Ersch. in: From a metaphorical point of view : a multidisciplinary approach to the cognitive content of metaphor / Zdravko Radman (ed.). - Berlin [u.a.] : de Gruyter, 1995. - S. 329-349. - ISBN 3-11-014554-5

Karin Knorr Cetina

Metaphors in the Scientific Laboratory: Why are they there and what do they do?

Primitive Classifications[1]

When an ethnographer begins the study of a strange people s/he is in a dangerous position. Compared with what one expects or what one is used to much of what one sees is vastly surprizing. In fact, the contrast between the new and the images one brings along may be so striking as to induce the sense that the differences one perceives are constitutive for the new field. The danger is that later work unfolds these early impressions without putting them into question. When that happens one misses the second, more interesting surprizes: the ones which come later when one finds out that none of the things that impressed one early on can safely be assumed to be what they appeared.

My first surprize when I began to investigate the field of experimental high energy physics some five years ago was the massive presence of technology, of three storey high detector complexes seven storeys underground, of 30 Miles-in-diameter beam pipes and magnets, of tens of thousend of yards of cables and wires, of rooms full of eletronic crates, and so on. It seemed that this jewel in the crown of basic disciplines, high energy physics, was a technology rather than a science. Indeed

1 This paper draws on a chapter of a book Epistemic Cultures (Knorr Cetina 1993a). It also draws upon 5 years of ethnographic research at the European high energy physics laboratory, the CERN in Geneva, and in a Max Planck laboratory in molecular biology. The cultural approach to these two fields and the various results of the research are best summarized in the above book.

in the following I found much confirmation for this impression. Advances in high energy physics are often presented in terms of energy regimes, and energy regimes are regimes of machines: of colliders and accelerators which provide higher and higher energies, of detectors which can deal with ever higher luminosities, and of computers which are fast enough to handle huge amounts of information within fractions of a second. It is this technology which consumes the huge amount of money high energy physics requires, and which necessitates, by its sheer size and complexity, the formation of large and long lasting international collaborations. Seen from this perspective, experimental high energy physics is indubitably brandmarked by, driven by and dominated by machines. And yet I was in for a second wave of surprizes which, it is only fair to admit, came much later. I sensed that technology was perhaps not the keyword upon whose understanding all depended, or better yet, that it told me a story which enfolded another story about the things the physicists were "really" dealing with. I began to hear this other story only after I started to pay more attention to the distinctions embedded in physicists' work, to how things were grouped together, to the "primitive" classifications continually drawn into technical subjects and talk. What "primitive" classifications? This is where we have to turn to Durkheim and Mauss and an essay they wrote on the subject at the turn of the century (1963 (1903)).

For Durkheim and Mauss, primitive classifications were symbolic classifications of natural objects by native tribes, such as the division of all things in nature as belonging to one or the other "totemic" animals. Durkheim and Mauss wanted to prove the social origin of these classifications. They did not believe the human mind had the innate capacity to classify the things surrounding it spontaneously and by sort of natural necessity (1963:7). Instead, they thought the mind needed a model, and this model was society: If the society was divided up in a certain way, then the rest of the universe would be divided up analogously and related to the categories established by social organization. "The classification of things reproduces the classification of men". This was Durkeim' and Mauss' great thesis, whose singular value it is, as Needheim pointed out, to direct the attention of sociology to the topic of classification.

The thesis itself proved untenable, but the question of classifications remained and has stimulated a line of work. Where do the strange classifications we apply come from, those we do not consider to be technical categories? The most recent Durkheimian to address the issue is Mary Douglas. In modern society, it is no longer society as a whole one wants to look at but modern institutions and their usage of analogy and metaphoric classifications. Institutions, Douglas argues, are conventions, and conventions need some stabilizing principle which points away from the fact that they are socially contrived arrangements. This stabilizing principle is naturalization, the links an institution established with "natural categories" through metaphor and analogy. The convention of the sexual division of labour, for example, may be justified in terms of an analogy with the complimentarity of the right and the left hand, and the analogical relation of head to hand can be used to justify such diverse social arrangements as the class structure, the inequality of the education system and the division of labour between manual and intellectual work.

