# LEARNING, WORKING AND IMAGINING

## TWELVE STUDIES IN ACTIVITY THEORY

Yrjö Engeström

*To Ritva, Jyri and Tatu*

# CONTENTS

# PREFACE

This book is a collection of papers from a period of nearly ten years. Each one of the papers is an attempt to apply some aspects of activity theory in concrete research. Even though each paper draws on rather specific empirical data, the book as a whole is about activity theory as a general and interdisciplinary approach.

Discussions around activity theory have tended to become purely conceptual. However, the very epistemology of activity theory is aimed at transcending the boundary between theory and practice. 'Individual and Societal Transformation' was the theme chosen for the Second International Congress of Activity Theory (May 1990, in Lahti, Finland). Such a choice is no accident. The transformations taking place on our planet are a tremendous challenge to social and behavioral scientists. This book may be read as a quest for a practice-oriented and interventionist interpretation of activity theory.

A collection like this is also a biographical statement. The book is divided in three parts: learning, working, and imagining. These three have been the central foci of my research.

In the early part of the 1980s, I concentrated on the problem of formation of theoretical concepts in school learning and instruction. The first part of the book contains three articles from that period.

During the latter part of the 1980s, I have concentrated on work as activity. The second part of the book contains six articles from that period. To provide for continuity and consistency, I have chosen those six articles so that they all deal with one and the same large research project.

The third part of the book contains three articles that deal with problems of imagination and play, each from a different angle. This was the main focus of my research during the late 1970s. But it has remained as an important strand of my thinking ever since,

sometimes embedded in in other topics, sometimes emerging as a sharply delineated issue of its own.

I have not been able to avoid overlap and repetition in the articles. Especially in the older papers, some parts seem outdated and naive when I read them now. That is a price one must pay when publishing a collection like this.

Five of the twelve papers were written jointly with my colleagues and collaborators Katherine Brown, Ritva Engeström, Jouni Helenius, Timo Kallinen, Kirsi Koistinen and Osmo Saarelma. Especially Ritva Engeström's contributions have been crucially important. The origins of each paper are listed in the bibliographical note after the preface.

I am grateful to my colleagues, collaborators and students for what they have done and are doing, creating shared activities of research and intervention that expand beyond the traditional limits of the academia.

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Solana Beach, California
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## BIBLIOGRAPHICAL NOTE

Chapter 1 was first published in 1984, in the volume *Fysik i skolen: Problemer og perspektiver*, edited by H. Nielsen and P. V. Thompsen (Aarhus: Aarhus Universitet, Det fysiske Institut).

Chapter 2 was first published in 1982 in Finnish, in the volume *Opetuksen ja sen evaluoinnin tutkiminen*, edited by P. Hakkarainen (Jyväskylä: Jyväskylän yliopisto, Kasvatustieteellisen tutkimuslaitoksen julkaisuja 325).

Chapter 3 was first published in 1987, in the volume *Cognitive Processes in Student Learning: Research in Education and Cognitive Psychology*, edited by J. T. E. Richardson, M. W. Eysenck and D. W. Piper (London: SRHE & The Open University Press).

Chapter 4 was presented in 1987 in a conference organized by Jean Lave, Seth Chaiklin and Roger Säljö in Stenungsund, Sweden. It is being originally published in this volume. A different version of the paper is to appear in a volume edited by S. Chaiklin and J. Lave (Cambridge: Cambridge University Press).

Chapter 5, authored jointly with Ritva Engeström, is originally being published in this volume.

Chapter 6, authored jointly with Ritva Engeström, Jouni Helenius and Kirsi Koistinen, is originally being published in this volume.

Chapter 7, authored jointly with Ritva Engeström and Osmo Saarelma, was first published in 1988 in *Proceedings of the Conference on Computer-Supported Cooperative Work*, Sept. 26-28, 1988, Portland, Oregon (New York: The Association for Computing Machinery).

Chapter 8 is originally being published in this volume.

Chapter 9, authored jointly with Katherine Brown, Ritva Engeström and Kirsi Koistinen, was first published in 1990 in the volume *Collective Remembering*, edited by D. Middleton and D. Edwards (London: SAGE).

Chapter 10 was first published in 1985 in the volume *Impact of the Threat of Nuclear War on Children and Adolescents*, edited by T. Solantaus, E. Chivian and M. Vartanyan (Boston: IPPNW).

Chapter 11, authored jointly with Timo Kallinen, was first published in 1988 in *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition*, Vol 10, p. 54-67.

Chapter 12 was first published in 1989 in *International Journal of Mental Health*, Vol. 17, No. 4, p. 29-41

# 8. WHEN IS A TOOL? MULTIPLE MEANINGS OF ARTIFACTS IN HUMAN ACTIVITY

## ARTIFACTS IN ACTIVITY

Donald Norman (in press) suggests that we may take two views of artifacts: the system view and the personal view. Under the former, the system is composed of the person, the task, and the mediating artifact. The artifact enhances the performance of the entire system. Under the personal view, the mediating artifact changes the nature of the task the person is facing.

The system view is typically taken by the observer, the designer, and the researcher. The personal view is taken by the user, the subject, the actor.

In his emphasis on the mediating role of artifacts in activity, Norman goes beyond the notions of 'situation model' and 'system model' proposed by van Dijk and Kintsch (1983) His approach may be seen as one important bridge between cognitive science and culturally oriented mediational theories of mind, such as those of Cole (in press) and Wertsch (1985)

In this paper, I will argue why it is vitally important for the actor to take the system view and for the researcher to take the personal view. This does not imply an attempt to merge or 'bridge the gap' between the two views in the sense often advocated by cognitive and computer scientists worried about difficulties in human-computer interaction I argue for switching between multiple views

My argument is rooted in the cultural-historical theory of activity in which human activities are seen as complex systems under constant change and self-organization (Leont'ev, 1978, 1981) My data and examples are taken from one activity system, namely from the work activity of a health center providing primary medical care My research group studied this activity system from 1986 till the end of 1989, using field observations, extensive interviews, and

videotaped patient consultations (see Engeström, 1989; Engestrom, in press; Engeström & al., in press).

