Together with the new entities (the windows/icons) and the new facilities developed by the programmer, also new

mappings between actions, events and objects are developed, which the musician must test and learn how to work with. A new domain of practical knowledge associated with the new software entity takes shape, which cannot be immediately charted by the musician. After several rounds of tests, moves, games and further 'for instances' offered by the programmer, again she complains:

> "One of the things that bother me is the messy screen, having all that junk on the screen…there are too many things floating around here… there is an awful lot of clicking involved… and suddenly there are all these things happening!"

She then comes along with a different vision of what she wants:

> "This is my fantasy: I want to be able to make a scribble with the mouse and hear it. Could we just make some spots on the screen and then hear them, and then print the pictures, and then edit the pictures?"

The new graphics procedure that the programmer tentatively develops in response to the musician's reframed requirements is a general purpose PITCH-AND-TIME GRAPHICS that allows the user to draw a spatial 'waveform' analogue of rhythm and melody. The musician can now sketch a frequency curve on the screen and then immediately retrieve and hear the music. Instead of typing numbers in with the keyboard, now she inputs the computer through

> "a gesture, using the mouse as a vehicle – a gesture which will be seen on the screen – and that gesture will turn into sound".

The frequency "waves" thus sketched will be translated by the computer back into numbers and played. The pitch-and-time procedure works as a further 'for instance' in the design process. With the 'for instance' new features come along, such as a 'play-and-paint' or 'sketch-and-hear' procedure, that are more perception-driven and allow for a smoother and faster connection between input (action) and output (the music). The new 'for instance' brings with itself a whole new graphics world different from the window-based one, allowing for a higher level of exploration of musical structure and more perception-based knowledge. In testing it the musician learns how to map new relationships between her own moves, the shapes on the screen, the computer

program and the music played. In the process she often stumbles upon what she perceives as a bug and gets stuck. This is how she describes the process:

> "The procedure he makes is basically a "for instance". He makes a version of it. I have to come along and play with it in order to push it one way or another to see what else can be done with it, but out of that, whole ideas come out that were not there at all before. A 'for instance' is necessary before one can think. It's precisely because it doesn't work right that it suggests a new possibility".

Around each version of the procedure a whole new network of relationships, moves, actions, practices, objects, ideas and images comes to life, constituting a domain of practical knowledge, each having its own unique coherence. The world thus built and the knowledge thus made have the value of hypothetical statements or options to be further explored. In their design moves the developers proceed by "doing things". First they modify some existing entities and procedures and produce new ones, then they test them to see how they behave. They cannot tell whether they will work unless they see what they look like, what they are. Each "for instance" acts as a piton by which the developers pull themselves up to see the materials in new ways. By doing so they end up "pushing at the limits of the old system" to the point that they begin to question whether they are fixing and updating the old software or actually making a new thing.

As the designers try to design a final product which they don't know as yet how it will look like, they move away from the old system and proceed toward the new system by producing and testing "for instances". A "for instance" is a transient construct that helps designers to develop knowledge and make sense of their own design efforts before it gets eventually modified or discarded. Around (and based on) the "for instances" a provisional configuration of objects, relations, procedures, representations and meanings takes shape. It is a "functional complex" (Vigotsky 1962) with which the developers experiment and work for some time and through which they build and test new ideas and forms of practical knowledge at the boundary of the music and the computer domains. The transformation from the old to the new system is characterized by a sequence of "for instances" to which different and temporary forms of knowledge are associated. Keeping track of the sequence on-line reveals features of the process that are not visible in the final outcomes.

It is useful to summarize here what gets changed at the knowledge level in the process of developing the new computer music system. With each “for instance” the intersect and the boundary between the computer and the music domain are changed, so that the level of aggregation of the designed objects and tasks goes from lower to higher, distancing from the computer gear and getting closer to the music domain. As a result, different connections between symbolic descriptions and perceptions are produced so that practical knowledge becomes progressively less analytical or numerical and more perceptual and sense-driven. Accordingly, the representational (notational) language adopted shifts from numerical to graphics and, within the graphics, from iconic to analogical. As a consequence of such shifts new mappings between actions, computer programs and the music played are drawn which enable more transparency and directedness of input/output relationships and a faster response time between human actions and computer performances. Mappings evolve as objects, features, relationships, functionalities and procedures are transposed and translated across the different “for instances” and continually re-shaped and re-named to meet ever evolving requirements. In the process new features are liberated while old ones are relinquished, but the developers tend to see and appreciate them when they can recognize them. And when they do, the moves and the features on the way are pushed onto the background and disappear.