Physics too, enlivens its universe through symbolic classifications. In experimental physics, like in any other science, the definition of things is accomplished by technical vocabularies. A detector and, presumably, all of its thousands of parts can be classified or paraphrased in a technical language. Moreover, physicists seem to share enough of this vocabulary to make themselves understood and to communicate with each other within this technical language. Yet there exists, in addition to the technical language, imaginative terminological repertoires which re-classify technical objects and distinctions. These constitute a symbolic universe superimposed upon the technical universe; a repertoire of categories and distinctions from the everyday world which are extended into science where they reformulate, elaborate and at times fill in for technical categories. Symbolic classifications of this sort have a double referent. On the one hand they refer to technical categories, distinctions and practices which could also be expressed, or at least paraphrased, in technical terms. On the other hand these classifications refer to "natural" and social concepts and kinds. One example is the "aging" of a detector. Why involve a biological process such as aging in a technical event? The technical vocabulary should be strong enough to carry the message of the deterioration of the measurement response to which detector aging refers. Why are chuncks of experience perfectly well describable in technical terms symbolically re-coded? Is it as Mary Douglas might claim that the reference to "aging" justifies this instrument or the expenses it causes through tieing it to a natural category?

I think not. Against Mary Douglas, I believe it is questionable how much legitimation such analogies buy in modern society. Detectors are justified in terms of the harvest of new particles they bring, and in terms of spin-off effects, industry development, the training of physicists, international competitiveness, and so on. There is indeed a discourse of legitimation, but this does not include analogies such as the above. Nor are these analogies made public such that they could provide legitimation.

For systematic classifications in modern institutions such as science, we need an alternative interpretation. But where can we turn? In science, in particular, the presence of metaphors has often been noted. There exists a sizeable body of literature that reports on their uses by individual, mostly famous scientists (e.g. Holton, 1973, 1986), and that spells out their possible usefulness in structuring and innovating scientific thought. This usefulness is best summarized by the idea that metaphors and analogies can provide for a "creative extension of knowledge" (Black, 1962; Schon, 1963; Hesse, 1970; Radman, 1992). Through metaphors and analogies, two phenomena not usually associated with one another are suddenly perceived to have some kind of correspondence. Through this correspondence, the system of knowledge and belief about the properties of one conceptual object can be brought to bear upon the other (and vice versa), which extends the knowledge that previously existed in relation to this object. For example, when Leonardo da Vinci described birds essentially as flying machines, that is as "instrument(s) working according to mathematical law" instead of as feathered vertebrate animals, he opened up the possiblity to consider it "within the capacity of man to produce (such an instrument) with all its movements" (Radman, 1992: 157). When Dante describes, in a literary context, hell as "a lake of ice", he extends the reader's previous image of hell by including in it those associations normally restricted to the lake of ice. This interpretation of metaphors and analogies proves important for understanding conceptual innovations in science and other areas. However, not all uses of metaphor and analogy boil down to the extension of theories or theoretical interpretations. To be sure, the metaphors and analogies referred to by Durkheim and Mauss, and by Mary Douglas, also involve an element of meaning-extension; but the reason for the presence of these figurative elements seems to lie elsewhere. An Australian tribe it would seem does not group men and women into clans according to totemic animals solely to extend its knowledge of these men and women, and a modern institution does not tie hierarchical social arrangements into analogies of the body to learn more about these arrangements. With some analogies and metaphors, especially those which tie into the classification of social and natural objects, the question of category derivation remains.

A Theory of Locales and of how Metaphors tie into them

To answer the question, I suggest that we look for a moment not at the grand meanings metaphors and analogies shift between domains but at the local settings from which these figurative elements emerge. In experimental natural sciences, this setting is the scientific laboratory, the locus of science-in-the-making and the place in which we can observe scientific pratice at work. What is a scientific laboratory? Elsewhere I suggested that the hallmark of natural scientific laboratories is that they imply, to use a term by Merleau-Ponty (1945: 69), *a reconfiguration of the system of self-other-things*, or of the *phenomenal field* in which experience is made in science (Knorr Cetina, 1992). The system of self-other-things for Merleau-Ponty is not the objective world independent of human actors or the inner world of subjective impressions, but the world-experienced-by or the world-related-to agents. The so called "laboratory studies", which have emerged in the new sociology of science as a first attempt to study by direct observation the making of knowledge in scientific practice[2] suggest that the laboratory is a means of changing the world-related-to agents in ways which allow scientists to capitalize on their human constraints and socio-cultural restrictions and possibilities. How? For example through exploiting the malleability of natural objects. Laboratories rarely work with objects as they occur in nature. Rather, they work with object images or with their visual, auditory, electrical traces, with their components, their extractions, their simulations. This *enculturation* and *reconfiguration* of natural objects brings epistemic dividends to science. For example, through the transition from whole plants grown in fields to the cell cultures raised in biotechnology laboratories, the processes of interest become independent of natural order time scales and conditions, miniaturized, and accelerated. The laboratory subjects natural conditions to a social overhaul and derives epistemic effects from the new situation. But laboratories not only "improve upon" the natural order; they also "upgrade" the social order in the laboratory in a sense that has been neglected in the literature. If we see laboratory processes as processes which align the natural order with

