Level 10

Models of Reality can be *Reality Itself*

Modern philosophy to a large extent consists of commentaries on ancient philosopher's writings. But this way of doing philosophy is outdated: The world has changed; we have so much new information about the world available today. Neocybernetics may offer new ways of thinking about the world around us. But this is not all: It can also challenge our ways of *thinking about thinking.* The new approaches address the very basics of scientific work.

Immanuel Kant started the "Copernican revolution" in philosophy, calling it the "prolegomena to all future metaphysics". Today, the same kind of ideas can be applied to any science; one could also speak of metabiology, metacognition, etc., when speaking of the principles below the surface observations. Perhaps neocybernetics is a step towards a "prolegomena to all future metascience" in general. This final chapter discusses some issues concerning the emerging "metascience".

10.1 Models are what there is

Models try to explain observed real-life behaviors applying some simplified theoretical framework. Also in this text, everything has been about constructing models of reality. And, traditionally, it is emphasized that *models are always false* — they simplify, they only capture some specific aspect of the real-life complexity; the essence of the real world cannot be captured. In principle, this starting point about deficiency of models applies also to neocybernetics. However, this is not the whole story.

10.1.1 Escape from the cave

Plato's "Allegory of the Cave" illustrates a dilemma that has been haunting philosophers throughout history:

> Imagine a prisoner who has been chained since childhood deep inside a cave. The only thing he can see is the cave wall, where shadows of objects outside the cave are cast. We know that the prisoner can only see a very limited view of reality — but to the prisoner, the shadows are the only reality he knows of. ...

The prisoner constructs his world view based on the very limited information — but he still thinks that this is the whole "truth". This may sound like a strange situation, but, indeed, also our observations are limited by our senses. In a way, we all are living in our personal caves (or cages): The reality cannot be observed directly, and there is no guarantee that our senses succeed in delivering a truthful image of the outer world. The transferred image is incomplete, but is it also distorted? Our conceptions of the world is necessarily subjective — how can one know that others share the same views?

There exist very extreme views: For example, René Descartes (1596–1650) observed that, after all, the only thing one can know for sure is that one *thinks,* and therefore this thinking mind must exist — "cogito, ergo sum". A yet more extreme view was coined by Gerorge Berkeley (1685–1753): There is no material substance and all things are collections of ideas or sensations, which can exist only in minds and for so long as they are perceived. This means that also we exist only in the mind of our creator God! Such considerations are rather fruitless — Immanuel Kant (1724–1804) was the pioneer when bridging *rationalism* and *empirism.* The perception is an interplay between what is "inside" and what is "outside": One only has access to the observation data, and it is filtered through the mental machinery; but the principles of this machinery are shared by all observers, and in this sense, there must be something in common in the subjective world views.

In a way, Kant is speaking of *internal models* and matching of data against them. And it is this model-oriented thinking that is the basis also in neocybernetics — the adopted model structure there is just another filter for the input data. The models that are based on the data covariation in the PCA style are advantageous as the data-based "semantics" can be characterized in a mathematically rigorous way. Only statistical phenomena can be captured, so that information on individuals is lost, but, on the other hand, the automated data analysis makes it possible to abstract over particulars. One can avoid predestinated, more or less subjective characterizations of the world; there is no need for explicit "ontologies" as the structures are determined in terms of correlation structures among data. The philosophical deadlocks are circumvented as "truth" is substituted with *relevance:* Constructs are important if they *exist,* what cannot be observed is not modeled.