**Second illustration: Making sense of evolving situations**

Transient knowledge is carried by the multiple and shifting stories that people tell to make sense of evolving situations in design and innovation processes. This second case treats stories as evolving artifacts. It is drawn from the on-line tracking of the curriculum innovation project following the design of Music LOGO. It deals with the making and remaking of narrative accounts that happened all along the process of adoption of the new computer music system in the music curriculum. As they engaged in curriculum innovation, the music teachers told different stories about what they perceived to be relevant process-related events. Not only they would generate multiple views of the same event or situation at a specific stage of the process, but also, as time elapsed, the same actor would develop shifting interpretations of the same event, depending on the changing situations and contexts (Lanzara 1990). As people recalled previous events and situations they had lived through and talked about

them, they also shifted and reshaped the boundaries and the connections between what they perceived to be relevant events, developing new meanings and telling different stories.

The stories originated within an ongoing conversation between the project participants and the observer, and perhaps also as a by-product of it. Indeed, having myself a formal role in the project as a facilitator and reflective interventionist, one of my tasks was to collect and write reports on the main events of the process together with the participants' perceptions, descriptions and evaluations and subsequently feed them back to the participants in order to get their "back-talk". These "thick descriptions" (Geertz 1973) would provide a detailed account of the implementation process, which was thus made accessible to everyone for inspection, reflection, discussion and further evaluation. Through the back-talk, many events that had been lived through and many behaviors that had been acted out unreflectively became objects of collective inquiry and reflection. They were turned into spot-like events happening in a flow of many other happenings, continuously rearranged within a changing plot. The back-talk was a reflective move (Schon 1990) that created an opportunity to build further knowledge around a process of innovation. By such move a space for reflective inquiry was opened up, creating a sort of mirror effect (a screen) where participants could look at themselves as actors playing on a stage and eventually re-interpret their parts, words and behaviors in the drama. The back-talk made the process "double back on itself" (Olafson 1979) so that events in the past were seen and reconsidered within a reflective space. Thus both reflexivity and historicity were cast onto the process, adding a self-referential dimension to it.

As I proceeded with my observations, at each round of back-talk I discovered unexpectedly that the participants changed their own perceptions and evaluations of the relevant events, leading me to change, in turn, what I had just laid down as a "faithful" account of the facts. For example, a demo of the new computer music system delivered by the developers to the music faculty was initially described as a *controversy* between opposing factions about the adoption of computers in music education. Then it was re-described as a collective *learning experience* by which the music teachers explored what to them was a "thing unknown". Finally, at a later stage, the demo evolved into an episode of *political cooptation*, concerning the lack of

academic and institutional incentives to the junior faculty to invest in curriculum innovation. At each round the making of a new story signaled a new way of repositioning the demo as an event within the flow of events: new events and relationships were evoked and labeled, new functional boundaries were drawn, and new understandings were developed.

The stories about the demo seemed to stem from the complex interaction of three distinct sources: previous stories, incoming events, the back-talk. As the process unfolded, actors gave different meanings to the demo by making coherent, self-contained universes within which such event made sense – universes that included the demo in different ways. In shifting from one story to the next, the demo acquired a specific functional position and valence within the broader context of curriculum innovation. At each point in time stories integrated what the actors (and the observer) knew so far about the events in which they were involved. Although the stories were different and somehow unique, they had their own internal coherence, their plausibility and their contextual validity. They were all, in a way, "true stories", that helped the participants construct order and coherence in time, frame their own role and make sense of situations as the project progressed. Most importantly, the stories were closely associated to the actors' choices and actions in carrying on the project and developing the curriculum. They gave us information about the ongoing changes in people's minds and in the academic institution at different stages of the process of institutional adoption. When time elapsed and new events came in, situations evolved, and so did the perceptions and representations that actors had generated. New features were added and previous ones were obliterated or recombined in order to build meaning and coherence *now*, in the light of the present situation. Thus the event itself was extended into an ever-evolving sequence of descriptions. For example, the *controversy story* reflected the early exposure of the music teachers to the computer music system. Confronted with the "new thing", some of the music teachers raised "the educational issue" about the usefulness of the new system as a tool for teaching music. Cautiousness if not skepticism about an "alien entity" seemed to be the dominant mood. However, after the teachers got busy with testing and using the system for some time, the early controversy story was replaced by a *learning story*, which reflected the ongoing learning experience and a more collaborative mood between the developer and the teachers, who were "making the thing together".