2 See for example Knorr (1977); Latour and Woolgar (1979); Knorr Cetina (1981, 1993a); Lynch (1985); Traweek (1988); Zenzen and Restivo (1982). For a recent overview see Knorr Cetina (1993b).

the social order by creating reconfigured, workable objects in relation to agents of a given time and place, we also have to see how these settings install "reconfigured" scientists who become workable in relation to these objects. Not only objects but also scientists are malleable with respect to a spectrum of behavioral possibilities. In the laboratory scientists are, on the one hand, "methods" for going about inquiry; they are a technical device in the production of knowledge. But they are also, on the other hand, human materials structured into ongoing activities in conjunction with other materials with which they form new kinds of entities and agents.

Now symbolic re-classifications, and this is my alternative to the Durkheim-line of argument, *express the reconfiguration of objects and subjects* within these local settings. Through symbolic repertoires, it is made apparent HOW the structure of things is reset in epistemic practice. Symbolic classifications describe WHO, independent of external definitions, is alive or not alive, who ware the organisms and who ware the machines, who are the agents with powers and dispositions to react and who are the passive tools and media in an interaction. Symbolic re-classifications make it apparent that there have long been relationships in these settings which include non-human participants (e.g. relationships with machines) and which define human participation in specifically limited ways. They make it apparent that the traditional concepts of a person, an actor or a role are not sufficient to catch up the structurings of reality within these experimental arenas. For example, it is not a physicist's role or the role of a machine which is at issue, but the definition of these objects as working components of the setting in relation to other components.

Reconfigurations Clothed in Metaphoric Classifications: an Example from Experimental High Energy Physics

Consider now some examples of the reconfigurations I have in mind from experimental high energy physics, first in regard to its usage of technical devices then in regard to its usage of physicists. High energy physics is, in the eyes of everyone who looks at it (I said this much before) a *science of big machines*. A detector is a quintessential technical device which dwarfs human subjects, consists of thousands of mechanical and electronic parts and subparts and is controlled through 20-30 terminals and computers. Yet seen from within the symbolic classifications in which this device is embedded, a detector is less a machine than a physiological being characterized by a behavioral repertoire, behavioral states, and behavioral idiosyncracies.

Detector Agency and Physiology

Consider for example the behavioral repertoire. A detector qualifies as a sort of ultimate *seeing device*. Pions and photons, as they strike detector materials, initiate movements of particles which can be registered as signals and after a cascade of transformations and amplifications end up as digital response counts. Here the detector functions not unlike the retina; physicists say the detector *sees* or *doesn't see* certain events, that it is not *looking*, *watching*, or *looked away*, or that it was *blind*, *sensitive* or *insensitive*. They continually construe the detector analogously to perception. The perceptual analogy is also emphasized through the vocabulary of *resolution*, a term from optics which refers to the degree to which an instrument can still form distinguishable images of objects which are closely spaced.

A second major behavioral complex comprizes categories such as the *response*, the *reaction*, and the *acceptance* of a detector. These terms are much larger concepts which sum up the whole complicated measurement return of the instrument with respect to a signal. The detector, in this case, is construed as an entity which *interacts* with particles and which responds to them in certain ways. A third set of categories, more achievement oriented, construes the detector somewhat like a

competing athlete – as *performing* or not-performing, and as *coping*, in its performance, with different environments. Physicists speak of the *performance* of a detector and of performance-enhancing measures. For example, gas-based detectors can be *doped*, which means that their performance can be stepped up by adding certain ingredients to the gas. Fourth, some categories applicable to detector refer to them as capable of producing utterences. Detectors and detector parts produce *noise* (e.g. "normal noise", "excess noise", "cross talk"), like electronic devices in general.