Two conceptual extensions are necessary before I can begin to elaborate my argument. First, the triadic structure of the system presented by Norman (person - artifact - task; or subject - tool - object) must be extended to account for the socially distributed and interactive nature of human activity. We may see the triadic structure as depicting *individual actions* which are the visible tip of the iceberg of *collective activity*. The hidden bottom part of the activity system consists of (a) the community sharing the same general object (e.g., the different health professionals sharing the same patient population), (b) the division of labor between the members of this community (i.e., what is done by whom with regard to the shared object), and (c) the rules regulating the actions legitimately taken by the actors (typically rules pertaining to issues of time and money). When the bottom part consisting of these three components is added to the original triadic structure, we get the following model of human activity (Figure 8.1; for further grounding of the model, see Engeström, 1987).
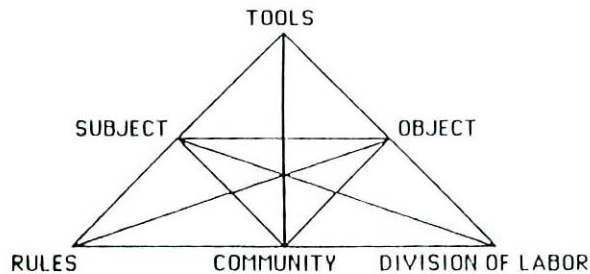


Figure 8.1. The human activity system

The second conceptual extension has to do with the hierarchical nature of human activity and with the representational function of artifacts. Leont'ev (1978; 1981) distinguishes between three levels in human activity. *Activity* is the molar unit, collective in nature and driven by a complex motive of which the individual actors are

seldom aware. Activity manifests itself in the form of goal-oriented individual *actions* in which the subject is consciously aware of what he or she is trying to accomplish. Actions in turn rely on automatic *operations*, dependent on the conditions at hand. There are continuous two-way transformations between these levels. Actions are internalized and become automatic operations through repeated practice. On the other hand, actions may also be expanded into novel collective activities.

Wartofsky (1979) suggests an analogous three-level hierarchy of artifacts. Primary artifacts correspond to the level of operations where the subject is essentially unaware of the means he or she is using. Secondary artifacts originally serve the purpose of preserving and transmitting skills in the production and use of primary artifacts. Thus, secondary artifacts are representations of the primary level, "reflexive embodiments of action or praxis, in the sense that they are symbolic externalizations or objectifications of such modes of action - 'reflections' of them, according to some convention, and therefore understood as images of such forms of action - or, if you like, pictures or models of them" (Wartofsky, 1979, p. 201). In other words, whenever we contemplate on the nature and use of a tool, we activate and manipulate secondary artifacts, internal and external representations concerning that tool. Being seen through these representations, the tool itself in some sense becomes a secondary artifact. This transition is typically observable when a smooth, automatic flow of operations is interrupted because of a problem, forcing the subject to enter the mode of goal-directed action and reflection on tools (see also Bunn, 1981, p. 24).

Wartofsky further suggests a class of tertiary artifacts.

"(...) we may speak of a class of artifacts which can come to constitute a relatively autonomous 'world', in which the rules, conventions and outcomes no longer appear directly practical, or which, indeed, seem to constitute an arena of non practical, or 'free' play or game activity. (...) So called 'disinterested' perception, or aesthetic perception, or sheer contemplation, then becomes a possibility; but not in the sense that it has no use. Rather, in the sense that the original role of the representation has been, so to speak, suspended or bracketed." (Wartofsky, 1979, p 208.)

Wartofsky's tertiary or imaginative artifacts - novel works of art, socio-political visions, scientific paradigms, religious creeds - are

typically artifacts that give indentity and overarching perspective to collective activity formations.

## WHY THE RESEARCHER NEEDS THE PERSONAL VIEW

A tool always implies more possible uses than the original operations that gave birth to it. As Leont'ev (1981, p. 215) puts it, the tool is the first "rational generalization". Thus, the presence of a tool in an activity system does not mechanically determine the way it is actually used and conceived of by the subjects.

This polysemy or multi-voicedness - the socially distributed personal view - becomes an objective challenge for a researcher who wants to make sense of *tools in use*, not just tools as ideally designed. This approach seems a necessity for applied cognitive science (Bannon & Bodker, in press). Suchman (1987) demonstrates this in her analysis of human-machine communication, and Hutchins (1988) in his analysis of team navigation. In cognitive anthropology, Dougherty and Keller (1985) and Gatewood, in cognitive psychology Ghiselin (1987) have demonstrated the the practice-bound and dynamic nature of conceptual structures as tools of human action.

In clinical work, the medical records are a central tool. A widely used textbook for general practitioners characterizes this tool as follows.

"The record is the cinderella of the doctor's tools. Too often the only use that is recognized is that of *aid-memoire*. Records provide a fascinating opportunity to analyse, compare and then predic clinical, emotional and behavioural patterns." (Hodgkin, 1973, p. 81.)

There is also another interpretation of the function and use of medical records.

"The chart today stands at once as product and symbol of highly developed rational systems, specialization, and bureaucratization in medicine. Is is impersonal. A dispassionate statement of a line or two can forecast death, indicate radical and maiming surgery, or signify reprieve for an anxious patient and relatives. (...)
The chart is more than nuisance, more than a vestigal remain, and more than red tape. The written form is a means through which values are affirmed and articulated in the modern hospital. It is an instrument for socialization of newcomers. It can confirm the group and its medical standards. It holds together the messages and recommendations in

the complex, specialized enterprise mounted on behalf of the patient." (Mumford, 1970, p. 139-140.)

The first quote talks about 'a fascinating opportunity', the second about socialization and coordination in bureaucracy. The first interpretation stems from the activity context of traditional general practitioners, displaying minimal division of labor. The second interpretation stems from the hospital context with complex division of labor.