Interestingly, within this new plot the demo as an event is re-shaped and narrated as a place where the teachers "were actually testing and appropriating the system". Similarly, the *cooptation story* reflected the rise of critical issues of academic politics, signaling the growing concerns of the music junior faculty about the ambiguous implications of curriculum innovation for their academic careers within the School. The demo is now projected into the past and onto the background of awareness, becoming a point of origin and losing some important connections with the present situation. Basically, the demo becomes "a piece of material" in the hands of the actors, that is repositioned, re-chunked and regrouped over and over again with later, incoming events, so that a cross-temporal structure - a plot, itself temporary and makeshift, can be formed. In each remaking of stories new knowledge is accrued to the plot while knowledge carried by the previous stories is, at least in part, obliterated. Historical revisionism is a familiar phenomenon in the making of process-related knowledge (Veyne 1971; Schon 1983).

Shifting stories are embodiments and carriers of transient knowledge. They reflect what the actors know about the project and the process, as they proceed with them, *up to that point*. They are intermediate and incomplete accounts, which actors create to cast some temporary, makeshift coherence onto a flow of events. Thus some plausible meaning to complex and ever changing situations of action is produced, and some fragile order to a chaotic array of ambiguous and ever evolving facts is fixed. Once created and told, shifting stories work as reference entities and tools for future action. In problematic situations they help agents cope with ambiguity and complexity, restoring some kind of provisional integration and cognitive coupling between the agents and their world.

**Third illustration: Drifting arrangements**

My third illustration deals with the re-design of organizational procedures and arrangements consequent to the introduction of a computer-controlled VCR system into six Italian courtrooms[1]. The system was introduced as a tool to produce instant

[1] The illustration is taken from a yearlong study on a process of innovation in the judicial system. The complete research findings are documented in Di Federico, Lanzara, Mestitz (1993), a research report to Italy's National Research Council. See also, for an inquiry into the knowledge making process in the courtroom, Lanzara and

records of the trial's proceedings. The records would be contained in videotapes, constituting a complete and faithful documentation of the hearings, immediately available to judges and lawyers for inspection and evaluation.

In spite of the simple technology, integration of the VCR into the courtroom's activity system was not at all easy to obtain. The new artifact did not immediately fit with the long-standing, deeply engrained courtroom practices of the judges. In many respects the VCR was at odds with the judges' established practices and with a judicial work environment heavily based on paper as a documentary medium, affecting their sense of personal mastership. The effective adoption and use of the VCR called for a switch from a traditional paper-based legal environment to one based on the electronic medium, but the transition could not be effected in one single step. The judges faced the problem of managing the debate so that the functional requirements of the VCR could be met. More specifically, if the judges were to produce high quality video-documents and successfully integrate the VCR into their legal practices in the courtroom, they were required to develop new practical knowledge and capabilities around a number of interrelated tasks, such as the on-line management of courtroom operations, the monitoring and evaluation of the visual replicas of the hearings, and the on-line re-design of new VCR-based micro-routines.

As I kept close track of the judges' early moves in the courtroom, I noticed that their response strategies to the challenges posed by the VCR were surprisingly similar to what we have seen in the former illustrations. They designed micro-worlds of practice where they could experiment with tentative routines and organizational arrangements going from low to progressively higher levels of complexity. Also, their strategies shifted as their experiments and transactions with the object shifted and they gained increasing familiarity with it. In the process, new forms of practical knowledge would be built, modified, and eventually discarded. At the same time the pre-existing routines and courtroom arrangements would be changed in ways that were largely

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Patriotta (2001). In the system, TV cameras are pointed to fixed positions and triggered by the voice of the speaker in the microphone placed in each position: so, with no voice, the speaker (judge, prosecutor, defendant, witness, or lawyer) would not be seen on video; while with multiple overlapping voices, control would automatically be switched to the panoramic TV camera.

unplanned and often unexpected: they seemed to undergo a process of gradual drifting. Let me try to describe this transformation and the outcomes of it in more detail.

At the outset, when they first engaged the VCR, judges and other actors suffered from a cognitive displacement in front of an "alien" entity. The sense of surprise and puzzlement provoked by the visual replicas of the courtroom action is well expressed by the words of the judges:

> "During the hearing I checked on the monitor, and there I saw the witness speaking, for the whole time!…I watched him at the bar…and then I watched the screen again, and there he was on the screen!"