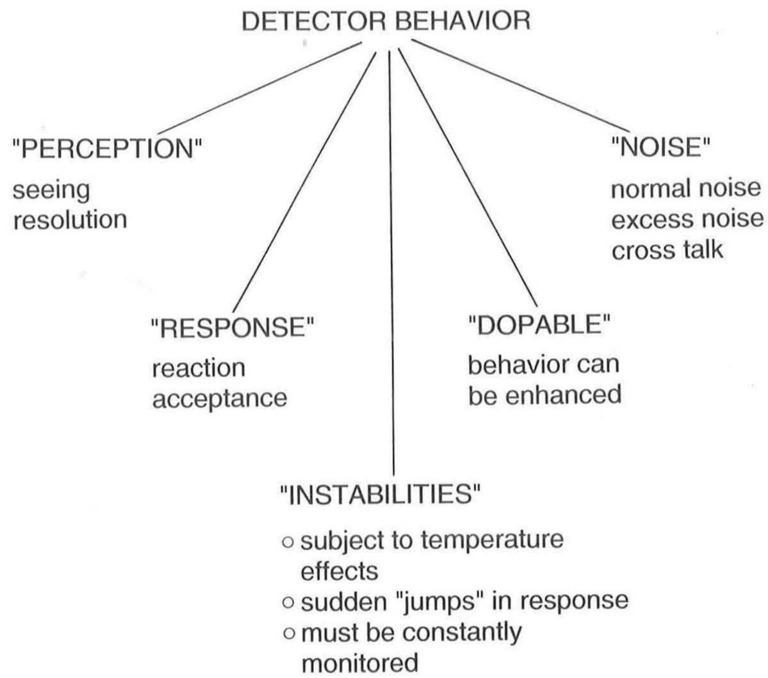

Figure 1

Added on to these action-capabilities of detectors, its capabilities to see, respond, interact perform and make utterances, are descriptions of behavioral states and conditions which con-

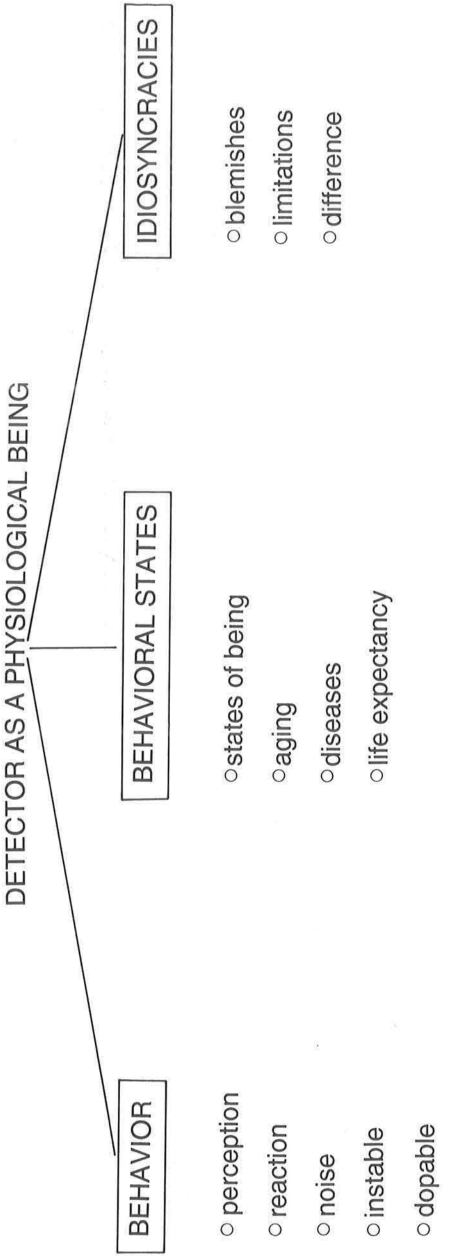

Figure 2

strue the detector as a *physiological* being. The agent appears to be supplemented by a kind of body with its own internal life and problems. Physiology comes into the picture when the detector is seen as continually *changing*. On the one hand detectors, like all of us, are slowly but relentlessly "aging". In fact, they are aging so predictably that, when for once they happen to "get younger", they stir quite a commotion in the experiment, and give rise to thorough investigations of this "problem". But detectors not only age they are also (like most of us) *instable*. They are given to sudden "jumps" in their behavioral response which may be environmentally triggered (temperature changes!) and they will at times "act up". Because of their aging and instabilities, detectors must be monitored. Monitoring also applies to the physiological states a detector or detector parts may be in, which are mostly described in terms of a vocabulary of *illness, disease* and *death*. Detectors and detector parts may be *alive*, *dead*, *killed* and *cannibalized*, they have a *life expectancy*, and their life may be *prolonged*. Furthermore, they may have *diseases*, be *sick*, *ailing*, *congested*, or suffer from *ion poisoning*. In response to these predicaments they may *complain*, be *diagnosed*, and provided with *antibiotics* and *first aid*. Upon which *the patient* may nonetheless *die* and remain *as dead as ever* or *recuperate* and be *cured* and *healed*. Figure 2 provides an overview over detector action capabilities and physiological conditions.