The Finnish health center stands somewhere between these two points. It is a relatively complex and bureaucratic setting of group practice, employing a number of professional groups, such as general practitioners, nurses, physical therapists, laboratory and X-ray personnel, psychologists, etc. On the other hand, the doctors are *general* practitioners, not specialists, and the majority of patients have problems which are not very serious or life-threatening in biomedical terms.

In the arly stage of our study, we conducted in-depth thematic interviews with all the 16 general practitioners working at two health stations of the health center of the city of Espoo. These two stations serve a district with some 40 000 inhabitants. The health center uses a computerized system of medical records, called Finstar, a version of the American COSTAR, originally developed in Massachussets General Hospital (see chapter 7 in this volume). Using the following questions, we asked these doctors to explain their notions of the medical records.

-What is essential in the medical record? What should be found in it?
-How do you use the information contained in medical records in your work?

The findings are summarized below in table 8.1

Table 8.1
Conceptions of medical records among general practitioners

| Type of conception | Number of answers | Key expressions |
|---|---|---|
| 1. Medical record as doctor's personal memory aid | 1 | I ascertain that I remember it correctly |
| 2. Medical record as effective means of storing concise biomedical data | 9 | Traditional classification; briefly; concisely; easily; swiftly; visits |
| 3. Medical record as a means for storing social background data and numbers of visits | 1 | Social matters; number of visits to health center |
| 4. Medical record as reliable shared storage of patient data | 1 | Up to date; reliable; accurate; wherever the patient is treated |
| 5. Medical record as support for doctor-patient relationship and as means for understanding the patient | 2 | All data is valuable, important for the patient; doctor-patient relationship, same wavelength; soft data; humane; patient worries |
| 6. Medical record as means for creating an overall picture and as caregivers' shared storage of patient data | 2 | Meaningful picture; cannot be broken down; red thread; medium for data transmission; common language; considering other colleagues |

The different conceptions characterized in table 8.1. have counterparts and origins in different historical forms of clinical practice and clinical theory (see Armstrong, 1983; Arney & Bergen, 1984; Shorter, 1985). Type 1 corresponds to the ideal-typical activity of the lonely *craftsman* doctor who uses medical records as idiosyncratic personal memory aids. Types 2, 3 and 4 seem to correspond to different aspects of the ideal-typical *rationalized* activity of doctors in bureaucratic medicine: efficiency, statistics, and reliability. Type 5 corresponds to ideal-typical *humanized* forms of medical work, focusing on mutual understanding and honoring the patient's perspective. Finally type 6 seems to go beyond both the rationalized and the humanized, seeking simultaneously cognitively meaningful structure and communicative use of the medical records.

Thus, the personal view of an artifact is not a monolithic, singular phenomenon. To the contrary, the personal view must be understood in plural. It consists of alternative historically grounded representations which can be understood and appreciated against the background of their cultural evolution.

These parallel historical layers of the personal view are not limited to the realm of conceptions. They manifest themselves also on the actual choice and use of tools. Figure 8.2 displays a nice example. One of the doctors works at the 'electronic text' (Zuboff, 1988) of his terminal. At the same time, the terminal functions as a board on which the doctor has pasted a number of handwritten notes concerning specific work tasks and issues of patient care. The old and the new tool exist literally as parallel and partially overlapping physical layers of representation.
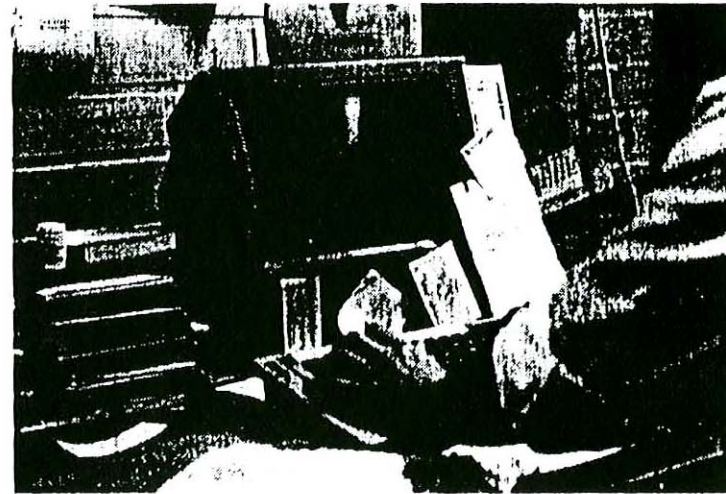


Figure 8.2: Two layers of a doctor's tools

Thus, the multi-voicedness of the personal view comes through even in the conceptions and actions of one and the same individual. In the interview answers summarized in table 8.1., the doctor depicted in Figure 8.2 represented the humanized conception of medical records (type 5). He emphasized the importance of the computerized records in the following way, quite typical to the humanized conception.

Doctor XV: One important point is that if the patient is less familiar to me, I at least know [from the records] whether I've met the patient before or not. (...) And from the viewpoint of the patient, of the patient-doctor relationship, it is awfully important that if the patient has seen the doctor before, so the doctor demonstrates that he knows the patient, even if he doesn't actually remember what has been discussed during the previous visit. If the doctor greets a patient whom he as already seen as if the patient were a stranger, that probably makes the patient quite insecure and distrusting. That's why I think it's awfully important to be able to check whether I've seen the patient or not.

An emphasis on the patient's viewpoint and feelings is a crucial feature of humanized and holistic forms of medical thinking and practice. However, the use of the idiosyncratic paper notes alongside with the computerized records suggests that there may also be a strong component of craft orientation in this doctor's personal view. This gets support from other parts of this doctor's interview.

Interviewer: What kinds of tools do you use in your work?
Doctor XV: I must have a room. And it must be sufficiently large and functional and cosy. In other words, a place, that's the first one. And then... then tools. Well, of course I am the most important tool myself. That is, eyes, ears and mouth, hands, sense of smell. Actually I must use these biological means quite a lot as tools.