The real-time *doubling* of events and actions happening in the courtroom produced a sense of disconnectedness in the judges, who were required to run the debate so that a good match between the flow of activity in the courtroom and its virtual replicas could be obtained. That was a necessary condition for the debate to be correctly reproduced on video. But contingencies, discontinuities, interruptions and misalignments often broke synchronization and as a result gaps were produced in the video-document, thereby reducing its quality. Interruptions were occasioned either by the technology or by the dynamics of the debate.

The early moves of the judges were on-line *ad hoc* responses to the emergent contingencies in the flow of courtroom action. When they perceived a misfit, they stopped the debate, invented a local patch and then rehearsed the action to see if the patch solved the problem. If it did, they tended to repeat the patch whenever they encountered a similar contingency. At this early stage the judges' responses were far from systematic. In order to explore the possible range of contingencies and misfits they had to run the debate long enough and be exposed to a broad variety of situations. After some time recurrent misfits and contingencies turned into more normal, expected events, triggering routine-like responses. The judges developed a loose collection of local patches by which they were able to respond more effectively to emerging problems, unblock critical situations and re-establish meaning. In this early phase the VCR is perceived as potentially disruptive of a long-established ecology of practice. Knowledge around the VCR is built through *reactive coping* and

is essentially patch-based and *ad hoc*, with lots of gaps and holes in it. Each problem is tackled in isolation, with little connection to one another. Local, scattered patches don't yet make a repertoire.

A new phase in the process was marked by the shift from puzzlement and from merely reactive behavior to a more conscious, design-like attitude. The most committed judges engaged in more systematic transactions with the VCR, both cognitive and practical. Thus, they made experiments or *design probes* in order to explore the potential of the technology. For example, with the help of the facilitators, they tested different configurations of the courtroom to obtain a smoother functioning of the VCR. Each design probe entailed some variation in the current procedure and some tentative re-arrangement of the courtroom "materials" (VCR equipment, transcripts, people, procedures, rules, tasks, positions, spatial relationships, timing, turn-taking, etc.). The new configuration would then be tested by running short segments of the hearings: it was kept if it worked well enough or else discarded to proceed to further re-arrangements until, by successive trials and repetitions, a satisfactory configuration was eventually stabilized. At the same time the judges developed provisional mappings of how the courtroom, the rules, the equipment, the relevant objects and the actors should interact within a modified system of activities. Gaps were filled and the functional territory of the VCR was more accurately charted. The challenge for the judges was to develop new forms of practical knowledge around the use of the VCR technology by restoring the delicate ecological balance of artifacts, tools, rules, practices and meanings within the courtroom and the legal profession. They were trying to meet at the same time two sets of requirements – the normative-procedural ones imposed by the code of criminal procedure and the technical-functional ones induced by the new technology and medium. Each makeshift re-arrangement of the courtroom materials was as an intermediate step towards an as yet undefined state. Any subsequent configuration of the courtroom differed from any other in terms of the mix of the pre-existing, paper-specific routines and the new routines induced by the technology. But it was not at all unusual that actors in the courtroom held multiple and simultaneous configurations, switching from one to the other according to need or chance.

Gradually, as a result of the judges' experimental activity, a loose network of routines began to take shape around the VCR. Most of the routines were hybrids, recombining pre-existing and newly designed components. They mediated between the different requirements, thus providing some integration of the VCR in the flow of courtroom activities. The VCR became a more familiar, *connectable* object - a tool to play with. Consequently, new forms of practical knowledge also developed, which were more *designed*.

Finally, in a more mature stage of development, some of the judges became skilled enough to integrate the loose and scattered collection of patch-like solutions into a more stable and structured repertoire of routines. In the courtrooms where VCR integration was more successful, at one point we noticed that some stability was reached in the configurations, with less frequent variations. Judges developed a capability to run the debate and the video in their minds at the same time and to anticipate outcomes and problems. That improved their capabilities to coordinate the debate and to restore the fluidity of courtroom action. At this stage the VCR was perceived as a usable tool and disruptions were not experienced as breakdowns anymore, but normal events for which a routine response was available. The character of the judges' practical knowledge shifted again, becoming more rule-based and associated to a stable problem-solving repertoire. It is important to remark though that the knowledge thus built did not look in the end as a fully coherent system. Rather, it still kept the character of a loose, drifting assemblage of hybrid routines characterized by recombinant properties, unstructuredness, and flexibility. This knowledge did not completely hide the accidental events it had gone through, did not fully and coherently integrate its past history into a "clean and tidy" functional outcome. In subtle ways it still kept the memory of the process.