Detectors as Moral and Social Individuals

True human beings are not only equipped with accents of agency and with a physiology. They also need to be true individuals, and include moral and social components. Detectors, which are sometimes likened to human beings, are construed along the same lines. First, they are construed as *strong individuals*. Strong individualism means that each detector is, in idiosyncratic ways "different" from another. Physicists will say[3]:

> There was a time in the seventies where there were more or less standard packages for the analysis, because the detectors all were basically of the same type [...] when you were doing bubble chamber type physics there was really standard analysis packages. In a collider experiment like this each analysis you do must develop all the tools yourself, I mean, you know *it depends on how the detector looks like, behaves.* (emphasis added)

Thus with collider experiments, everything depends on the idiosyncracies of the detector – the background one gets, the resolution provided, the events accepted, the overall detector response, and thereby, the measurements. A detector is difficult to simulate because of these idiosyncracies. The implications of all this for physics analysis are outlined elsewhere (Knorr Cetina, 1993: Ch. 3). The extreme idiosyncracies of a detector fit into analogies from biology rather than from technology. Biologicial organisms of a particular category too, are individuals in the sense that there is in their physiology and disposition to react a great diversity and variation. With humans, these variations are, in addition, due to culture, but the basic phenomenon remains.

Idiosyncracies and individualism however, do not preclude detectors from being *social* beings with respect to each other. In any of the big collider experiments, a detector consists, as indicated before, of several sub-detectors which are sandwiched around each other and wrapped around the beam pipe. These detectors are social in the sense that they *cooperate*. For example, they provide different segments of particle tracks which are then assembled into one overall track by the pattern recognition program. Detectors also cooperate in correcting for each others' insufficiencies. For example, one can kill all the ghosts in the scintillating fibre detector with a working silicon detector. In cooperating, detectors *consult* each other, for example with respect to finding the tracks of particles.

3 This and the following quotes are by physicists at CERN whom I interviewed at various occasions and whose talk among themselves I recorded.

However, if one detector always "consults" another and part of the first one is lost then the second cannot function either. Detectors therefore first perform individually and consultation is deferred to a second stage. When they are consulted by another detector, detectors will *agree* or *disagree* with each other. Consultation and cooperation implies some sort of communication between detectors; and indeed, detectors are said to *communicate* with each other and with other components of the system with which they may enter a *dialogue*. For example, a readout-chain starts by a computer *telling* a detector that it is ready to accept an event from it. In the language of physicists,

> there is first a computer that *talks* to our electronics, and the electronics sends signals down, and the detector *acknowledges* them and sends them back, and then again the computer is *informed*. So you make the closed loop where there is a *dialogue* between computer, electronics, detector and computer again. (emphasis added)

Finally, detectors can also enter more antagonistic and competitive relationships. For example, they *check* each other. If one wants to know how often a detector finds a track, one runs the tracking with this detector excluded:

> (You) check each detector one against the other by saying all these other detectors saw something which looks like a track going through, so does this guy respond the way you expect. You can say the calorimeter sees something that looks like an electron, does the TRD see it as electrons, and so on.

Participants normally try to measure the efficiency by *playing off*, as they say, different parts of the global detector one against the other. For example, the preshower of the scintillating fibre detector and the silicon detector are used to measure the former's tracking efficiency, the tracking efficiency and the silicon are used to measure the transition radiation detector's efficiency, two other detectors and the scintillating fibre are called upon to try to measure the silicon efficiency, and so on.

Detectors cooperate and communicate and can be played off against each other, but they are also *moral* and *morally responsible* beings. Some of the terms mentioned above have evalua-