It has been claimed that models are "out" — it has been always admitted models cannot capture the essence of systems, but when studying complex systems in particular, it seems that they cannot even capture the behaviors of them: In chaos theoretical models small deviations in initial conditions result in completely different outcomes. In neocybernetic models, however, stochastic variations are not significant. It is statistically relevant constructs or attractors of dynamic processes within the phenosphere that are being captured, and role of the transients fades away. As the approach is thus inverted, the emphasis being on balances, in the resulting emergent models one can capture *not only*

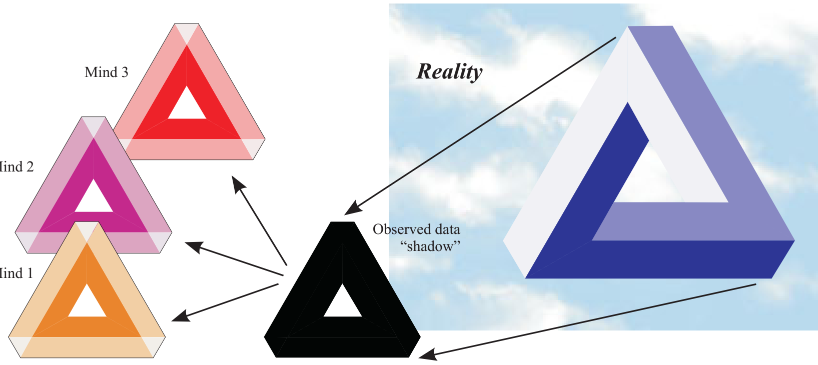

Figure 10.1: Visualization of intersubjectivity. It does not often truly matter what the reality looks like (pattern on the right), as long as the subjective reconstructions (on the left) based on the measurement data (the “shadows”) are similar — the mental constructs can then be shared and are negotiable, being a solid basis for a “supermind” extending over a single brain

the behaviors but also the essence.

10.1.2 Intersubjectivity and interobjectivity

The model construction principles of cybernetic systems also applies to the cognitive domain: The mental system constitutes a “mirror image” of the environment as determined by the observations. No matter what the underlying realm truly is like beneath the observations, the mental machinery constructs a more or less unequivocal model of it; this modeling can be repeated in different minds, and the results are always essentially identical as long as the statistical structures in the observation data remain the same. This means that the separate minds then share the same mental representations, and *intersubjectivity* among minds has been reached. It may be that this mental model does not represent the real world object in the best possible way — but from the point of view of the minds understanding each other, this does not matter (see Fig. 10.1). Thus, there is a possibility of constructing yet higher level models based on the consistent world view shared by the intelligent agents.

The models in the infosphere remain intact even if the models were implemented in another medium. For example, if the same cybernetic modeling principles are copied in the computer, there will be a fundamental correspondence among the data structures as constructed by the computer, and the mental representations as constructed by the brain in the same environment. This makes it possible to reach intersubjectivity also among artificial and natural minds: The world models can be essentially the same, not only between humans but also between humans and computers. This makes it perhaps possible to reach artificial intelligence in the deep, not only in the shallow sense. Clever data processing becomes possible: The computer can carry out the data preprocessing in a complex environment, and the constructed data structures can be interpreted directly in terms of corresponding mental representations. The cybernetic computer can do real modeling, not only tuning of predetermined parameters in man-made models, applying the metainformation it then has.

But intersubjectivity can also exist in the same way directly among computers in Internet. Today's ideas of "semantic web" are plagued by the need of defining hard-coded artificial ontologies; when the network of cybernetic computers is truly semantic, computers can interact without the help from humans. When the human is dropped out of the network altogether, the possibilities of AI become practically limitless as the communication among computers and adaptations in them can take place practically instantaneously. The time axis once again contracts towards a singularity, and the emergence of yet higher-level systems can take place. In the spirit of Friedrich Nietzsche, the smart computers can host "oversystems" recognizing that their "God is dead" ... perhaps it is clever to implement Isaac Asimov's "Three Laws of Robotics" in computer hardware when it is not yet too late!

Intersubjectivity is not all there is; indeed, one can reach *interobjectivity.* If nature itself tries to construct models for eliminating free energy in the system applying model-based control, as presented before, the human trying to model these cybernetic systems can touch not only the shadows of the behavior (in the Platonian sense), but the actual essence – these models can be *fundamentally the same.* This means that if some naturally evolved cybernetic system (an ecological system, for example) is modeled by a human applying the appropriate (cybernetic) principles, this model has a deep correspondence with the system itself. Essence of systems is not in the building blocks but in the information structures. This is a very deep observation: Human can truly understand one's environment; there is a unity of knowledge and nature, and *epistemology* and *ontology* become the same (see Fig. 10.2). The model can represent the actual system losslessly regardless of the non-ideal noisy observations there are in between.