## Discussion: The dynamics of transient knowledge

Together with some differences the cases share significant similarities. Each case is an illustration of processes by which actors disconnect from previous forms of knowledge and build up new knowledge associated with new artifacts, tools, routines,

representations and organizational arrangements. In order to design new things and implement innovation actors have to move away from established practices and objects and learn new ones, but that is not so easy for them. The transition from old to new often entails a perturbation in the previous activity system, so that actors may experience a cognitive displacement from current practices. Changing the practice requires a shift or a switch of the knowledge system. Actors, through their own experiences, must construct new knowledge that is not available at the outset of their activity. They are involved in design situations in which they do not know what kind of knowledge will emerge until they actually make it and recognize it (having made it), and in which they do not know the path to get to such knowledge (eventually the path will be known *post facto* – retrospectively)[2].

In the processes of transformation and learning actors experience high ambiguity which might cause a loss of structuring and sensemaking capabilities (Weick 1993). On the one hand they cannot fully rely on previous knowledge, as they must disconnect from it in order to move on to restructuring and re-design; on the other hand they cannot yet rely on new forms of knowledge and on different ways of doing things, as the latter must be discovered or constructed in the process, or eventually emerge *through* the process and as a by-product of it. To be more precise, as it will be illustrated in the following, it is not easy for the actors and the observer even to tell the new and emerging from the old and established in the process of knowledge making. Thus actors float in ambiguous, dynamic and ever evolving situations where action is difficult but necessary at the same time, and must be undertaken *before* one can know and *in order to* know (Starbuck 1985; Weick 1987). The cases in the previous section depict developers, curriculum innovators, professionals and organizational actors caught in the midst of transformations where they must cope with ambiguity. Ongoing, close-to-action observation of the process reveals specific strategies of knowledge making, based on the making of transient constructs and the synthesis of transient knowledge. I will discuss the dynamics observed in a number of points.

[2] This problem dates back to Plato's dialogue, *Meno*.

As actors undertake action and make sense of the flow of events happening in the ongoing transformation, they proceed by making transient constructs and playing with them for a while in order to test and explore their possibilities for future development. As a result of their experience with them, they modify or discard them, and engage in making new ones that might eventually keep some of the features of the previous ones. In my illustrations such artifacts happen to be software procedures, stories of a relevant event, new routines and organizational arrangements. Independently of the stuff they are made of, which can be material as well as symbolic, transient constructs help the actors to cast some provisional order and structure to a shifting situation. Actors engage in practical and cognitive transactions with them. They *do things* to them, see how they work, and evaluate whether they should be kept or trashed. By having a sort of "commerce" with transient constructs actors learn how to integrate them in their practices, so that they might turn into meaningful and practically useful things.

Each transient construct is an embodied hypothesis, a hypothetical statement, about how an object or tool could look like, how a situation could be understood, how the surrounding world could be organized. It refers to a provisional ontology. For example, the different versions of the music software procedure evoke different software objects and relations, trigger different kinds of activities and representations, and different ways of intersecting the music and the computer domain. Each version is a virtuality, an "as if" statement that opens up some possibilities for action and thinking while curbing others.

In a similar manner, the multiple and shifting stories that are told about the music curriculum innovation encapsulate the understandings that participants develop of the situations in which they belong and act. When situations evolve, their meaning shifts, and events, actions and even identities need to be reframed and repositioned within a different and extended plot if they are to make sense. Consequently new stories need to be told as well. Stories are revisable and amendable, therefore the knowledge they embody and convey is bounded in space and time, featuring what the participants in the process know so far – *up to that point in time*. In other words, each story conveys a temporary intelligibility of what's going on in the process of innovation. Though provisional and incomplete, this intelligibility is necessary for the actors to cast some

order onto the unfolding events, take some action and keep moving, eventually towards new forms of intelligibility[3].

Along the same lines, the magistrates try to integrate the VCR technology into the set of courtroom practices and into their professional cosmology by arranging and re-arranging their work routines and the courtroom layout in different configurations that they submit to testing. Each new configuration is a possibility to be explored and a probe into the future: first the magistrates do things with/in the new arrangement to see how it works, then if necessary they revise or discard it. Because the incoming technology provokes a perturbation and a temporary loss of structure and meaning in the courtroom, magistrates have no other means to re-establish sense-making than proceed by designing small practical experiments within micro-worlds of manageable complexity.