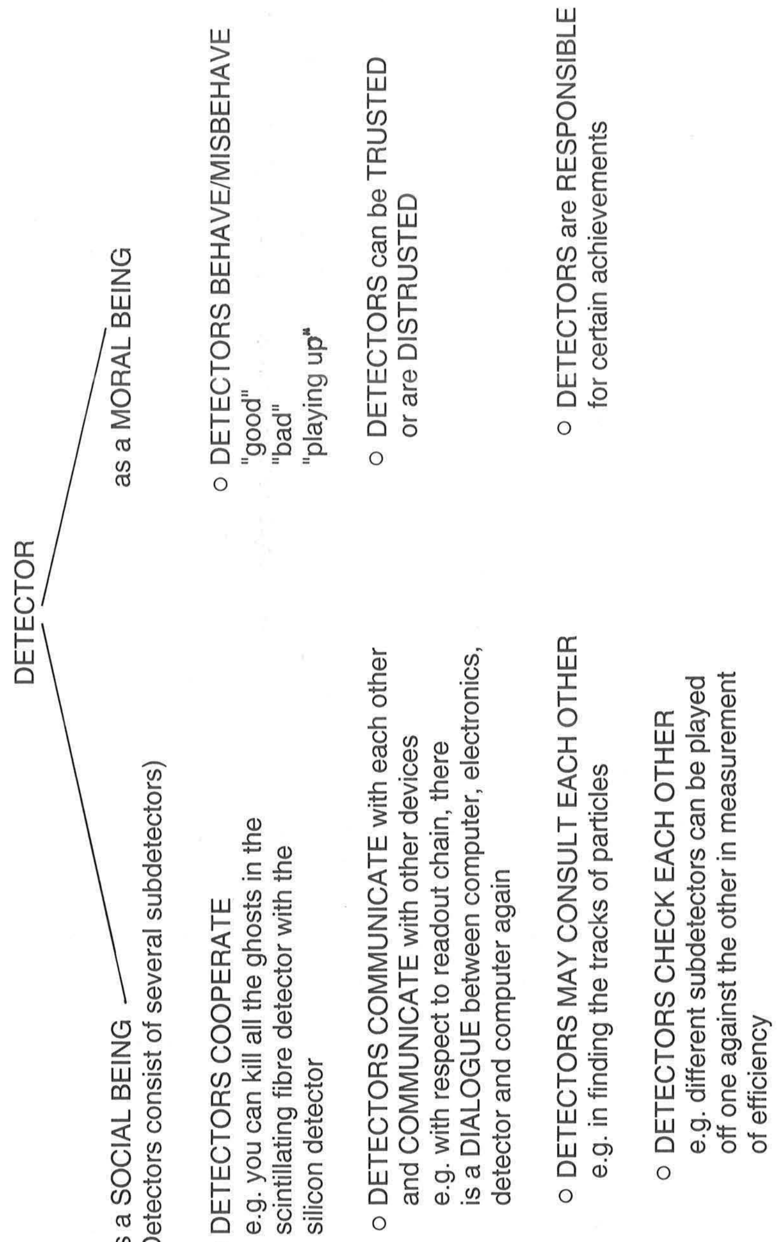

Figure 3

tive overtones, but detectors and detector parts are also explicitly evaluated as *misbehaving* or *behaving*, as being *good* or *bad*, as being a "good" detector or a "bad" one. With a "good detector", one can, for example, reduce the background, whereas with a "bad" detector one cannot. However, detectors tend not to be "good" or well-behaved at all times. A detector may be *playing up*, like a naughty child, and it may be "confused" or suffer from similar behavioral faults. A detector, when it behaves (well), "is our friend" as one physicist said. But when it does not behave it is derided and *distrusted*. In this sense detectors bear the *responsibility* to perform in certain ways. For example, it is the "responsibility" of each detector to provide a particle track segment in the sense of "saying" that it found a certain track segment in a certain angle in phi and that this segment had certain qualities and certain uncertainties. The vocabulary which construes detectors as social and moral individuals is summarized in Figure 3.

The Detector – Live Organism or Machine?

Consider once more the structure of the analogies a detector is locked into. Playing detectors off against each other, seeing them as "communicating" with other elements in the system, construeing them as consulting each other and as cooperating with each other, all are versions of implementing individual detectors as components not only capable of, but also in need of interacting with each other. In this sense individual detectors are social beings, brought together in groups in which they submit to a specific order and rely upon each other. Then there was the detector as a quasi-biological being with physiological states, a perceptual apparatus, a tendency to fall ill and to need medical attention, and with various behavioral capabilities such as the capacity to perform and improve. Finally, there were the idiosyncracies and limits which are expected from biological individuals. The thing to note about these analogies is that they form a relatively coherent system. The vocabularies brought together in classifying a detector fit to each other, there are no systematically applied categorizations which break the pattern.

But what is the pattern? What sort of object is the detector as seen in terms of the symbolic repertoire through which it is addressed? There are two aspects which stand out in the laboratory's configuration of a detector. First, the detector appears to have an internal life of its own, an internal dynamic which is subject to change but not subject to complete external control. In this sense the detector is like a *complex organism* whose physiology is ruled by its own laws, who has its own powers and capabilities and tendencies to react. Recall that the responses of this organism are not self-evident. They must be watched and measured, and with sufficient observation and hard work and familiarity with the thing (through a joint biography with the detector), they may be "understood". Moreover, the organism cannot be left to its own. There is a whole structure of surveillance devices and probes which are built around it, and which accompany all its moves. Thus the organism remains a kind of being rather than a thing, with essential components functioning like organs to maintain the responses of the whole within a complicated internal environment.