It is the common endeavor of Nature and Human to understand the Universe — and both of these are built by the Universe itself ... for doing introspection! As the reality is too complex to be modeled in the simple mathematics of neocybernetics, more sophisticated models are needed: The human carries out the task nature has given him, modeling those systems that are too complicated. In any case, the end result is the same — models are used for better understanding, for exploiting the resources and bringing them to heat death.

10.1.3 Unity of models

Usually in sciences, there is less and less in common between fields of research, as one goes deeper and deeper. In cybernetic studies, however, it seems that no matter what is the scale, going deeper and deeper makes different fields have *more and more* in common. This is due to the starting point: As it is completely distributed systems that are being studied, the analyses boil down to understanding the underlying individual agents being at the mercy of their environments. Survival there, and capability of exploiting the available resources,

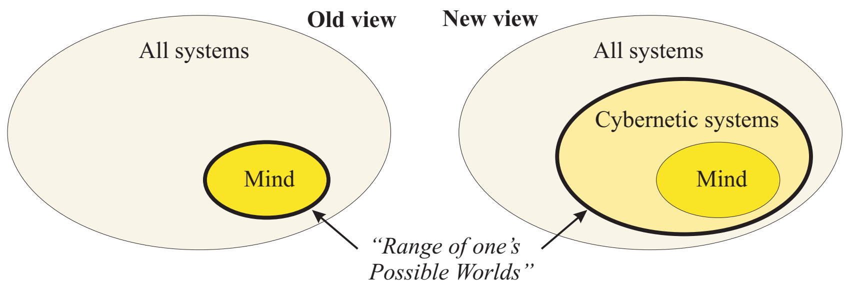

Figure 10.2: From Platonian shadows to Platonian ideals. Neocybernetic analyses can extend the range of human understanding: One can not only construct models of the systems in the environment — one can reconstruct the systems themselves in one's mind in a more fundamental sense. In the spirit of Eastern philosophies, one's world and one's mind can become *one*

can be reached when the very simple rules are followed, these rules supplying self-organization and self-regulation being always the same; when seen from above, the systems always seem to be composed of consistent balancing tensions.

Atomic physics underlies chemistry, biology is based on chemistry, psychology emerges from the biology of neurons; sociology, economics, etc., are built on the interaction of countless individual humans. But closer analyses reveal that there are also interactions between these levels, and the hierarchy of disciplines is becoming a matrix. *Consilience,* as discussed by Edward Wilson [90], is an intuitive belief that the fields of human intellect are fundamentally the same. In the neocybernetic framework this intuition can be extended: The unity of disciplines does not apply only to sciences. As there is the tight coupling between mind and matter, there is a relationship between mental and material cybernetic systems, so that everything becomes a strange, fractal but holistic mosaic. Neocybernetics makes it possible to carry out concrete analyses, as everything can be understood in terms of measurable information: This means that the domain of natural sciences is still extended — but, at the same time, the fields of philosophical speculation are extending.

What are the neocybernetic models like — some characteristics are summarized. To capture the emergent pattern, the time axis is eliminated in the models, so that the final state of dynamic balance is represented. When the static structure is found, its natural dynamics can be derived from its internal tensions, abstracting over individual trajectories, so that one has model over plausible behaviors. In the slower time scale, there is adaptation towards constant stiffness of the system as experienced by the outside observers — this characterizes the evolutionary goal of the system. As the cybernetic model is general, applicable for analysis of very different kinds of systems, analogies are a valuable tool for understanding complex systems.

When looking the model closer, it is interesting to note that at certain level of model complexity it is *causal* representations that become the most appropriate.

This claim has a very solid motivation, as studied in chapter 3: Modeling is done in terms of own actions and corresponding reactions from the environment, or x is the cause for Δu. In this sense, the hierarchy of models becomes a hierarchy of causalities.

