

A new artifact in the trade

Notes on the arrival of a computer-supported manufacturing system in a technical school

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Introduction

In the following chapter we will report experiences and insights from an intensive, three-year-long study in a vocational school (École Technique de Sainte-Croix), situated in the northwest of Switzerland, in a moment of change. The arrival of a new artifact – a computer-supported manufacturing system – was at the origin of the study. For us, readers of activity theory (Scribner, 1984; Lave, 1988; Säljö, 1999; Engeström and Miettinen, 1999), this has proven a wonderful event to observe: humans and non-humans, resistances, discourses, actions, conflicts, institutional changes, and perhaps learning. Transformations occur not only at the level of the individual and inter-individual action and thinking. Concomitant and consequential changes of the “event” (this entrance of a complex new artifact in a learning environment) will also be observed at the social, institutional, political and economical levels. Yet, in the school, these changes were not always reflected upon or even noticed by learners and teachers. This resulted in diffuse and sometimes strong anxiety in these persons. It has offered researchers a unique opportunity to perceive the interdependence between artifacts and people; to observe the resistance to or search for the transformation of the activities, and the explicit and implicit learning that was occurring. The potentially complex transformative effects of the introduction of this new technology into the teaching of small-scale precision engineering had not been expected by the partners.

We will try to give the reader a chance to have a taste of what this has meant. The situation is complex because the school is quite dependent on the local watch-making area, which is supported by its traditions of professionalism and quality, but is at the same time undergoing the strong impact of globalization. An observational study of three years is a multidimensional enterprise, and the lessons that can be learned are quite numerous. Here, to make it short, we will adopt a narrative tone in order not to hide the complexity of the reality observed, and to account for its deployment in time. Other publications permit a more in-depth approach, either to the whole study or to some specific aspects (essentially Perret and Perret-Clermont, 2004; but also Golay Schilter *et al.*, 1997, 1999; Perret

calling attention to the individual learners and teachers as well as their contexts, but also to the interdependency between thinking, technologies, norms, roles, identities and goals (Resnick *et al.*, 1997; Martin, 1995; Verillon and Rabardel, 1995; Latour and Weibel, 2002; Engeström and Middleton, 1996; Ludvigsen *et al.*, 2003). We would draw upon our ongoing work regarding the psycho-social processes involved in teaching-learning situations (Perret-Clermont and Carugati, 2001; Perret-Clermont and Iannaccone, 2005); and, in particular, we would again pay attention to the discrepancies between the wishes of the designers of an educational setting and what really happens as seen from the side of the recipients of the pedagogical offer (Perret, 1985; Muller Mirza, 2005; Marro and Perret-Clermont, 2000; Willemin, Perret-Clermont and Schürch, 2006; Zittoun, 2006).

Our interlocutor, director of a technical school, was concerned about the anxiety and as a consequence the discouragement he sensed in staff and students. The area around the school was depressed because of difficulties in the local industry. He was hoping to find ways to boost the school's development and imagined receiving support for that from the area. One of his major steps in this direction was the (expensive) acquisition of a computer-supported manufacturing system (CSMS) to be used as a didactic tool in the workshops of the school. He had managed to get subsidies, reorganize the building to house it, advertise the acquisition in order to attract new students, yet he was left with unsolved problems regarding the curriculum and the teaching: how could the skills required by such a technological device be taught? Would the staff engage in the necessary efforts to adapt? Would the representatives of the profession, who participate as experts in the students' final examinations, acknowledge the learning of these new skills which were not (yet) part of the official curriculum? Would the students perceive and appreciate this modernity?

This school had a long tradition in the acquisition of financial resources by selling the work done in the school: the professors of the school have a record of new technical advances developed by themselves (in numerical control, for instance) and they had been successfully selling this technology and training courses to enterprises in Switzerland and abroad. Student's work performed with it was also sold to local firms. But how would this be done now?