A fixed personal workspace as well as one's own self and bodily organs considered as central instruments are classical examples of craft orientation. The ancient craft orientation and the much more modern humanized orientation are here, like in many other cases, expressed and applied by one and the same subject.

The system - in this case the health center - would not function without the subjects and their representations. They are integral constituents of the system, not arbitary additions to it. Therefore, to disregard the historically evolving, multiple and distributed personal view is to misconstrue the system, to create an oversimplified system view.

## TOOL OR RULE?

Sometimes medical records are not regarded as tools at all. The initial reaction of one of our subjects is a case in point. When asked about her tools as a physician, she named her own personality as the central tool. She was then specifically asked about the medical record as a tool.

Doctor XIV: Is it a tool? No, I don't think it is. Tool, I don't see it as a tool. You do something with a tool. But there you only store the medical record. It is, in the sense that you see the laboratory tests and results in it. But it is not a tool in my opinion. Or maybe I don't understand that word right.

The subject first denies seeing the medical record as a tool, then hesitates and admits that it may function as a tool in some restricted sense, then denies the idea again, and finally qualifies the denial by questioning her own understanding of the term 'tool'. Billig & al. (1988, p. 144) point out the potential importance of expressions like this.

"The presence of contrary themes in discussions is revealed by the use of qualifications. The unqualified expression of one theme seems to call forth a counter-qualification in the name of the opposing theme. There is a tension in the discourse, which can make even monologue take the form of argumentation (...)."

What is behind the denial of the 'toolness' of the medical record? If it is not a tool, what is it? Another subject of ours articulates the problem more extensively. He first names several technical weaknesses in the Finstar system, then continues as follows.

Doctor XVI: Even all these problems would be somehow understandable and acceptable if this were used for the task in which this is good, namely for processing and organizing and selecting and treating statistically the data. It is used up there in the administration for some administrative statistics. But a regular physician gets no feedback concerning his own work, which is quite absurd.

In other words, the medical records system is conceived of as a bureaucratic *rule* rather than a tool. It represents an administrative demand from above. This obscures its tool character.

Such a displacement and ambiguity between the tool and the rule is not uncommon. To the contrary, it is typical to forms and administrative procedures in a variety of settings. This

displacement is not just a subjective failure to grasp the tool. It is a built-in feature of the system. Medical records and the associated recording procedures do objectively function both as tools for the practice of medicine and as restrictive rules imposed upon the practitioners. To understand this feature of the system, the researcher needs the personal view of the actors.

JoAnne Yates (1989) has analyzed the transformation of managerial control around the turn of the century through the invention of various forms of systematic record keeping, cost accounting and internal communication.

"Frequent routine reports communicated to higher levels the amounts and types of work done on various orders. (...) Similar developments in cost accounting constituted a major technique of systematic management." (Yates, 1989, p. 13)

The computerized medical records are a belated example of this managerial effort. In the case of the health center of Espoo, the FINSTAR system was from the beginning conceived of as a tool for the central administration. The administrative interest is *cost-efficiency and control of the use of resources*. In a public service, this interest represents the *exchange value* aspect of the tools, corresponding to the more clearcut profit motive of a private company. Certainly the computerized records were also meant to help the physicians  enhance the quality of their clinical work. This interest represents the *use value* aspect of the records. This duality of purpose is the primary contradiction built into the the computerized records from the very beginning. It is this duality that gives rise to the displacement and ambiguity concerning the the 'toolness' of the records. Such feelings are expressions of alienation from the means of labor, generated by the internally contradictory character of those means.

This primary duality also penetrates the daily actions of the physicians. It manifests itself in the form of the conflicting tendencies of using the records *either* as means of restrictive control (identifying the 'inappropriate' or 'excessive' use of the services) and acceleration of the work pace *or* as means of integrating information holistically and collaboratively with patients and colleagues. In the former case, the physician actually assumes a managerial control role in relation to the patients and to

him- or herself, a role that Arney and Bergen (1984) vividly characterize as the 'management of living'.

## TOOL AND OBJECT

Tools are dependent on the object of actions. The object is a transitional being. It is both "anything presented to the mind or senses" and "an end or aim" (Webster's Dictionary, 1987, p. 257). In other words, the object is both something given and something anticipated, projected, transformed, and achieved. In the transformation of the object, also the tools, or mediating artifacts, are transformed.

When the physician meets a patient, the external features of the patient present themselves as the initial form of the object. Out of this 'raw material' the first impression of the patient is formed (Figure 8.3).

In this first step of object formation, the physician's largely unconscious expectations and preconceptions function as mediating artifacts. However, before the patient enters the consultation room, the doctor habitually glances at the initial data on the patient in the computer screen: name, age, sex, previous visit. The expectations are thus 'modulated' or 'filtered' by these data entries. What entries are searched and found depends in turn largely on the doctor's algorithms and routines for using the Finstar system of computerized records.

This step of object formation is affected not only by the object and the mediating representations but also by the rule that draws a strict demarcation line between acute visits (without appointment) and visits with appointment. The acute visit is supposed to be short in duration and concentrate on the acute complaint only. The appointment visit is allowed more time and any number of complaints may be handled during such a visit. In our 1986 sample of 85 consultations, the average acute visit lasted 517 seconds while the average appointment visit lasted 940 seconds. This division is a systemic feature of the situation, but its impact can only be understood if we take  seriously the personal view of the subject.
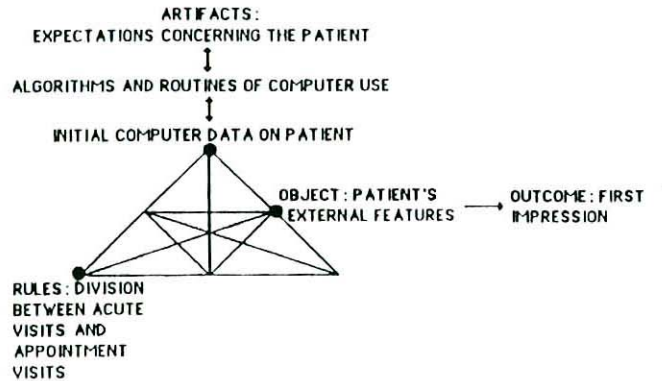
ARTIFACTS:
EXPECTATIONS CONCERNING THE PATIENT
↕
ALGORITHMS AND ROUTINES OF COMPUTER USE
↕
INITIAL COMPUTER DATA ON PATIENT