Though short-lived, transient constructs are manageable loci of stability in an ongoing flow of events and activities. For some time they are able to capture perception and attention, facilitate interaction and support minimal coordination. For example, each version of the music software procedure (each 'for instance') becomes a recognizable place where the music teacher and the programmer can engage in transactions and jointly design the system across their distances and misunderstandings; in music curriculum innovation each story connects and holds the actors, their actions and the events together, thus supporting causal attribution, evaluation of events, and recognition of different identities and stances. Likewise, in the courtroom setting each tentative arrangement is a relatively safe micro-world where actors can build up practical knowledge around the VCR technology and learn ways to coordinate their actions to make it work.

In this perspective transient constructs are "entities" around which and upon which some practical work can be done and some cognitive activity can develop. They work as "fixes" to assure some provisional order and structure, "holding still" the meanings that actors give to materials, events and situations. Each construct becomes a

[3] In this sense each story has its own kind of validity, that depends on the position and function of the story in the overall process. As the musician said: "Yes, the stories are all different and they are all true!".

reference for these meanings. A tuneblock procedure, a descriptive account, a tentative courtroom arrangement are "reference entities" – embodied and enacted descriptions of what the agents know so far (Bamberger & Schon 1983). In processes of design and innovation reference entities come to play an important sense-making function when actors cannot rely on a complete and coherent knowledge system. When the preexisting framework is lost or unusable and a new framework is not available yet, actors must act and experiment with the stuff they have at hand, without owning a full representation of the domain. Like climbers on a cliff, actors need "pitons" to pull themselves up when no other mean is available. The route to the top is traced as a result of local trials, and can eventually be appreciated in its entirety only by looking downwards from the top. Indeed, if we consider the sequences of reference entities that are sketched in our three illustrations, they look like a materialized "log" of the knowledge making process.

The latter remarks point to a further interesting aspect of the dynamics of transient knowledge. Transient knowledge is also "transitional" (Winnicott 1953), in the sense that, in its various transformations, helps actors cope with the ambiguities and the perceived risks of unfamiliar and threatening situations by establishing a provisional link with some features of the situation that can be handled. Thus actors can recognize some problems, attach names and labels to component objects, make sense of local events so that they are not overwhelmed by ambiguity and anxiety. As Winnicott has argued, transitional objects and transitional phenomena are paramount in the process of making sense and shaping coherence in an evolving world (Winnicott 1953). When everything around moves at a fast pace, when events keep rolling on and situations continually evolve towards unknown end-states, something needs to be fixed, and to this purpose transitional objects fulfill an "anchoring" function for the agents. But at the same time something needs to be kept open and reconfigurable. That's why objects are transitional, pointing to other possible knowledge configurations[4].

[4] In psycho-analytic research and therapy Winnicott has noticed the role that toys, dollies and teddy bears play as transitional objects for children. Children surround themselves with such objects and engage in transactions with them to chart the unknown world around and be reassured. They make the world around more familiar by communicating with them. Then they may suddenly abandon them when they feel they don't need them anymore. I submit here that these "transitional" and "transactional" objects have a cognitive function, too.

In our process description transient constructs seem to come one after the other along a time sequence, but the linear pattern should not deceive us. In the process of knowledge making there is a lot of repetition and re-working of the very same materials, Every time the programmer makes a “for instance” for his partner to play with, somehow the clock seems to be reset anew in search of a solution. Every time a new story is told, it leads to the repositioning and the reframing of events and actors. In their search actors proceed in cycles, going back and forth in an uncharted territory and often revisiting places and possibilities that had already come across to them in the process.

In this regard, it is interesting to analyze how transient constructs unfold into one another, carrying forms of knowledge that are themselves in perpetual evolution. In other words, how do actors move from one construct to the next in their search for coherence and meaning? In each of the processes described we can observe moments or, to be more precise, momentary articulations of an on-going process, in which actors come to see things in a new way. They often start from a problem, a discrepancy or a contingency which surfaces in the material they are dealing with (artifact, tool, routine, situation). In an effort to make sense of what they have they engage in a series of continuing experiments. As they give different shapes to the materials, actors shift in their uses of them and with the uses also the modes of description shift. In these “shifts” new features are accrued or “liberated”, while previous ones are wiped out and others are re-arranged and recombined in different ways. For example, the new PITCH-AND-TIME software procedure for playing music with the computer does not completely wipe out some of the elements of the previous GRAPHICS TUNEBLOCK procedure, it just recombines the basic materials at a higher level of aggregation. Although we perceive a discontinuity going from the one to the next – the developers’ perceive it is as “a jump into a different world”. PITCH-AND-TIME could have not been designed without the experience gained by playing with the previous procedure. Each new version of the program is made of patches of old and new components, but it is not a simple matter of copying or translating the old into the new. In a way, a new version integrates the practical knowledge that has been developed around the previous version with the new developments, shifts of direction and “branching outs” in the process of designing.