The CSMS has not been developed by the school and comes in as an outsider. It doesn't seem likely that the school will get orders from industry, for products made with this technology. The school could still hope to sell training courses to future users of CSMS, but that was really the point: how should such training be organized? The new machine seems to disorganize the school, the curriculum, and the professors' agendas. And, furthermore, this technology always has bugs and breakdowns and seems unreliable when planning lessons!

We knew that other changes were simultaneously taking place on the wider scene: technical schools were being reorganized at the cantonal level; the local market was suffering from unemployment and less likely to ask for the school's offers; the student population was changing due to demographic shifts in society, etc. As we expected that the anxiety that was rapidly increasing in the school did

1997, 2001; Perret-Clermont *et al.*, 2000, 2001; Kaiser *et al.*, 1999, 2000; Marro 1997, 2004).

Special attention was paid first to what the arrival of a major new artifact (a computer-supported manufacturing system) has meant for teaching arrangements and students' learning. In trying to account for the changes observed, we have come to realize the interdependency of different activity systems: the local school, other competing schools, the cantonal state, the federal state, the trade, the lobbies that voice the technological needs of local firms, the employment market, and so on. All participate in defining what happens in the school at a given moment. In parallel, students and teachers develop their own understanding of what is happening. Obviously, there are clashes, paradoxes, unawareness, born from competing demands, misunderstandings, prejudices, personal goals, and so on. Our own growing awareness of this complexity, as well as our efforts to spell it out, will lead us into reconsidering what is "learning" and "teaching" in such a socio-technical setting.

Questions from the field and questions from theory: setting up an investigation

The recent development of computer-supported technologies has profoundly affected workplaces and is transforming, sometimes inconspicuously, the social organization of the professional and educational fields. Schools and political authorities are aware of the need for changes. The Jura Mountains, which depends on the small mechanics and watch industry, needs to meet the new challenges of the trade in order to survive economically. But nobody really knows how vocational education should be reorganized in order to meet the multilevel changes of technology. Providing students with the opportunity to develop adequate skills, attitudes and competencies that will allow them to "join society," as apt citizens but also as employees or entrepreneurs in professional activities requiring a high level of performance is a pressing goal (Gilomen, 2002; Trier, 2000, 2003; Perret-Clermont *et al.*, 2004). Local firms strive to maintain their tradition of creativity and quality, in order to keep up with the changes in the market. This means that they also have to remain sufficiently attractive to young people.

We were looking for an opportunity to contribute to a better understanding of these transformations when Roland Bachmann, a friend and director of a technical school, asked for help. He was looking for independent interlocutors to reflect upon the contradictory pressures that he was trying to deal with in a growing climate of uncertainty.

We agreed that we would enter his school as observers, as would ethnographers in a new field (Delbos and Jorion, 1984), i.e. trying to learn the language and the worldviews of the partners, observing and taking notes, asking questions and making interviews, sometimes interfering as a way to test intuitions. But our theoretical background was not going to be anthropology. We would look at the school's activity through the "lenses" of a cultural-historical psychology and activity theory,

not have its causes (or solutions) only within the teaching-learning process, we readied ourselves to inquire about the interdependency between different factors, by paying close attention to the crisis and to the contradictions encountered by the school in its attempts to adapt. The director agreed with this plan: the study of the entry of this artifact (CSMS) into the school was going to be considered as the principal object of study for itself, but also as a “critical event” to serve as an analyzer of the processes at different levels: individuals (teachers, learners, administrative staff); interpersonal relations; role distributions; social representations of learning and teaching; understanding of the technological change; time perspective; social positioning of the school among other schools; relations to the local enterprises and to the state.

