Modelling Creative Contradictions for Organizational Change

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ABSTRACT
This paper tries to explore the concept of 'contradiction' in order to use it in dynamic designs for organizational change. The paper distinguishes between contradictions in the in the information sphere and contradiction in reality, both terms to be defined in the paper. Formalizing our approach by the use of some game-theoretic concepts opens up the possibility to discuss the influence of new information and communication technologies as a support for creativity and innovation.

INTRODUCTION

It is a common phenomenon that applications of simulation methods in organization design cannot be founded on straight forward optimization models of the entities under consideration. There are several major reasons for this deficiency: First, the respective actions of entities are interdependent, second the entities themselves are heterogeneous and third entities are model-builders including in their models other entities' models. The classical answer to these problems is the game theoretic approach. Especially the first two questions - how to incorporate interdependence and heterogeneity - have been extensively explored[1]. Game theory might correctly be considered as the most important tool to formalize conflicting optimization plans.

But as the third problem area - the model-building aspect of entities - shows, contradictions can arise at different levels: On the one hand different, contradicting models of the same reality can be used by different entities (this evidently draws on the idea of 'bounded rationality', originally developed by Simon [Simon, 1982]). This type of contradiction we call *contradiction in the information sphere*. On the other hand conflicts evidently also occur in reality - the actions of entities in an organization contradict each other, what is good for the one is bad for the other. We call this second type *contradiction in reality*.

To deal with problems of the just mentioned kind game theory has to be extended to include the production and acquisition of information, that is the emergence of the information sphere. After a short general introduction to the historical background of the formalization of contradictions, section 2 of this paper tries to outline ways how to do that. Using "wrong" or more precisely "preliminary" models of reality usually implies adjustment of models if they persistently fail. In other words, *time* has to be made explicit, the model-building process has to be described as a dynamic process.
Section 3 tries to explore how time needed for adjustment and cost occurring due to acquisition and production of information influence *contradictions in the information sphere* of an organization. It is interesting to see what the existing AI techniques could provide in this respect. (For similar approaches compare [Moss/Rae, 1992], for an evaluation of possible trends in AI see [Hanappi/Egger, 1993a])

Contradictions in reality, conflicts within organizations, are the topic of section 4. Re-interpreting these contradictions as sources for creative organizational change, instead

[1]) In [Egger/Hanappi, 1993] we introduce a method to structure heterogeneous problem levels correlated to different agents within an organization

of viewing them as purely counter-productive disturbances, opens up the possibility to sketch promising ways for computer support of this creative potential. Again AI-techniques can be used as a starting point for organizational responses to contradictions in reality.

The last section links both types of contradictions. The conflicting entities develop diverging world-views, contradictions appear in the real sphere as well as in the information sphere. We call this type of combined contradiction *complete conflict*. Interference between support of diverging world-views and direct support of actions aiming at the solution of real contradictions clearly will result in a rather sophisticated design of organizational response. As a consequence, strong interaction between precisely specified computer support and human conflict resolution techniques will be necessary to use the creative potentials of complete conflicts.

1 Contradiction - some historical approaches to the concept

At first glance it seems to be a rather daring idea to propose a new concept like 'contradiction' for dynamic modelling. For most scientists using formal languages this word has a bad connotation: contradictions are something one has to avoid. At best it could be accepted as something like a test to falsify preliminary formulations. Looking at the history of thought the sudden decrease of the reputation of this concept within the last hundred years is astonishing. 'Contradiction' indeed is one of the oldest concepts used for scientific reasoning.

Aristotle considered his 'principle of the contradiction' to be the most fundamental of all possible axioms [Aristotle, 1966, 4th book, p.1005b]. It basically states that one cannot hold two contradictory views at the same time. To show how self-evident this idea is, he argues that any dialogue between entities *holding contradictory views* would be impossible if each entity for itself would not hold a non-contradictory view. Contradiction and identity of views are logically bound to each other and form the basis for any scientific progress, for any 'dialogue', as Aristotle puts it. In some sense this contains already the nucleus of what we want to put forward in this paper. In particular section 2.1. tries to build on this ideas.