Heinz von Foerster essentially claimed that the mind (a cybernetic system) cannot understand systems of the same level of complexity, or another cybernetic system — there is the problem of *infinite recess.* Analysis of such intertwined systems, or "Second-Order Cybernetics", ends in problems: Thinking about a system necessarily invokes both levels, first-order and second-order systems, and there is a mess, one cannot distinguish between them in analysis. In neocybernetics, there are no qualitative leaps between the levels of systems; the hierarchy of levels collapses into a singularity. Human can be liberated from the loop of analysis, there are powerful conceptual tools for artificially "understanding" the inner and outer processes alike: The human thinking is just another system to be analyzed.

10.1.4 About "truly general relativity"

Unification of models sounds like a panacea: Assumedly one only has to write this one world model once and for all? However, even though the model of the environment is objective and deterministic, as studied above, it is *still not unique,* and there is still diversity of systems.

There will never exist a complete world model as the model is relative to the observer and observations. How the *potential* becomes *actual* and in which form, is dependent of the coupling between the observer and the system — or in other terms, determination of the features that are used to characterize the system. And, further: As studied in chapter 4 in context of the 'steel plate" analogy, the environment being measured (the world) is deformed to match the probes. It is not only time (and space) that are relative — all information that is acquired is relative. The Heisenberg's "uncertainty principle" does not only apply in microscale, the same compromising has to be accepted also in macroscale, when observing large complex systems: If coupling is made tighter, the environment is deformed and the measurements change. And when doing observation, it *is* necessary to firmly push the systems to make them reveal the real structures of the underlying tensions. World consisting of elastic systems tries to yield and escape measurement, information being redirected in the non-restricted dimensions — one could speak of a "generalized Le Chatelier principle'. As Heraclitus observed, "nature loves to hide".

There is an age-old philosophical dilemma: *If a tree falls in a forest with no one to hear it, then does it make a sound?* — similarly one can ask whether a system exists if there is nobody to model it. If there is variation, it is information only if it is exploited by some system. George Berkeley claimed that "to be is to be perceived". To exist, or to be relevant, is to be in interaction with other systems and affect them. Systems and models are mixed, and experimenting and identification takes place all the time — the world is truly a holistic place. But also subparts can be studied, because such subpart reorganizes to fit the observer's expectations. A human is also a probe, an interface of a memetic system into the world.

The system is different when it is seen by some other — and the world as a whole is different when seen by some other. This observer (model constructor) need not be a human, it can also be another system. It is not because of subjectivity of models — it is because the system truly is different when seen through other eyes. If one selects some variables to construct a model with, the environment is reformed to obey the assumptions. The world view can become consistent because it is forced to become consistent, and the starting points can be motivated afterwards.

Man is the measure of all things — and this can be extended in the cybernetic spirit, as *a system is the measure of other systems.*

Speaking of relativity and numerical nature of models can lead to incorrect connotations. Statistical models sound like something uninteresting — if statistical averages and expectations are concentrated on, nuances vanish, and one only has some obscure "genderqueer models". However, in neocybernetic modeling the emphasis is on variation and differences; sparse coding in the final models means that structures that are relevant as independent entities become separated. In the spirit of Eastern masters:

> Before Zen, men are men and mountains are mountains, but during Zen, the two are confused. After Zen, men are men and mountains are mountains again.

10.2 About "new kind of science"

Stephen Wolfram [91] prophesized that old ways of doing science are powerless when studying complex systems — traditional mathematics has to be forgotten. As has been observed, such absolute pessimism is probably not motivated; one only needs to apply new interpretations and fresh ways of thinking when doing mathematics.