Interestingly, in making transient constructs the designers discover not only the limits of what each version can do, but also the boundaries of their own knowledge. Namely, they discover that all further design, construction and learning happening in the process stem from previous knowledge. In the music teacher's words:

> "(The old system)…works very well. It does everything that I want done. But, you see….it does everything that I want done because that is what I know how to do. …I don't even know what else is possible. Well, I think I know what I want the system to do, but….only in terms of what I know already!"

But at the same time she discovers that the only way such boundaries can be tested and pushed further is by making and remaking knowledge in an endless process of search, discovery and design.

We can appreciate similar dependencies and connections between the existing knowledge and the knowledge-to-be-made in the courtroom setting. The transition from the previous setting to the new one that comprises the VCR system is not an instant switch, nor a linear sequence of moves. It cannot happen "fast and smooth", because the actors do not know which will be the ultimate configuration. In their early efforts at VCR integration the magistrates go through the same experience and share the same feelings of the Music LOGO developers. They first stick to the familiar procedures dictated by the law introducing small variations in the procedures and the layout to accommodate the new technology. For example they change the positions of the cameras and the microphones, assign different positions and give instructions to participants, assign control and monitoring tasks to the court staff assistants. By doing so they proceed in multiple rounds of testing, introducing new variations and complexities in the courtroom configurations at each round. The new arrangements that come about are hybrids resulting from a recombination and regrouping of old and new component procedures. Most new routines are crafted by assembling pieces of existing routines with pieces designed anew, in a repeated effort at meeting both the technological and the judicial requirements. In experimenting with the new court arrangements the magistrates show "behavioral oscillations" between routines grounded in the traditional trial and routines connected to the visual medium, as if they could not yet decide which should be the right form of integration between the technology and the traditional trial setting. A high degree of instability can be

observed in the setting during the process of experimentation, with recombinant routines and configurations that are first put aside because they do not seem appropriate and then get "rediscovered" later on and re-enacted for further testing. In the framework proposed here hybrids, oscillations and instabilities should by no means be interpreted as signals of the actors' incompetence or resistance to change, rather as symptoms of an on-going process of structuring and sensemaking where the actors build up new practical knowledge by "fixing" makeshift procedures that "do the job" for a while. The knowledge thus crafted, though always in a state of transiency and far from being "sound", turns out to be a crucial resource for the magistrates in their practical and cognitive de-coupling from a highly structured setting and in their efforts at making sense of the new possibilities brought about by the VCR technology. In the last section I shall draw some implications and conclusion of my discussion.

## Implications and conclusions

Based on the discussion, some implications can now be drawn. They are laid out here as a final seal to the paper, inviting to see issues of design, innovation and knowledge creation in organizations in a new light.

Knowing as making things. Rather than viewing knowing and knowledge making as a largely mental activity, the picture that comes out of this research describes knowing as a kind of making things. The making of knowledge and the very act of knowing amount to shaping things that have some coherence and meaning. In other words, the relation between knowing and making is turned upside down, and the model of practice is transposed to a more cognitive domain, where material artifacts, shapes, moves, positions and physical arrangements may assume vicarious representational functions, that is, may directly embody and convey meaning without the need for an explicit representation (Scribner 1986). In this perspective, knowledge making seems to be closer to crafting and artistic creation, resembling the act of casting a form on materials within a specific medium rather than being a kind of instrumental problem-solving within constrained task situations. In their search the agents do not seem to proceed by means-ends analysis or according to some pre-established logic. They do

not know where they are heading to, nor how to get there, and often they come to recognize things that they didn't know, and eventually like them, retrospectively, *after they have made them*. Within each setting observed the agents come to "know" through a process of making things, and what they learn is tightly intertwined with their materials, their practical moves and the transient objects that they happen to make and remake. They sketch, interrogate, listen, respond, keep and trash. The process of making things and building knowledge resembles a conversation between the maker and what happens to be made (Schon 1987; Bamberger and Schon 1983).