A grant of the Swiss National Science Foundation, in a program dedicated to the analysis of changes and efficiency in the educational system, allowed us to set up a three-year-long observation plan starting for two years with: visits to the school and to its partners; reading of archives and other written sources; participant observations, for long periods of time, in classes, workshops, staff meetings, meals, open days; feedback meetings; interviews; and a questionnaire given to the students. This enabled us to better understand certain important elements of the scholastic, professional and existential problems encountered. On this basis, a specific activity was then chosen to become the center of the observations of our third year of study: namely the practical training sessions devoted to computer-supported manufacturing. It became a privileged observation point from which to identify, along with the professors, what they considered to be “traditional know-how” and “theoretical knowledge” required by the CSMS activity. (The teachers were unaware of activity theory and it was not our aim to teach them such a perspective. We only wanted to access their understanding of the situation in their own terms. But of course we were quite aware of the misleading aspects of these very common distinctions between theory and practice, know-how and formal knowledge.)

Special attention was paid to observing how the students interact with the CSMS, and among themselves or with their teacher, when working in small groups on the machine, and to how they interpret what is happening. We were expecting to see reflected here, at this level of micro-analysis, a certain number of psychological and social elements of the wider reality of the lives of the students and of the school.

A narrative account of some observations

The Jura Mountains, in the northwest of Switzerland, has a long history of clock-making and small mechanics, along with cultural and organizational traditions to cultivate the numerous skills required (technical, artistic, mathematical, commercial, etc.). This area has also developed institutional settings for their transmission, which have varied in time: each technological innovation has brought changes in the components of the trade, has put new demands on professional education, and required specific social organizations.

Traditionally, in Switzerland, a large proportion of apprentices are mostly trained by working directly with a master in a (often small) firm, a well-defined community of practice in which the learner gradually moves, according to a defined itinerary, from the status of peripheral participant (paying to have the chance to observe the trade) to the status of certified professional, earning his or her income by being fully involved in the professional activity. This practical training is complemented by some formal teaching. It is a “dual system”: on one hand, the apprentices spend most of their time in the firm’s workshops but also go, for a series of hours per week, to a professional school to benefit from lessons designed to serve as background to understand the trade in which they are being trained. The learners belong to two different, relatively independent, activity systems: the firm and its workshops, and the school and its classes (but there is an overlap as the firms often participate in deciding what should be taught and in assessing the student’s final examinations).

In watch-making, earlier perhaps than for some other professions, it became clear that the basic knowledge required from professionals was very demanding and could not be dealt with in a day or two of lessons given just as a complement to the know-how acquired in the workshops. At the end of the 19th century, this gave birth to full-time technical schools. The Sainte-Croix is one of them. These professional schools (*écoles de métiers*) are seen as bridges between school and work. This implies a tension in the school workshops, as they oscillate between school activity and industrial activity. Teachers manage this tension by setting up “authentic” activities that reflect the “reality” of the trade.

These schools receive financial support from the state. But this economic input has always proven insufficient: the schools themselves have had to be largely self-supported, via the acquisition of funding, by carrying out mandates, or by selling innovations or training. As a consequence, their staff cannot at all be identified with the figure of a “teacher” (in the role of a teacher in compulsory education), but rather with that of a professional engineer who develops products, and takes part in production via mandates that the students execute both as an opportunity to practice their newly acquired skills and as a means to finance the school. In these schools, students are not just learners: they are also invited as (peripheral) participants in part of the development and production activity.

Two different activity systems are present in only one organizational entity: namely the activity of the school as a school, and the activity of the school as a firm. These two systems overlap: when needed, the teaching is modified in order to cope with the production demands; the teachers (or “professors”) are aware that they have to keep their professional knowledge updated. Of course, the school is not an isolated activity system: it interacts with the public authorities, that contribute to its financing and edict regulations for the recognition of the diplomas; the school equally interacts with the economic sector of the region – and gradually with the whole country and abroad as the globalization process increases – in order to acquire mandates and offer or sell advice and training (as the school presently does in Brazil).

New technologies and fear of an economic threat in the Jura Mountains

In the 1970s, the school had already introduced computer numerical control (CNC) and carried out pioneering work in designing and selling new systems. This had changed part of the content of the teaching but not the format, because CNC kept requiring *individual work* from the technician. In the early 1990s, as in earlier circumstances on the arrival of a new technology, when computer-integrated manufacturing (CIM) emerged, schools and trades were shaken by what they perceived as a new threat and challenge. But they had the feeling that this change would be more important than previous ones because relying on *team work*: the technological advancement was not coming in support to the individual worker's action but automating a whole production chain and hence completely redefining the workers' tasks and status.