The qualities of a living being which a detector has, like the quality of agency described below, are not, this needs to be emphasized, idle poetic embellishments of technological processes. The internal life of a detector with its dynamics of its own is a recurring experience in the lab. Detectors cannot, for example, be opened up and taken apart at any point in time. Once they have been assembled and "run", their internal life is accessible only indirectly, or in small sections at great costs in time and losses of luminosity during "access periods". But event when they don't run only certain parts of a detector can be removed and inspected. The internal life of a detector cannot be precisely described, as the difficulties with simulating a detector show. In the words of one physicist,

You don't know exactly what material is in there and how it is arranged, e.g. there is a carbon fibre wall in the silicon, then there is an aluminium electron shield and then there is a piece of silicon and then there is a printed circuit and scattered across that are different pieces of electronics. And then there is another aluminium shield and then some carbon fibres and so on, and you can't (know) all that in details. So you always end up oversimplifying your MC, to the extent that we see twice as many hits as we expect (from the simulation). You might believe the MC for the topology for top events, but all you're understanding is the basic physics. But if you're asking about the details of the charge distribution in the preshower (a detector part), then I don't think anybody would seriously believe the simulation.

The second quality of a detector which stands out is its *autonomy* as an agent who interacts with the particles. In this sense the detector enters between the scientist and the object of interest, performs the work of observing and interacting with this object, and does all this in ways which remind not only of biological but of human beings: idiosyncratically, never ideally, and, at certain moments, by getting in the way of real progress. In this sense the detector carries all the emotional ties and ambiguities of a *friend* who is at the same time a *business partner*, someone to whom one has not only an expressive but also an instrumental relationship. These ambiguities are also expressed by physicists when they talk about their relationship to the detector:

A detector is a tool, a toy and a friend or whatever, which is used to measure something and the result of our job. So in a way we shouldn't care at all about the detector. But in reality, ok, we live so long with that object, it's like a human being a detector [...]

Friendship, it seems, is linked to the joint biography with the detector, and dramatized through emotional attitudes. Unlike particles, which are the object of one's own and of the detector's work and the goal one is interested in, detectors are "loved":

I think we don't love the W's, but we love our calorimeter, if you may say so, psychologically [...]

On the other hand, it is recognized, somewhat sadly, that the loved friend has "faults" and "blemishes" which get in the way of the usefulness expected of him and of the desired ideal situation. Physicists often mention or complain that the detector is "not ideal", that "even the best detector" cannot distinguish between certain kinds of background and "cannot tell you" whether certain jets come from a top or from the initial state in the W production, or that the design of their detector "is not the smartest". This recognition of a detector's limitations ties into the concept of "leaving the detector behind" when it comes to particles and physics analysis.

Summary and Conclusion

Let me summarize this paper by drawing attention to two claims I am making with respect to the transformation of a technical instrument into the kind of being illustrated above. I have argued that primitive classifications, that is classifications which tie into metaphors and analogies from agency, from the body and from other areas, *accentuate and display the reconfigurations of self-other-things* which are the hallmark of productive spaces such as high energy physics laboratories. They accentuate and display these reconfigurations by superimposing, upon the technical vocabulary, a language in which the new ontologies of the laboratory can be expressed, the epistemic relationships which obtain between objects and subjects, and the redistribution of roles and characteristics of entities as these entities pass through the laboratory. Though I have not illustrated this in the present paper, it should be stressed that such symbolic vocabularies apply to many objects and phenomena in the laboratory, for example to the "background" physicists are constantly dealing with, to the computer programs they are writing (the "code"), or to scientists themselves (see Knorr Cetina, 1993a: Ch. 5). It is important to note that the analogies which apply to the detector, to the code and to the background *differ systematically* from each other. For example, the figurative vocabulary which extends to the background is based upon the master metaphors of antagonism and deception, with various subcategories referring to ways of "beating" or "killing" the deceptive phenomenon. Such vocabularies do not involve the same terms as the analogies which apply to the detector, nor do they imply the same structure of relationships between objects and subjects.