Some two thousand years later René Descartes rediscovered this aspect of classical Greek philosophy and gave it the twist of attaching it to the personal activity of the researcher: doubt is said to be the only, and therefore most fundamental of all principles, since it cannot be doubted [Descartes, 1980 (1643)]. As Krahl later notes [Krahl, 1977] this statement already implies a primacy of intellectual activity, namely doubting, over non-intellectual practice. In the paper our assumption that the emergence of new behavioural strategies is a phenomenon that presupposes *intellectual* discontent with the current Nash equilibrium, i.e. processes in the information sphere, draws on Descartes' view.

Our distinction between contradictions in the information sphere and contradictions in reality is based on the analogue distinction made by Immanuel Kant in his 'Critique of Pure Reason' [Kant, 1763]. As Lucio Colletti emphatically argues [Colletti, 1977], the lucidity of Kant's analysis concerning this concept has been underestimated by most modern interpreters. Kant, the ancestor of classical German idealism, by introducing this distinction opens up the road to the analysis of 'reality' and its links to the information sphere.

His follower Hegel centres his whole theoretical oeuvre on the attempt to describe the emergence of the new as a logical process characterized by iterative negations [Hegel, 1812]. In a sense this marriage of Descartes' doubt-concept with Kant's idealistic view that the information sphere determines the real sphere enables Hegel to become an excellent philosopher of history. Historical processes can be described as being logical[2]. We owe to Hegel our view that social entities emerge and 'grow', a process taking place in both spheres - what will describe in more detail below.

Finally we have to confess that our view that it is the real sphere which predominantly drives the information sphere in an ever more interdependent world, is firmly rooted in left-Hegelian thought[3] (see [Feuerbach,] and [Marx,]). In particular, the contradiction between markets and hierarchies, recently made popular by [Williamson, 1975], can already be found there. We use this idea when discussing asymmetries in power relations in firms as in sections 3.2 and 4.2.
As this brief synopsis shows, the concept of contradiction does have a rather heavy weight of philosophical meanings to carry. Our attempts in this paper should only be considered as a modest attempt to re-introduce it into current debates[4].

2 Formal descriptions

2.1 Contradictions in the information sphere

Taking the proposition that entities are model-builders serious means that building a model of social entities includes the modelling of modelling. Several routes are open to do this. The one we propose starts off with the idea that constructing and using models is a resource consuming activity. More precisely, models will be developed and used to the extent that returns from their use exceed the costs they incur. With decreasing marginal returns and increasing marginal cost - think, in particular, of the opportunity cost of substituted activities - model-building will always stop at a certain, imperfect level. This, of course, is just the economic foundation of Herbert Simon's concept of 'bounded rationality': entities do build models and use them for rational choice, i.e. for optimization, but they enlarge these models *only as long as expected gains from these enlargements are high enough*. This is the way in which their rationality is restricted. The model they are looking for is the best model they can get *at a certain cost*. Occam's razor, the postulate to focus on the essential features of a model, is just a popular formulation of this rationale.

With different expected returns and cost functions even interdependent entities will come up with different models of the same real interdependence. Each entity has its own view of the relationship, though some features, probably the ones where 'objective' inter-actions occur, will be shared. It is this set of common properties[5] of all models which induces entities to believe that there exists a true model of reality. Figure 1 depicts the situation.

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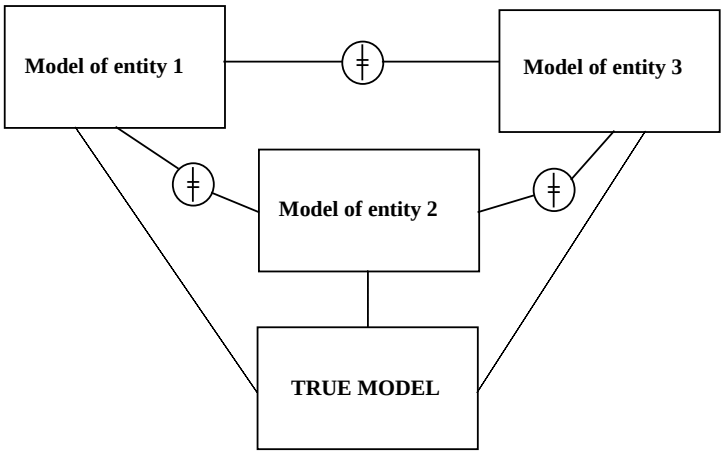
[2]) An interesting recent formalization of Hegel's dialectics can be found in [Kesselring, 1984].