In the little mountain town of Sainte-Croix, the seat of a renowned (typically Swiss) watch and music-box industry, it is the arrival of a small low-cost music-box, produced by fully automated systems on the other side of the earth, that created a turmoil: it made evident the fact that traditional technology could not compete anymore. The whole local economic life was suddenly seen to be at risk. The firm immediately reacted by acquiring a computer-integrated manufacturing system. But such an expensive device was to create a new problem because, in order to be profitable, it had to run all day and night. This meant that, contrarily to former machines, it was not possible to stop it in order to train the staff to use it. A specific teaching space had to be organized. The firm therefore turned to the technical school, across the street: the school would buy a "didactic" machine (with some financial support from the federal state's action in favor of new technologies) and organize courses both for its students during the day and for adult workers in the evening.

A technological source of worries and conflicts

The arrival of this new technological device in the school was not inconspicuous. Not only was it very expensive and the source of a lot of pride ("our school is acquiring top technology") but also of gossip; it was very cumbersome and required the reorganization of the building to free a whole floor for it.

Members of the school staff were worried: would the new technology render classical machining skills obsolete and deprive them of their jobs? The students were preoccupied: "What are we training for? Will we end up in silly jobs, just looking after a machine that does everything by itself? Mere button-pushers?" The staff were aware of major changes on the horizon, but didn't really know which changes they ought to introduce into the curriculum, ending up with minor adaptations – but these were not understood by the representatives of the trade on the board of examiners of final diplomas: they were sceptical and kept requiring the traditional skills without giving much credit to the new know-how. Indeed,

the identity and ethos of the trade were questioned: "This type of manufacturing cannot compare with traditional quality. A good worker should master his piece all along the machining process." Conversations were intertwined with the ideas of "Swiss identity" and "traditional quality."

It then appeared, as a matter of fact, that the local firm did not need to train anybody anymore: new qualified computer engineers had been recruited and the established technicians set in the role of helpers to those experts; the under-qualified part of the staff had none of the necessary prerequisites that could allow them to benefit from a training program on the didactic machine. Therefore, the collaboration between the school and the firm on this issue was stopped, with discouragement as a consequence. In the meantime, the member of staff in charge of the didactic machine was spending many more hours than foreseen trying to master it, in order to make proper demonstrations to the students who were very critical towards any bug!

The CSMS machine had in some manner been "pushed" into the school as a "must" in order to remain up to date. The firm and the school had been collaborating for decades. But, eventually, the change was too large to be dealt with by means of this traditional cooperation. It was creating much deeper disruptions than foreseen within role distributions, material arrangements of the building, school program, learning modalities and hiring policy. Directors, professors, workers, students, political and school authorities had different goals. They co-existed without clear awareness of the contradictions.

Another problem arose a year later, when the school understood that the assembling chain of the computer-supported system had been delivered to them without all the necessary software "because of insufficient pre-definition of the requirements." But nobody in the school could even imagine what these requirements should have been.

What should be learned?

We had been called into the school in order to evaluate the relevance of past and present learning processes and discuss readjustments. Tradition had established a step-by-step introduction for the learners of the various professions (mechanics, electronics, etc.), starting from basic skills (e.g. filing) up to the final masterpiece that the apprentice would do on his own to demonstrate his expertise. Now, following the "step by step" tradition of teaching, the director and teachers were trying to rearrange the curriculum to include a theoretical introduction to CSMS. Of course, this meant also a reconsideration of the time allocated to the traditional contents of the teaching, threatening the occupational time (and hence the salaries) of some of the teachers. This meant more things to learn.