OBJECT: PATIENT'S EXTERNAL FEATURES → OUTCOME: FIRST IMPRESSION

RULES: DIVISION BETWEEN ACUTE VISITS AND APPOINTMENT VISITS

Figure 8.3: The first step of object formation in the physician's consultation work

*Interviewer:* Did you get any Information on this person from the computer?
*Doctor II:* Not really. She came as an acute case.
*Interviewer:* Yes.
*Doctor II:* The very first patient. And I guess the list said 'fever'. In the medical record, I guess I glanced at it, there was that she has had a number of different illnesses, so I didn't go through it. It would have taken a lot of time.

Typically, the doctor may perceive - either in the patient or in the initial computer information - something indicating that the patient is coming as an acute case without sufficient medical justification. This easily triggers an expectation of 'misuse' that may have a pervasive effect on the subsequent process of the consultation.

From the first impression, the physician moves to the formation of a meaningful pattern, a more orderly representation of the patient's problems (Figure 8.4). This typically takes place in the history taking phase of the consultation.

Now the doctor uses the patient's accounts as well as associated records and documents (medical records, previous test results, etc.) as primary means for constructing the meaningful pattern. However, the doctor elicits those accounts with the help of a learned method

of history taking, a method that often bears a resemblance to the corresponding presentations in medical textbooks. Finally, the doctor makes sense of the accounts with the help of some more or less consciously held explanatory model of illness (see Kleinman, 1980; Helman, 1985).
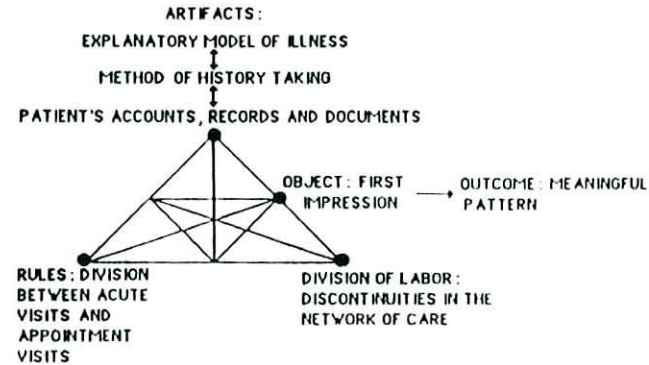
ARTIFACTS:
EXPLANATORY MODEL OF ILLNESS
↕
METHOD OF HISTORY TAKING
↕
PATIENT'S ACCOUNTS, RECORDS AND DOCUMENTS

OBJECT: FIRST IMPRESSION → OUTCOME: MEANINGFUL PATTERN

RULES: DIVISION BETWEEN ACUTE VISITS AND APPOINTMENT VISITS

DIVISION OF LABOR: DISCONTINUITIES IN THE NETWORK OF CARE

Figure 8.4: The second step of object formation in the physician's consultation work

The rule distiguishing between acute visits and appointment visits still plays an important selective role in this step. An excerpt from a physician's interview illustrates this. During an acute visit where the chief complaint was high temperature, the patient also presented another problem: she had lost 17 kilos of weight during recent weeks

*Interviewer:* What did you think when the patient talked about losing weight?
*Doctor II:* Well, I thought first of all that it doesn't belong to this situation. It is an important thing In itself, but not with regard to the reason she came for, now that she's been sick a little over a week. So I count and classify them without doubt as two separate phenomena. One is losing weight and the other is this acute situation I consider it very probable that they are two separate things. (...) My own idea in this situation was that I'll write that down, too, and It will be scrutinized In J's hospital, or by me later. But first we'll take care of this high temperature, these high test results, we'll investigate this situation. And then, it's clear, losing 17 kilos, that has to be looked into at some stage.
*Interviewer:* You did write It down, though?

*Doctor II:* I guess it went into the Finstar, and then it went into the referral.
*Interviewer:* But you did not comment on it?
*Doctor II:* I did not comment on it, also because I.... I did not want to, because it would prolong the consultation to an absurd degree, and it was an acute visit. We've got such a routine within which these things are steered.

In this step, also the division of labor, another system component, may quite visibly influence the physician's way of constructing the object and utilizing artifacts. This occurs especially when the doctor tries to create an overview of tests, examinations and care provided by other practitioners. Discontinuities or gaps in the communication between the patient's various providers often manifest themselves in the form of missing documents which would be vitally needed in order to complement the patient's accounts.

*Doctor XIX:* I wanted to find the EKG film. But there are no old tapes there. They can't find it. They can't find any information about that carditis which is the most important thing here. I mean, what is the situation, has it left a permanent heart insufficiency which might be a risk factor concerning fevers, and needs to be treated actively. That has impact on this very situation. I found very unsatisfactory information on that. I also want to say that in that record from J's hospital (...), the text is very ambiguous.

The meaningful pattern is eventually transformed into a diagnosis and a prescription for treatment. The physician accomplishes this through examination and testing (Figure 8.5).

The doctor's choice and interpretation of examinations and tests is guided by a hypothesis concerning the patient's problem. But the use and outcomes of tests and examinations depend on the mastery of procedures and algorithms pertaining to those particular tests and examinations. Interestingly enough, artifacts like the official classification of diseases did not seem to play an important role in this step.