[3]) This development of the concept of 'contradiction' up to Hegel does not seem to be a purely occidental specificity as Mao Ze Dong with his comparisons to classical Chinese authors shows [Mao Ze Dong, 1937].

[4]) A critical assessment of the most rigid work in formal logic (and its derived programming tools) would show that precisely those schools, which condemn contradictions most are the ones that (logically) depend most on it.

[5]) Properties can be certain commonly used variables as well as relationships between them.

Figure 1: Contradictions in the information sphere



As indicated by the unequal sign each model is different from the other two in sense to be explained in the sequel. At the same time, all models have *some* common features since they are abstract representations of the *same* reality. That is, each one claims to incorporate the essential features of a more complete 'true model' - the existence of which usually is agreed upon by all model-building entities. The broken lines in figure 1 thus indicate the process of simplification of an underlying 'true model'. The proposition that the concerned entities abstract from the same 'true model' represents the idea that they model their interactions, that they in fact are interdependent elements of the same reality.

A simple example will demonstrate what the inequality of models actually comes up to. Assume that there is a common agreement of entities that variables x and y are essential and are somehow linked to each other. This means that they should be part of the 'true model'. Assume that on the other hand there is disagreement of the three models in that the model of entity 1 states:

$y_t = f^1 (z_{t-1})$, $z_t = f^2(x_{t-1})$,
while the model of entity 2 states that
$y_t = f^3 (x_{t-1})$,
and finally the model of entity 3 holds that
$x_t = f^4(z_{t-1}, y_{t-1})$.

Though there are some common grounds of these models, in particular they can be estimated by the use of the same historical data set[6], they clearly are different. Anyone who combines the three estimated models in a meta-model easily can derive logical contradictions of the form {K*y = M*y, with K ≠ M}. This gives rise to our formal definition of a contradiction in the information sphere:

Any set of models concerned with a common underlying 'true model', implying a meta-model combining them, which, in turn, implies logical contradictions is considered as a *contradiction in the information sphere*.

[6]) John Casti makes the important point, that these variables must be *observable*: ' .. the study of natural systems begins and ends with the specification of observables describing such a system, and a characterisation of the manner in which these observables are linked.' [Casti et al., 1992, p.6].

An interesting special case immediately arises if the reality concerned by the 'true model' is itself a formal language. In that case the elimination of contradictions in the information sphere becomes equivalent to the construction of a logically consistent formal language. According to Goedel [Goedel, 1931] and Tarski [Tarski, 1935] even in this purely formal arena contradictions (in this context usually called 'paradox') cannot be solved within the lower level language, but lead to the development of meta-languages - their creative potential induces a 'growth of language'.

Beyond this special case, the inner life of formal languages, evolving and solving of contradictions in the information sphere causes what has been called the 'growth of knowledge'[7] - and simultaneously a growth of power of manipulative ideology. These more general cases will be the topic of section 3.

2.2 Contradictions in reality

As our treatment of contradictions in the information sphere showed, even for this type of contradiction some *common experiences in reality* of the entities under consideration are a necessary precondition for some shared model features, summarized in a common vision of a 'true model'. By introducing the notion of 'contradictions in reality' we suggest that at this lower level there exists an analogue, though basically different type of contradiction, which has to be dealt with separately.

The ingredients for a formalization of this type of contradiction are similar but not identical to the ones used in the case above. First one again needs a set of entities, which could be said to be in a state of 'contradiction in reality'. For didactic reasons let us assume that there are only two entities. Furthermore these entities must be linked to each other. A well-known and fairly general formal tool to present such a link is the Edgeworth-box [Edgeworth, 1881] interpreted as the conflict over two types of scarce resources[8]. With well-behaved utility functions of the entities[9] we can define a so-called conflict-curve: a set of distributions of the two types of resources, where each entity can increase its utility only by decreasing the opponents utility. Figure 2 presents a typical Edgeworth box.