Some professors started criticizing the long weeks spent by the novices in learning how to file with precision, when later the computer-supported machine would do it automatically; but others would argue (justly, according to Martin, 1995) that a first hands-on experience with the matter to be filed would subsequently prove

very useful towards understanding the automated processes and to know how to adjust it according to the type of metal. Some teachers were used to give more space gradually to the students' own activity (production of machined objects) and would not give this up in favor of theoretical courses on the programming of computer-supported manufacturing. The staff valued neat and precise work from the students. In their opinion, this was not possible anymore in (bugging, complex) digital manufacturing – and the ethos of quality of the whole profession was considered to be at risk. The capacity to plan work within precise periods of time (in the final examination the students have to demonstrate their capacity to accomplish all interdependent parts of a difficult task in a limited amount of time) was equally important to them: but the computer-supported manufacturing is so frequently stopped by bugs or unforeseen programming problems that this quality seemed difficult to cultivate! Hence, some of the professors were very sceptical about the educational value of the new technology. And students, at times, reflected the same point of view.

There was a growing awareness that students were mostly trained to work on their own and demonstrate individual competencies, but that they would need now to learn social skills in order to be prepared for teamwork. The school did not have the proper culture for that: some teachers would tell us they had “no idea how social skills should be taught.” In the questionnaires on how they learn, students responded in a very ideological way, feeding us back statements such as: “by practicing, practicing, practicing . . .”; “to repeat something many times is the best way to learn”; “you have to listen very attentively”; “it is important to work on your own”; “no, I don't ask help from the teacher or from my colleagues.” But when visiting classes and workshops, we could observe students helping each other all day long, asking questions, imitating gestures, and teachers moving from one student to another giving them hands-on support, and so on. But the staff were unaware of these social skills and, as a consequence, were not explicitly fostering them.

Diagnosing the “bugs”: a major challenge not recognized as such

It was found that the students' lack of trust in the “didactic machine” (“it is not a real machine,” “firms work on different machines”), which they had not made explicit, notably interfered with their motivation. The professor thought he had to demonstrate elegant examples of perfect production with the CSMS. Yet, from our observations, it is now clear that the expertise in CSMS resides, to a greater extent, in the capacity to diagnose inevitable “bugs” properly rather than in the preparation of a “perfect” demonstration in front of the classroom. In fact, what might have initially appeared as “bugs” were not bugs but necessary adjustments for a complex machine. Yet, this community (professor and students) had a spontaneous sense of it: whenever the machine broke down and the professor would ask for help, the atmosphere would change from that of a classroom (with its childish ritual

fighters for less possible efforts and best possible grades) to a positive novice-expert relationship collaborating to solve the problem. In those moments, the students were actively learning about the functioning of this technology and taking responsibility for making it work, but this was not considered a learning experience, just as a moment devoted to helping so that the computer-supported manufacturing could start again! In these moments of breakdown and de-bugging, the traditional border between students and teacher was challenged and the whole process was weary by lack of understanding the diagnosis referring to the causes of “bugs” as a major task to be managed and learned online. Students would concentrate on how to finish the machining on time to catch their train as soon as the school bell would ring. And the teacher would make many efforts for little reward.

A parallel change in the larger landscape impacts the school

While “The Machine” was becoming a nightmare for the whole school, the local economic crisis, induced by these major competitive and technical challenges, encouraged the firms of the area to refuse the traditional economic role of the school. The local enterprises did not want to finance any more mandates to the school and they even asked the state to forbid the school to undertake any financially profitable activity. They were now considering it as an economically unfair competition. The state was to make it a full state school and support all its costs. At first, the staff didn’t mind this pressure: a state status would offer them more security, longer holidays, and so on. But discontent was slowly growing, and professors were becoming bitter: their technological initiatives were not being rewarded anymore and were considered as having nothing to do with the state school plans – they were even perceived as disturbing them!

Lessons learned from these observations

Paradoxes and conflicts are likely to engender new learning (Yamazumi, Engeström and Daniels, 2005). But potential gains in terms of knowledge acquisition are likely to be submerged by a tide of other preoccupations, if special care is put into retrieving this new knowledge and disseminating it.