Again, the rule exerts influence on the formation of the object and on the choice of the artifacts. For example, when the patient comes as an acute case but the doctor is not sure of the exact nature and scope of the problem, the doctor often refers the patient to further examinations in a hospital, thus avoiding a prolonged examination within the framework of the initial visit.
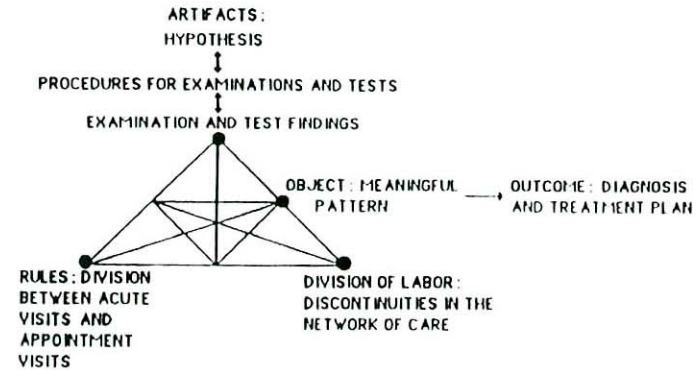
Figure 8.5: The third step of object formation in the physician's consultation work

*Doctor II:* Let's say that, obviously, if you referred only such cases in all of which you find something really alarming, you'd probably work too far here. In other words, there are situations in which you yourself are almost sure that there is nothing serious here, but still you refer.

The patient of whose case the above physician is talking received a referral to hospital examinations. Her complaint was a prolonged high temperature. In her interview, she commented on the referral as follows.

*Patient 3:* Well, you always get such a feeling, if you get a referral to hospital, that it's something more serious than I thought. That it isn't just a flu, that there may be something else there. But maybe I am a bit used to it, having got so often a referral here in other situations. So I have a little bit such a feeling that they somehow want to transfer the responsibility forward.

The referral functions here as a tool that actually enables the doctor to *avoid* the formulation of diagnosis and treatment. This kind of tool use may be prompted by the rule that creates time pressure. But it is also intimately connected to a specific kind of division of labor. In this case, the division of labor is fragmented in such a way that no doctor has an explicit responsibility for a given set of patients. Thus, a referral - as well as other means of postponement - may be effectively used to pass the problematic patient on to whoever happens to be the next practitioner receiving the patient. On the other hand, under such a division of labor, even a doctor who

strives for a long-term relationship of care and tries to employ corresponding artifacts may find that the built-in discontinuity in the system renders such efforts futile.

Finally, the patient's problem-as-diagnosed is treated and transformed into an altered state of health (Figure 8.6). This step takes place in the form of actual treatment, be it medication, sick leave, or some other type of therapy.

In this last step of object formation, the doctor uses a variety of guidelines, instructions and algorithms to steer the selection and implementation of treatments. In prescriptions, such algorithms are actually translated into instructions for the patient. The meaningful pattern now functions as the overall representation against which the course of treatment is justified and evaluated.

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                    ARTIFACTS:
                 MEANINGFUL PATTERN
                         ↕
  INSTRUCTIONS AND ALGORITHMS BEHIND SPECIFIC THERAPIES
                         ↕
     MEDICATION, SICK LEAVE, OR OTHER THERAPY
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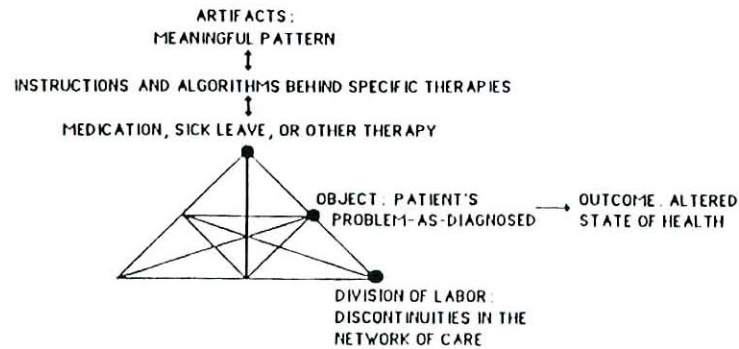
Figure 8.6: The fourth step of object formation in the physician's consultation work

The rule has no immediate effect on this last step of object formation. But the division of labor has. Medications need to be renewed and their effects must be followed up. The treatment often involves multiple providers - other doctors, physical therapists, nurses, etc. Under a fragmented and discontinuous division of labor, gaps and disruptions tend to appear in treatment almost inevitably (see Strauss & al., 1985, chapter 7). The case of a male patient in

his 20's illustrates this. The physician referred the patient to physical therapy to be treated for tension neck. The physical therapy nurses found that the patient behaved disruptively. They removed him from group therapy, suspecting serious mental problems.

*Interviewer:* Did you get any information concerning this patient?
*Nurse:* No, only what was written, like just the test results. And I guess in the examination, he had been OK.
*Interviewer:* You mean the doctor's examination?
*Nurse:* Yes, the doctor and also the physical therapist had examined him before his was placed in this group. So he was supposed to be placed directly. So it went.
*Interviewer:* So the physical therapist had gotten a referral from the doctor?
*Nurse:* Yes.
*Interviewer:* The information you read, was it written by the doctor?
*Nurse:* No, they are written by the physical therapist.
*Interviewer:* Did you read anything written by the doctor?
*Nurse:* Well, only what she had written into our referral.
*Interviewer:* And it contained nothing of this type?
*Nurse:* No, it didn't.

The physical therapist tried to call the doctor but she was on vacation. So she sent a written feedback note to the doctor.

*Interviewer:* What was the content of that message? Do you remember what it was, did you hint at psychic problems?
*Physical therapist:* I don't remember exactly what we wrote. Anyway, something about this behavior, that it was strange here in physical therapy. Something like that. I don't remember very exactly.
*Interviewer:* Yes.
*Physical therapist:* We did not quite use the word 'psychic' or anything similar, because we cannot stigmatize like that.

In her interview, the doctor mentioned having received the feedback note from the physical therapy. But she did not recall anything requiring special attention in the note, and the note had no noticeable effect of the further course of the therapy.