Hybrid assemblages. The processes observed reveal that knowledge making is a much more chaotic and less "tidy" activity than usually thought of. Transient knowledge often comes in cycles and repetitions. A space of multiple possibilities is crossed back and forth in multiple directions. Shifts of attention, changes of direction and unexpected switches in the use of materials punctuate the process of making. Long periods of routine work or apparent inertia may be broken by sudden bursts of activity and by divergent search and drifting. Therefore the statement that knowledge itself is more undetermined and unstable than thought (Tsoukas 1996) should be taken more seriously than it has been recognized in the literature. What is ultimately stabilized and frozen as a "solid", reliable knowledge package is often a hybrid assemblage of components of different kinds that obey to different logics; or it comes as a set of layers of the sedimented outcomes of local moves that have been made at different times and perhaps with different goals in mind. Thus, in our established knowledge repertoires there may be a bunch of things that apparently do not fulfill any specific function but are there for the simple reason that they were made, used for a while, and never discarded later on. The cognitive and practical status of these components is ambiguous: on the one hand they may be obtrusive and yield cognitive inertia, on the other hand they may add to the overall redundancy of the system.

Reconfigurable orderings. Transient knowledge points to the critical importance of "versioning" and reconfigurability of products, routines, and organizations as a strategy for design, innovation and knowledge making. It evokes the idea of movement and instability and the sense of continuing mobility that is associated to change and transformation. The transient constructs we have been observing – procedures, stories, organizational artifacts - are "versions" of reality, working

hypotheses of how the world could be in practice. Having a provisional status, they definitely point to a process-based ontology rather than to an ontology of static objects. Their value is not specifically associated to ultimate properties, but to the circumstance that they may lead to further versions and knowledge configurations. Thus they do not reflect *the* order of things, but only *ever reconfigurable orderings*. For its reproduction knowledge relies on "permanently beta" objects (Neff and Stark 2002), that is, versions that at each point in time integrate the experience of the past while at the same time, being there to be further revised and updated, point to the future. All transient knowledge is indeed beta knowledge.

Unfolding plots. Although provisional and patched up, transient knowledge is nevertheless *knowledge*, that is, a kind of ordering of things, to which some local structuring and meaning are associated and from which one can move on. Grounded on it, some kind of purposeful action can be taken. Versions have a two-fold function and meaning: they always evoke a manifold of different shapes and functionalities an object can assume; at the same time, because at one point they are obliterated and replaced by other versions, they help us cast some inter-temporal ordering to our dealings. The continual re-chunking and re-grouping of components, features, and events lead to chains of revisions, and to revisions of revisions, thus producing some kind of sequencing. The next – next – next chain of versions provides some orientation in time connecting the past to the present and the future in unfolding plots always subject to revisions.

Conservatice cycles. Even if moving forward in iterated cycles of continual recombination and re-design, the process of knowledge making has some kind of irreversibility. Inconspicuous traces of previous moves and choices are left imprinted in transient constructs and in the path that is traced by them. These traces may have long-term influences on the final configuration of a knowledge system (artifacts, practices, representations). Choices, actions, and their consequences are not completely reversible. Not all designs can be discarded, and most new designs are built on previous ones. Similarly, new knowledge is built upon previous knowledge. When transient constructs achieve some stability and are rehearsed over and over again, they become templates for further designs and for knowledge reproduction.

Scaffolding. The above remarks lead to the observation that previous knowledge embodied in artifacts is sometimes used as a scaffold to support further design steps and operations. Often the process of converting previous knowledge into a scaffold takes place inadvertently, as a by-product of the process of designing. It has to do with the way designers exploit the features of available objects and frameworks as tools or platforms to keep moving on and yield new knowledge. Scaffolding is not a separate activity from the actual design; rather, it results from it.

Forgetting and remembering. Transient knowledge should not be regarded as a step or a stage in the ladder to climb up to more stable, and harder, knowledge configurations, but also as a crucial dimension of the phenomenology of designing and world making (Goodman 1978). It is what our concrete knowing and designing efforts are made of when we strive to change ambiguous, problematic situations. Indeed transient constructs are with us all the time, being the "stuff" of our mundane practical and cognitive activities. The knowledge they convey reflects "moves on the way" that are critical in the process of building but not necessarily visible in the final configuration of the built. Such knowledge is not necessarily of lower status with respect to more formal, institutionalized forms of knowledge, which are conventionally considered of higher status. The things that we forget or throw away are no less important for the process of knowing as the things we happen to remember and keep. We should consider that those things have played a significant part in the on-going process of weaving and reweaving of the extant texture of objects, relations, representations and meanings that we come to call "reality". Therefore they are always present, in some objectified form, in the outcomes of our designs.

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