Retrieving knowledge first requires acknowledging that such a new learning is taking place. “*Acknowledging*” means that knowledge and know-how exist only if they become a conscious reality via social recognition. Second, it requires paying specific attention not only to the gain in knowledge that is produced via this learning, but also to the actors’ own understandings of what is happening: are they aware of any knowledge production? Are they dealing with these activities and their changes in terms of learning and knowledge gains? It may well be that the actors, far from perceiving the events as opportunities for learning, attribute breakdowns to their (in)competencies, or to factors standing out of their reach and that, in consequence, they neglect trying to understand. The retrieval and

transfer of learning, gained during the changes in the activity system, require an understanding of oneself (or of one's community of practice) as an active source of new learning and as a stakeholder of knowledge and know-how. Knowledge exists if individuals and groups maintain some kind of responsibility to retrieve it, which equally implies the responsibility to transmit it and some kind of recognition of one's role and competencies in this circulation of knowledge.

How does one acquire knowledge within change processes? Individuals and groups need special and secure "thinking spaces" (Perret-Clermont, 2004) to reflect upon the cognitive, technical, social and economic events, their meanings and their alternatives. They also need secure spaces to securely test their understandings of the processes involved. But such spaces are rare in schools: the dominant ideology of teaching and learning relies upon a dependence of novices on experts, considered as possessing context-independent knowledge, from which universal solutions can be deduced top-down (Perret-Clermont and Iannaccone, 2005). This epistemological perspective comforts hierarchies, but is very emotionally demanding, especially when supposedly "universal" knowledge fails to apply to the complexity of singular new situations, as is often the case with technological change.

On the contrary, if learning is understood as the result of a mix between, on one hand, experience retrieved from the past offering mediations to decipher present experience and, on the other hand, lessons learned from present inquiry turned towards a creative future, then it becomes clear that learners should be offered learning opportunities that are not the mere "spelled out" transmission of dominant knowledge. Open "thinking spaces" are required for such a learning to occur and to be acknowledged: open but bounded like game-fields (the "ball" has to remain on the field, i.e. thoughts have to concentrate on the matter), in which individuals, groups and communities can test actions and thoughts via trials and errors, debates and argumentation, experiments and investigations. They can, of course, opt to change the field boundaries and the rules of the game (change matter, of zone of enquiry, conceptual tools, etc.) but this, also, has to become an object of thought. These thinking spaces need some kind of "protection": by this we mean, as mentioned above, that the social architecture of these spaces has to allow that actions and thoughts be tested and discussed without taking undue risks (for health, finances, reputation, etc.). Creating such thinking spaces means creating opportunities to promote learning as a research-like process of diagnosing problems, testing hypotheses and understandings, elaborating tentative solutions and checking their impact. In the school, CSMS had created disturbances and bugs. But these new characteristics of the situation were not consciously used as resources for learning and the development of social skills. Yet, in these repairs and breakdowns, we have observed that new relations between staff, students and machine were emerging, creating opportunities for knowledge building and retrieval (for example, bugs and other disturbances were creating new thinking spaces in order to de-bug the machine, adjust or fix it). But these were not thought of as moments of knowledge production and learning, nor were they acknowledged as central in the training: they were merely seen as a

loss of time. The significance of these practices had to be made visible by the researchers.

Concluding comments

A technological change is not only a technical change. It induces other changes for the concerned individuals, groups and society. Human–artifact interdependencies are quite clear when observing such a learning scene. The arrival of a new artifact created notable changes in the budget of this small school, but also architecturally and socially. Quality norms as well as the curriculum, timetables and other organizational aspects were changed. The role of the expert and the challenges to the novices were new, in particular concerning social interactions in collaborative work and learning. And all the actors were under strain, trying to give meaning to the changes. They felt threats on their self-image and professional identity and insecure about their competencies.