The four steps of object formation presented above give a schematic picture of the continuous transformations in the artifacts typically employed in clinical work. Wartofsky suggests that we differentiate between primary, secondary and tertiary artifacts. The analysis above suggests a modification of this hierarchy. Wartofsky's secondary artifacts may be understood as algorithms or rules directly guiding the use and formation of primary artifacts. These are readily found in each of the four steps. However, there are also expectations, explanatory models of illness, hypothesis, and

meaningful patterns. These are too narrow and specific to be Wartofsky's tertiary artifacts - but too general to be secondary artifacts in the above mentioned meaning.

It seems plausible that we can differentiate between two types of secondary artifacts. The more general type tells us why the object behaves as it does and thus justifies the selection of a certain primary artifact. This type may be called 'why' artifacts. The more specific type tells us how a certain object shall be handled with a corresponding primary artifact. This type may be called 'how' artifacts. Following this logic, the primary artifacts are 'what' artifacts. The hammer as a primary artifact functions as means of identifying objects to be hammered (e.g., nails, but also other potential objects-to-be-hammered; just watch a child with a hammer in his hand, looking for objects). The artifacts identified in the four steps of clinical object formation are summarized accordingly in table 8.2.

Table 8.2.
Artifacts found in general practitioners' consultations

|  | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| 'Why' artifacts | Expectations concerning the patient | Explanatory model of illness | Hypothesis | Meaningful pattern |
| 'How' artifacts | Algorithms and routines of computer use | Method of history taking | Procedures for examinations and tests | Instructions and algorithms for specific therapies |
| 'What' artifacts | Initial computer data on the patient | Patient's accounts, records and documents | Examination and test findings | Medication, sick leave, or other therapy |

The primary 'what' artifacts are usually fairly easy to notice and define as external physical entities: marks on the computer screen; patient talk and associated documents; test results and examination findings expressed in numbers or conventional classifications; and

pills, medicine bottles or certificates for sick leave. The 'how' artifacts are partly visible and external - for example, standard instructions for specific therapies are often expressed in handbooks and transmitted to the patient in condensed written form. Smilarly, routines for using the Finstar computer system can be found in manuals. But the internalized personal versions of these algorithms and procedures remain invisible, to be reconstructed by inference from the subject's operations and explanations. Finally the 'why' artifacts are the most elusive in the sense that their physical form is not easy to pin down. However, even mental explanatory models are material in the sense that they are derivations and internalizations of socially shared cultural patterns of thought and communication, commonly stored and transmitted in texts. And they are externalized time and again through practical actions, gestures, words, and symbols.

There is a further general point to be learned from the above presentation. Artifacts are not only evoked and employed according to the nature of the object and the action to be performed on it. Their selection and formation is simultaneously molded by the rules and the division of labor characteristic to the activity system in which the actions take place. Rules and division of labor are relatively constant, systemic features of the activity.

## TOOLS AND COMMUNITY

Above, I have examined tools as transitional, fluid entities. This is the form in which tools appear in the flow of individual actions. But tools have also a more stable and communal aspect. In the health center, laboratory and X-ray facilities are typically such tools. Practically all members of the multi-professional community acknowledge them as basic tools, almost as utilities. Yet regular doctors, nurses and other clinical personnel use these tools only indirectly, mediated by specialized personnel who actually operate the laboratory and X-ray equipment.

Star (1989) discusses various types of communal intellectual tools which she calls 'boundary objects'.

"Boundary objects are objects that are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site-use.
Like the blackboard, a boundary object 'sits in the middle' of a group of actors with divergent viewpoints." (Star, 1989, p. 46)

The question of stabilization and collective recognition of tools becomes crucial when the activity system has to change its way of functioning. In training and facilitating learning in organizations, the classical problem is: how to guarantee that the new concepts and skills taught to the personnel will actually be used in practice. Or: how to overcome the 'folder phenomenon', the familiar situation where the learners taking a course acquire a folder full of new ideas - and as they return to their work, those ideas remain in the folder. In organized work activities, the collective inertia of business-as-usual is tremendous.

An example from our health center study illuminates this issue and highlights some possible solutions. Above when I discussed the second and third steps of the doctor's object formation, I pointed out that the fragmeted division of labor often created gaps and discontinuities in the communication between the patient's different care providers. This was especially true with regard to patients who used large amounts of basic health services. It was conceivable that the gaps and discontinuities in communication actually caused a fair portion of the excessive usage of the services. Therefore, our research group introduced a new artifact to be tested and used by the practitioners in oder to identify such gaps and discontinuities.

The new artifact is a model of the 'network of care', i.e., of the different providers from whom the patient has received or is currently receiving health-related services. Figure 8.7 presents an example of the application of the model.
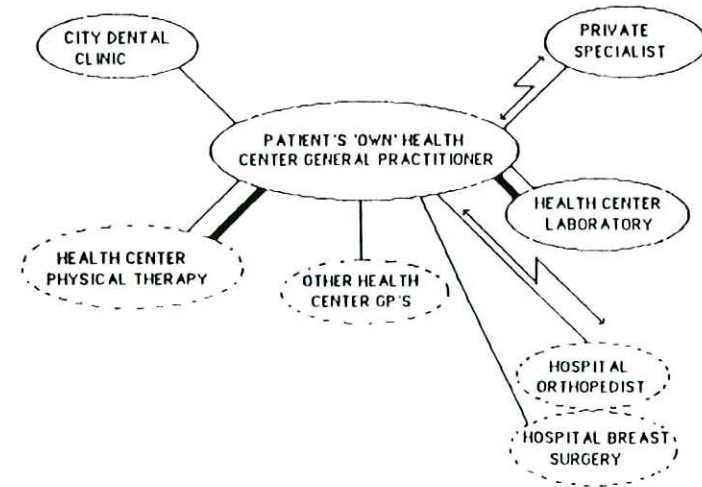
Figure 8.7: Model of a patient's network of care

In the model, the circles symbolize providers of care. Broken circles are providers whose services have been used in the past, intact circles are providers whose services are currently used. Thick black lines between circles symbolize direct communication channels between providers. Narrow lines indicate that the doctor has obtained indirect information from the patient concerning another provider. Finally the lightning-shaped arrows between circles indicate that there is a gap or break in communication between two providers whose direct communicative contact would seem to be important.