10.2.1 Mathematics in a change

As has been already observed, the potential of "old science" are not yet exhausted. But the ways how observations are interpreted are changing; and because it is this observation data that is the basis of one's world view, one is actually facing *a new kind of world.*

Wolfram's vision of ignoring mathematics altogether is futile, as *any* reasonable formulation of logical thinking is mathematics, after all. And there exist other motivations for sticking to the old modeling tools: As Eugene Wigner [87] expressed it, "the amazing applicability of mathematics to the physical world is a mysterious, undeserved and inexplicable gift". The main philosophical problem is not the applicability of mathematics to our descriptions of physical reality, but, rather, the major role of human-created mathematics in the *discovery* of new phenomena. What is more, it often turns out that it is the very simple mathematical machinery that only is needed — perhaps the reason for this is that in neocybernetic models, as studied before, no sophisticated mathematics is truly needed? Cybernetic models are based on mathematically simple quadratic optimization criteria. And there is another thing to remember: A cybernetic system implements sparse coding among its variables. When looking at the resulting models, this means that relationships between variables are compressed and projected onto separate relations of the form $\bar{x}_i = q_i \bar{u}_i$. Complex systems are decomposable, only the action (input variable) and the reaction (corresponding latent variable) need to be studied at a time. Rather than having to manage the mess of all contributing variables at the same time, one can concentrate on a subset of localized variables.

Still, there are some points that deserve a closer look; what are the characteristics of this mathematics that is especially efficient in this discovery of new models?

Since the ancient Greeks, the methods of doing science have remained the same. The rules of the "game" were invented obeying some aesthetic and pragmatic objectives. For example:

> In Euclidean geometry, only a compass and a ruler were allowed in derivation of theorems, and there had to exist a finite sequence of operations for reaching the result. It turned out that a vast body of problems really could be formalized in this way – but, on the other hand, some problems turned out to be too difficult. Whereas an arbitrary angle could easily be divided in two equal parts, the seemingly analogous problem of *trisecting an angle* could never be accomplished. What is more, there were annoying inconsistencies: As the division in two and four equal parts was so simple, why the case there between them is so different?

For the Greek, mathematics was only a free men's pastime activity, not to be applied in real life. From the practical point of view, however, having a homogeneous conceptual toolbox that would work in all cases without abrupt collapses would be more useful. In the era of the computer, the rules of the game can be changed: *Infinite procedures* have become realistic. For example, employing this opportunity, trisecting the angle can be carried out by dividing the angle in two alternating halves an infinite number of times.

In the traditional way of thinking, the computational approach is not elegant — but it offers the homogeneity: Algorithms crunch the numbers, no matter what is the input data. The neocybernetic models simulating the operation of underlying agents, as implemented in the parallel fashion applying matrix methods, is robust but efficient — indeed, as Albert Einstein has said, "God does not care about our mathematical difficulties; he integrates empirically". Among mathematicians, there is resistance against computational approaches as the calculations cannot be carried out using pencil and paper, but a computer is needed. On the other hand, when seen in the neocybernetic perspective, the paradigm that trusts iterations towards convergence are very natural: Computation is also a process proceeding towards a dynamic balance.

Another change in mathematical thinking is most profound: In the neocybernetic spirit, relevance is more important than absolute truth or provability. When modeling large-scale complex systems, one can never assure that all assumptions are met that have to be fulfilled for some mathematical result to hold. This means that analyses can become either very misleading or completely meaningless because of sloppy simplifications. Even if the theories say that in certain circumstances the identification algorithms, say, converge to fixed values, this convergence can take infinite time — and sometimes it does, meaning that such methods are not practical. It is better to collect real information from the system and apply the models that are naturally dictated by the system; when data is gathered over longer time of system operation, and relevant structures — those that are visible in behaviors — in the data can be determined through statistical analysis. The same "sloppiness" also applies to today's methodologies: Different kinds of soft computing methods, etc., are today routinely used even though their operation cannot always be assured — it is enough that they usually work. Such practices can change the direction where the whole field is proceeding, as research is what the researchers do. The humans determine what is "hot" and what is not. When modeling ecosystems, for example, the dynamics of memetic system needs to be mastered just as well as the genetic one.

It should not be forgotten that a research community is a cybernetic system following its natural dynamics — and another complex cybernetic system with human minds as a medium is that of practicing engineers, those who finally either use the new approaches or not. One must not underestimate the role of intuition when estimating the dynamics in such system — completely new methodologies cannot easily penetrate. In this sense, neocybernetics nicely combines old and new ways of thinking: For example, in the field of industrial automation, the basic ideas are already quite familiar — control, information, ideas of local linearity, etc., are routinely employed.