The second point I wanted to reiterate is that metaphoric classifications are not "idle rhetoric" or "mere embellishments" of drab technical routines. This is already implied by the reconfiguration model, which suggests that objects which figure importantly in the laboratory tend to *become* entities different from what they are in other settings. The shifts in boundaries which occur and the strange metaphoric attributions mark a redistribution of roles and properties which corresponds to how entities are experienced, must be treated, and function in the laboratory. If a machine like a detector acquires life-like properties, a physiology, behavioral qualities, and some enigmatic characteristics of agency, this implies that in the laboratory, a detector does indeed *not* work (or to put it more weakly, does not only work) like a machine. This has strong implications for the orientation of physicists toward this instrument, for what it means, in this science, to do empirical work, and so on. For example, the detector as a somewhat enigmatic physiological being with an internal dynamic of its own is counteracted by a structure of surveillance which physicists install to guarantee that crucial internal changes and occurrences are noticed and met by the appropriate response. In addition, the epistemic attitude of physicists toward the detector is that its behavior must be first and foremost *understood* - a project that begins when the first detector parts arrive in the laboratory and does not end until the detector is dismantled and the experiment comes to an end. In the experiments we studied, physicists spent more time on understanding, observing, and describing the detector which they themselves had built than on any other task in the laboratory – by far more time than on taking and processing "real" data, whose analysis is always anyway mediated by an understanding of the detector. One can compare this attitude with observations in molecular biology in which life organisms are often reconfigured in ways best described in terms of an industrial vocabulary: they are reconfigured as machines, production devices, little factories of life materials (Knorr Cetina 1993: Ch. 6) Not surprizingly, the molecular biologists observed correspondingly lacked the emphasis on – and the vocabulary of - "understanding". For them, it seemed more important to arrest and repeat a production process if it did not work than to understand the causes for its problems.

What little I said so far suggests that figurative and symbolic vocabularies in modern institutions, when these vocabularies are extended systematically to certain object and subject domains, sends us a very specific message: it is a message about the blurring of boundaries between ancient categories such as organisms and machines, or objects and subjects. The classifications recorded display the essential flexibility of these entities, the uncertain character of their boundaries, their qualities, and their important characteristics. What characteristics technical machines like detectors assume depends entirely on the reconfigurations accomplished in stable local settings. Whether they are fashioned as organisms or machines also depends on these reconfigurations. The original entities are taken as gound materials which, seemingly, can be featured in any role and combination, and put to work in any fashion. Symbolic and figurative classifications exhibit the work accomplished in refashioning original entities into new orders of self-other things, and thereby, into new kinds of being.

References

Black, M. (1962), *Models and Metaphors*, Ithaca: Cornell University Press.

Douglas, M. (1966), *Purity and Danger: an Analysis of Concepts of Pollution and Taboo*, London: Routlege & Kegan Paul.

Durkheim, E. and M. Mauss (1963), *Primitive Classifications*, Transl. by R. Needham. Chicago: The University of Chicago Press.

Hesse, M. (1970), *Models and Analogies in Science*, Notre Dame: University of Notre Dame Press.

Holton, G. (1973), *Thematic Origins of Scientific Thought: Kepler to Einstein*, Cambridge: Harvard University Press.

Holton, G. (1986), *The Advancement of Science and Its Burdens*, Cambridge: Cambridge University Press.

Knorr, K. (1977), "Producing and Reproducing Knowledge: "Descriptive or Constructive? Toward a Model of Research Production", *Social Science Information*, 16: 669-96.

Knorr Cetina, K. (1981), *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*, Oxford: Pergamon Press.

— (1992), "The Couch, the Cathedral, and the Laboratory: On the Relationship between Experiment and Laboratory in Science", in: A. Pickering (ed.), *Science as Practice and Culture*, Chicago: The University of Chicago Press, 113-138.

— (1993a), *Epistemic Cultures: How Scientists make Sense*, (forthcoming).

— (1993b), "Laboratory Studies: The Cultural Approach to the Study of Science", in: J. C. Petersen, G. E. Markle, S. Jasanoff, T. J. Pinch (eds.), *Technology and Society Handbook*, Los Angeles: Sage (forthcoming).

Latour, B. and S. Woolgar (1979), *Laboratory Life: The Social Construction of Scientific Facts*, Beverly Hills: Sage.

Lynch, M. (1985), *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory*, London: Routledge and Kegan Paul.

Merleau-Ponty, M. (1945), *Phenomenologie de la perception*, Paris: Gallimard. English translation: *Phenomenology of Perception*, London: Routlege and Kegan Paul (1962).

Radman, Z., (1992), "Metaphoric Measure of Meaning – The Problem of Non-Literal Use of Language in Science Reconsidered", *Philosophical Studies*, vol. XXXIII: 153-170.

Schon, D. A. (1963), *Displacement of Concepts*, London: Tavistock.

Traweek, S. (1988), *Beamtimes and Lifetimes: The World of High Energy Physics*, Cambridge: Harvard University Press.

Zenzen, M. and S. Restivo (1982), "The Mysterious Morphology of Immiscible Liquids: A Study of Scientific Practice", *Social Science Information*, 21/3: 447-73.