Such a technological change doesn't come alone. Simultaneously, and by various routes, the global technical revolutions induced by computer-supported technologies were threatening as well the market and the local socio-economical practices and networks. It was very difficult for the actors of the educational field, when left alone, to attribute the changes and difficulties not only to the new machine and themselves, but also to parallel social and institutional changes. Anxiety and a feeling of helplessness were discouraging students and staff as insecurity grew without adequate meaning-making strategies. Transitions are difficult to manage when identity, competencies and meanings are threatened simultaneously (Zittoun, 2007).

Boundaries were being challenged: was it reasonable to fight to preserve traditional know-how? How much is it necessary to change habits and identities to develop (ill-identified) new skills? Is the school's autonomy, and in particular its economic autonomy, important? Will the contact with the local firms be lost and is this a problem? All these questions are still open for the individual learner and professor, but also for the school and its director, as well as for the cantonal and federal states that are reorganizing the dual vocational system.

In this study, the entry of a cumbersome new artifact (CSMS) into the school was considered by the researchers and analyzer (a "critical event"). It has opened a window on the complexity of the processes involved in the activity of teaching and learning micro-mechanics in the Jura Mountains. By following, week by week, the arrival of this new technology, it has been revealed how institutions, individuals and groups are affected. Representations, norms, practices and identities had been shaped by decades of activities with other artifacts. None seem to have made demands as complex as this one. The school had imagined that it was just a matter of "taming" one more new machine and adapt the curricula accordingly. But, in fact, training for CSMS was threatening the linear tradition of step-by-step teaching.

The school was in the course of being reorganized by state authorities (themselves looking for international recognition in Europe), in order to conform to

the new state regulations. All the attention was laid on curriculum, teacher status (bringing them back to the norms of “normal” teachers and leaving no more space for entrepreneurship), timetables and evaluation. The goal of the school’s activity was gradually becoming that of producing outcomes such as: numerous students with standardized diplomas, successful examination records, low costs, and so on. As a result, the enthusiasm around the CSMS or even the interest in it declined. The machine was not becoming the expected boundary object at the centre of an expanding process. The teacher in charge of the CSMS was left alone (alone, with the researchers). In spite of the tradition of engaging professors in development and students in real industrial tasks, this was abandoned in favor of a top-down new management mode. Students’ desire to catch the train in time at the end of the day and other similar attitudes started prevailing over other dimensions of the activities in the practical training sessions devoted to computer-supported manufacturing. As a consequence, students seemed to restrict themselves to following instructions in order to get rid of the exercises on the CMCS as soon as possible – even developing tricks to “feed data” into the machine so that it would proceed (even if it was at the cost of poor performance and no learning).

A final consideration raised by this study is that the research process matters. For instance, what is meant behind the terms “student” or “teacher” cannot be taken for granted. An informed cooperation between researchers and the different actors of the activity systems is necessary. In the present case, our main task, as researchers, has been to describe the on-going activities, their changes as well as the adaptations and learning that have occurred; to contribute to the elaboration of thinking tools (micro-models and micro-theories) in order to retrieve the information linked to various events; and finally to develop communication that could help actors and researchers in the reflective and critical processes of knowledge building on what teaching and learning had meant and what it was becoming. Research thereby becomes a cooperative activity between “scientists” and “laymen,” both groups reflecting on the impact of their actions on their social, natural and technical environments (Latour, 2005).

To some degree, the school has “absorbed” this jointly created knowledge. It has used it to communicate, adapt the teaching (in particular in the practical training sessions devoted to computer-supported manufacturing), save face, preserve its identity, understand changes and stakes. In the meantime the CMCS stopped being considered affordable by the technical school and the local enterprises. Some of the staff, building upon the lessons learned, moved out to undertake new jobs, such as consultants, experts for the teacher training centres, and so on. Others found that the newly acquired status of a state teacher was rewarding and the whole school merged with another technical school, but this is not the end of the story: the processes described are also at work in the enlarged teaching environment on a greater scale.

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