There is also need for fresh ways of thinking what comes to the mathematical tools — but the need of fresh thinking goes deeper than that.

10.2.2 Questions of "why?"

Natural sciences like physics traditionally try to answer the "how?" questions: One derives formulas to explain behaviors and to estimate them. In biology and ecology, for example, the questions are of the form "what?", describing nature in terms of direct observations, and constructing taxonomies. In humanistic sciences the emphasis even seems to be on "who?", concentrating on singular cases rather than on statistical relevance, not to mention general rules. There is a hierarchy among the sciences what comes to their power in explaining phenomena — one could say that "how?" is an emergent-level problem setting as compared to "what?", and one cannot reduce such explanations to a set of lower-level ones in a one-to-one fashion. In the same manner, the next emergent level above "how?" is "why?".

If we trust Theodosius Dobzhansky, evolution must be seen as the basis of all biological and ecological phenomena. And the kernel of evolution boils down to this question.

It has been said that by definition science does not answer questions of that type — *teleology* and *finalism* are notorious words today. But what if this constraint could be relaxed; what if this starting point is just a problem of current ways of thinking, still reflecting the cybernetic battle between religious and non-religious explanations? After the studies in the Middle Ages, when all explanations *had* *to be* divine, they now *must not be.* After the other extreme we are now in the other, and balance is still being searched for. Indeed, these issues seem to be a *taboo* — so aggressive is the resistance against the creationistic movements, for example.

Still, it is clear that the old problem settings are becoming obsolete. Today, the data is so high-dimensional that there is an infinite number of ways how they can be explained — if only accepting the "how" explanations. There is never enough fresh data to cover the exponentially increasing space of the variables. Postmodern science is becoming a "fiddler's paradise" where the strangest formulas and theories are proposed. Observation data can be reduced into unequivocal formulas only if applying strong model structures and modeling principles — and the models based on the question "why?" give the tightest framework with the least number of free parameters. Instead of speaking of some *primus movens* or *elan vital* one can also more neutrally speak of *maximum entropy production* as studied in chapter 9; however, this is just a terminological trick, the fundamental underlying explanation for the behaviors remaining equally mysterious.

In technical terms, nothing very peculiar takes place: Finalistic criteria are often reflected as optimization problems. The motivation for this is that operation in a cybernetic system is based on the competition among the low-level agents — as seen from outside, in the slower scale, the "losers" cannot any more be seen, only "winners" being visible. The Fermat's principle (light chooses the fastest path) can be explained in terms of photon populations; similarly, the idea of the "selfish gene" [20], for example, can be reduced to analysis of populations. The way of looking at the emergent illusions just makes the system look clever and behaviors in them look pre-planned; finalistic arguments make it possible to express the emergent patterns in a compact form.

When doing cross-disciplinary studies, one must not underestimate the role of intuitions and connotations there are. After all, however, it does not matter whether one speaks of emergy pressure or tension — or of "life force" or "will", in the sense of Arthur Schopenhauer.

There also exist other kinds of emergent-level criteria for constructing models. Remembering that our own mental machinery has been polished by millions years of evolution, one can perhaps also propose "anthropomimetic modeling". What kind of dependency structures does the mental machinery utilize in its subconscious modeling process? Using everyday terminology, it seems that one of such principles is *beauty,* or, more specifically, *symmetry.* Symmetries make it possible to capture dependencies in patterns, thus efficiently compressing information, as studied in chapter 9. Harmonic patterns please the eye because they match our innate models — or they help to enhance the models. Extending this to other systems is not as esoteric as it sounds — why should the human be the only example of natural systems where such sophisticated models of fractal symmetries are introduced; perhaps nature is beautiful of necessity, to make the quantum-level systems cybernetically modellable and thus controllable? Perhaps nature is understandable not only at the conscious level, but also on the very deep sub-conscious level — but, still, this beauty is there not to please us; it may be that an ugly universe could not be balanced in the first place! Anyway, symmetries are more or less explicitly used as the starting point of modeling in quantum physics today — mainly for pragmatic reasons, as this is the only way to decrease number of parameters there, but perhaps these symmetries really reflect reality. It is not only the best of possible worlds, in the sense of Leibnitz (and also in the neocybernetic sense), but it is also the most beautiful one — Miss Universe, as judged by the jury of systems (including us).