For the doctors, this simple tool is a challenge to explicate and represent systematically information which is otherwise 'floating' in bits and pieces in the doctor's memory, in the medical record, and in the accounts given by the patient. The model is a 'why' artifact in the sense that it tries to explain certain troublesome phenomena by identifying their potential sources in communication gaps. It is a representation that can be gradually refined and made more accurate, both by the doctor alone and jointly by the doctor, other staff, and the patient. Potentially, such non-institutional 'providers'

as supporting relatives and friends of the patient can be added to the model.

However, this 'why' artifact was not adopted by the health center community as we first presented it. It remained just another abstract idea, perhaps interesting but hardly useful in the eyes of the practitioners. This stance was broken only when the model was connected to certain 'what' artifacts.

We asked a team of four doctors to produce summaries of the medical records of some of their patients who used large amounts of health services and to construct networks of care on the basis of this material. We also viewed the videotaped consultation of one problematic patient together with the doctor in question, then asked her to produce a network of care for this patient on the basis of the information contained in the videotape. Subsequently, the models produced by the doctors were discussed jointly, with the participation of the four doctors as well as nurses and nurse practitioners. The model began to catch on. In the next meeting of the team, the doctor who had viewed the videotape presented three complementary versions of that patient's network of care which she had produced on her own, using different time slices of the medical record of this patient as her 'what' artifacts.

In those team meetings, it became clear that videotapes and medical records function as artifacts that ground and contextualize the relatively abstract model. At the same time it became also clear that the lack of 'how' artifacts weakened the doctors' models. Typically, two procedural failures in the construction of the networks of care could be observed. Firstly, the doctors tended to depict information that they had routinely received from another care provider through the Finstar records system as direct communication channel (thick black line) - whereas we had intended that this symbol would indicate *a two-way communicative contact* or interaction between the providers. Secondly, the doctors avoided pointing out gaps (lightning-shaped arrows) even in rather obvious cases of discontinuity of communication. Thus, the initial models produced by the doctors gave an overly optimistic picture of the situation. This bias could obviously be counterbalanced by giving the doctors unambiguous instructions ('how' artifacts) that make a bridge between the 'what' artifacts and the 'why' artifact.

## TOOLS AND SUBJECTIVITY - WHY SUBJECTS NEED THE SYSTEM VIEW

The above story implies that new artifacts are more likely to become communal artifacts if they are simultaneously constructed at all the three levels described in table 8.2. A new descriptive 'what' artifact (for example, a videotape or a printout of a medical record) may provide for temporary involvement and discussion - but it *alone* is not likely to achieve much change in the practical actions of the community members. Correspondingly, a new algorithm or a new explanatory model *alone* will probably remain a curiosity, no matter how obvious its need may be to the researcher.

But the story is still incomplete. The doctors' acceptance of the model of networks of care was not based only on contextualizing it 'downward', by means of relevant 'what' artifacts. Perhaps most importantly, the new 'why' artifact was also contextualized 'upward', by creating a perspective for the future of the entire collective activity system.

Beginning in 1986, the practitioners in the health center worked out models of their activity system, trying to identify deeper level contradictions behind their everyday troubles and disturbances. They used the triangle model presented above in Figure 8.1 as a tool. Each node of the complex triangle was analyzed and characterized, and key contradictions were indentified as discrepancies or tensions between the nodes.

During 1987, the practitioners formulated a new overall model for their activity system, again with the help of the triangle. In this model, a systemic solution to the contradictions was sketched by redefining each node of the model. In the fall of 1988, the practitioners began to implement the new model in practice.

Without this overall perspective of change, the model of networks of care would have been a relatively isolated 'why' artifact, even when contextualized 'downwards'. Within the framework of collective creation and implementation of a qualitatively new form of practice,

the model of networks of care is more than a separate innovation. It is an aspect of a full-scale cultural reconstruction at the workplace.

Such a cultural reconstruction of the activity system is guided with the help of artifacts that go beyond the explanatory or diagnostic 'why' function. It may be argued that the triangles created by the practitioners are close to Wartofsky's tertiary, imaginative artifacts. Such tools of vision may be called *'where to'* artifacts. Their primary psychological importance may well be their motivational power and potential for subjectification of the participating practitioners.

The need for 'where to' artifacts in the implementation of technical innovations is indirectly but very convincingly demonstrated in Cuban's (1986) analysis of educational technologies and in Grudin's (1988) analysis of technologies of computer-supported cooperative work. Both authors point out that the new tools have been largely rejected due to repeated failures to analyze the current and future organizational complexities of their application context. In other words, demanding changes in tools are hard to accept and implement when an overall analysis and vision of the future form of the activity system - the 'where to' artifact - is missing.

The system view represented by 'where to' artifacts differs from that suggested by standard approaches of systems design. Firstly, it is a view of socially distributed activity systems, not just of man-machine systems designed for an individual user. Secondly, it is a systems view designed by the users themselves. Finally, it is a relatively long-term projection into the future. The system view is not a representation of the the system as it is; it is a representation of the central elements and relations of a system to be built and implemented in time.

It is becoming increasingly clear to cognitive scientists that learning is above all a question of the contextualization of concepts and skills to be acquired. So far, the most elaborate attempts at understanding this have concerned centextualization 'downward' (Brown, Collins & Duguid, 1989; Lave & Wenger, 1989). When learning is embedded in qualitative changes of the activity system - an increasingly common phenomenon at workplaces - contextualization 'upward' may be even more important. Both directions of

contextualization require novel artifacts. Research in this framework has barely begun.