Perhaps there are still more general ideas available — guidelines that could be exploited to model and control the higher-level memetic system of *science making* itself. When trying to understand the world, and when modeling it scientifically, one is facing data coming from complex systems. But if the system being modeled is cybernetic, one already knows that there exists a model — the model that is implicitly being used by nature for keeping that system hold together. Here it is reasonable to present the *Gaia hypothesis* by Joe Lovelock:

> The Goddess of Earth (Gaia) has purposefully designed the geological, climatological, etc., processes to support life.

This strange principle makes it possible to draw strong conclusion concerning life on earth; there also exist closer analyses (for example, see [45], [33]). Similarly, one can propose such emergent-level laws — let us define the "Pallas Athene Hypothesis", or, actually, the "Antero Vipunen Hypothesis", as follows:

> The God(dess) of Science has purposefully designed the biological, ecological, etc., processes to support science.

The triumph cannot end now — the Goddess of Science protects us so that nature will continue to be graspable to humans, and science will continue to prosper. It seems that system complexity and analyzability go hand in hand: If nature has been able to construct sophisticated model structures for the cybernetic systems, why not us? The claim here also is that *cybernetic systems can always be modeled,* human's task is to detect these models. When searching for the models, there are always many ways to proceed; but the above hypothesis gives strict guidelines about where to go next; indeed, this whole text is based on such assumptions — or the world is seen through "neocybernetic eye-glasses". One of such fundamental assumptions was that of (piecewise) linearity: Otherwise, reductionism does not work. However, even though the model structures are linear, it is not so that the combined system would be simply decomposable: As new boundaries against outer environment are exploited, new "forces" are detected, and the "steel plate" is no more the same. But when one starts from simple assumptions, the result remains simple — the linearity assumption is like the *parallel axiom*: if this assumption is adopted, a consistent, nontrivial framework can still be derived, revealing a very different view of the world.

Actually, the key question in neocybernetics is not "why?", but "why not?".

10.2.3 Mental traps

Many beliefs from the past seem ridiculous to us — how about *our* beliefs as seen hundreds of years in the future? Even though we know so much more than the medieval people, it is difficult to imagine what we cannot yet imagine. And, indeed, because of the new measurement devices and research efforts, the number of "non-balanced" observations and theories is now immense. There are many fallacies and logical inconsistencies in today's top science — many of these are related to the astonishingly clever orchestration and implicit control of complex processes. Categorically avoiding the "why?" questions results in unsatisfactory models: Today's explanations for gene transcription and translation, for example, make the role of message-RNA sound, really, like an agent story, this agency representing some central intelligence.

Today's challenges involve different kinds of complex networks, and today's conceptual tools do not help in understanding them. Indeed, when seen in the appropriate perspective, most challenges today can be characterized in terms of networked distributed agents: For example, the advertised possibilities of nanotechnology can only become true if some mechanism of self-organization and self-regulation among the nano-things can be implemented.

The agents doing science are humans, and it is the patterns of "common sense" thinking that have to be overcome to reach new ways of seeing the world. A person that has adopted Western thinking is in the prison of centralized thinking. To understand complex cybernetic systems, old thinking patterns have to be recognized. It is like the Zen masters say, "if you are thinking of Buddha, you must kill it" — or if you notice that you are thinking you must stop it! It is the religious ideas that are among the most fundamental patterns of thought, one of them in the Western culture being the monotheist dogma of a personalized creator. After detecting such thinking patterns, escaping them is still not easy. Jean-Paul Sartre has said that *even the most radical irreligiousness is Christian Atheism* — one explicitly (aggressively) tries to eliminate all divine-looking explanations, but in vain.

Getting distributed by definition means loosening the controls. Indeed, traditional centralized control is a prototype of Western ways of structuring and mastering the world. But even though the Eastern wisdom better captures the essence of cybernetic phenomena, engineering-like approaches are necessary to "bootstrap" ones understanding, and powerful conceptual tools are needed to construct new kinds of emergent structures. The hermeneutic mind alone is not enough, one needs a link to the outer world. Some kind of synthesis of Eastern and Western ways of thinking is needed; and neocybernetics seems to offer a framework where it is possible to reductionistically study holistic distributed systems.

Can "cybernetics" then offer some alternative content for one's personal world? Fortunately, creating maxims out of nothing is not needed — it has already been done. Eastern holistic thinking offers a model of how to create the new world view. For example, the underlying vitality principle beyond the Chinese philosophy and medicine is based on the ideas of balancing and ordering (see Fig. 10.3); in Indian philosophy many principles (stationarity, desire and consequent suffering, etc.) reflect the cybernetic ideas; and the Japanese pantheistic belief on the millions of Gods, each managing its own subsystem, is also appealing. According to Eastern philosophers, the reason for suffering is missing knowledge and understanding.

Figure 10.3: Chinese symbol for the mystical *ordering principle,* also denoting *air* or *vapor*

10.3 Rehabilitation of engineering

In the beginning, in chapter 1, it was wondered whether control engineering can have anything to do with biology. As a conclusion, it can be claimed that there is contribution in both directions.

Since 1960's, after the great discoveries of modern control theory, there have been no real breakthroughs in the branch of control engineering. It seems that this stagnation does not need to last long: There is a Golden Age of control engineering ahead. Control theory and tools can be applied not only in technical applications, but also in understanding really complex system — biological, social, economical, etc. There do not necessarily exist explicit controls in such systems, but understanding the natural dynamics in such systems is still based on control intuitions.

It is traditionally thought that philosophy is the basis of all science: Logic is part of philosophy determining the rules of sound thinking. Mathematics if "applied logic", implementing the logical structures and manipulating them according to the logical rules. Natural sciences, on the other hand, can be seen as "applied mathematics", where the ready-to-use mathematical formulas are exploited to construct models. Finally, the engineering disciplines are "applied science". Engineering is inferior to the more fundamental ways of structuring the world.

This is a formal view of how deductive science is done, and how new truths are derived. However, also these viewpoints need to be reconsidered: If the presented neocybernetic modeling can cast some light onto the mysteries of what is the essence of complex systems, the deepest of the philosophical branches, metaphysics, is addressed. It is mathematics that offers the *syntax* for discussing the issues of what is there beyond the observed reality, and it is control engineering that offers the *semantics* into such discussions. It can be claimed that control knowledge is necessary for understanding complex systems, natural or artificial (see Fig. 10.4).

Martin Heidegger once said that as classic philosophy fades away, cybernetics becomes a philosophy for the twentieth century. This will be even more true in the 21'st century: Philosophical considerations can be interpreted from the viewpoint of information science, they can be given fresh contents, and, what is more, there are new conceptual tools available — the language of mathematics.

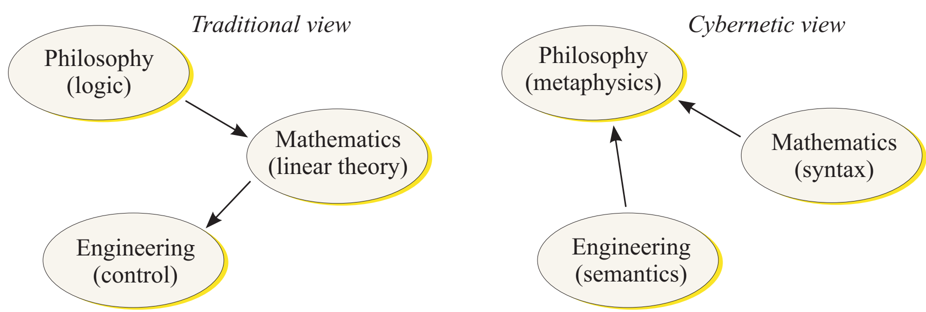

Figure 10.4: New view of control engineering studies as delivering substance to philosophies