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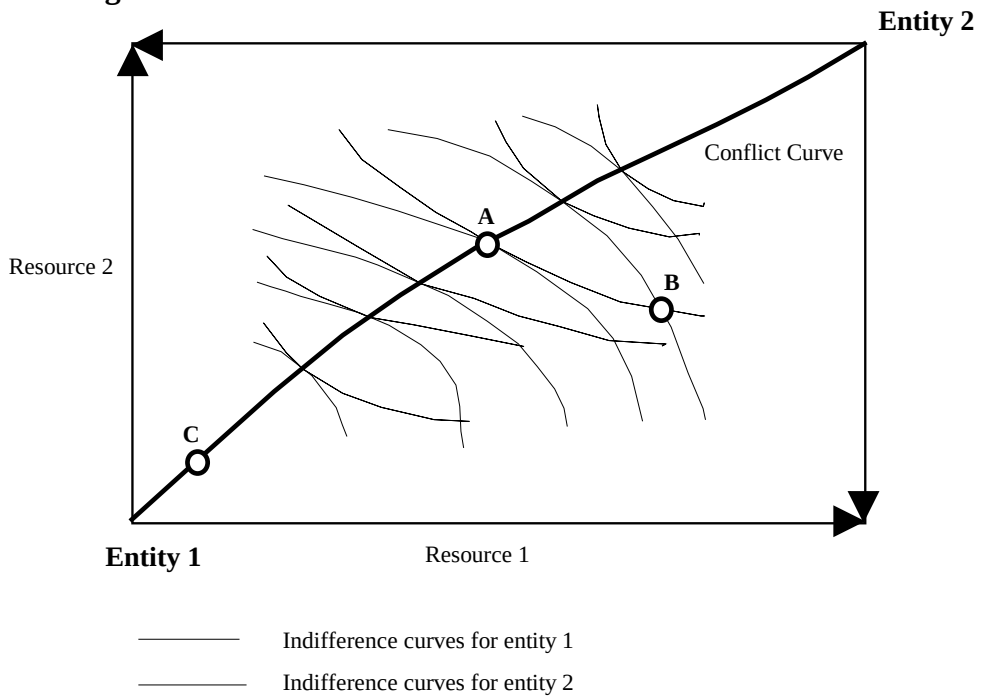
[7]) Bruce Caldwell correctly identifies the so-called 'growth of knowledge'-tradition as the state of the art of contemporary philosophy of science. As he convincingly demonstrates, - though some scientists still ignore it - positivism has passed its zenith decades ago [Caldwell, 1982].

[8]) Of course alternative formal tools can be used. We borrow this one from economic theory mainly because its use is wide-spread and more readers might be familiar with it.

[9]) See [Kreps, 1990] for a thorough treatment of preference functions.

Figure 2: Edgeworth box



The length of the two sides of the rectangle represent the amounts of the two types of resources that are to be distributed. Each point within the box represents a distribution of the two resources, such that the horizontal distance from the point to the left border of the rectangle measures what amount of resource 1 is given to entity 1, while the remaining amount of resource 1 is measured by the horizontal distance from the point to the right border of the box. The same procedure is applied to the vertical distribution of resource 2. With the two entities residing in the two opposite corners as shown, their indifference curves - points representing distributions of equal utility for an entity - can be drawn. From a point like B the utility of entity 2 can be increased without decreasing the utility for entity 1, simply by wandering along the indifference curve of entity 1 towards point A. Point B thus is not a point of the conflict curve as defined above. Points like A are on the conflict curve because there two opposing indifference curves touch each other. All these points are said to be Pareto-optimal.

The conflict curve derives its name from the fact that it depicts distributions where improvements cannot be achieved peacefully, like the shift from B to A, but only via a conflict between the two entities. Points on the conflict curve evidently represent different power constellations between the two entities. In point C, for example, the utility of entity 1 is much lower than in A and the opposite is true for entity 2. In fact one could *define relative power* of the two entities with respect to the distribution of the two resources by the use of the position on the conflict curve as observable power index. The question is, why the fight over distributions should settle in a specific point. This is exactly where our main assumptions concerning the formalization of contradictions set in:
First, we assume that the entities under consideration are social entities interacting in a social context which has provided some institutionalized mechanisms to approach Pareto-optimal solutions. In other words we confine our discussion on social settings with a sufficiently developed institutional background guaranteeing that we can restrict further arguments to those concerning movements *on* the conflict curve.

Second, we propose that social entities, since they are model-builders, are not content with the states of low relative power. Point C in figure 2 will not be solution with which entity 1 is willing to live for a long time. Nevertheless even very unequal power distributions can prevail for some time. We call such periods '*periods of relative stability*' and formalize them by the use of the game-theoretic concept of Nash equilibrium[10]. In figure 3 the strategy pair {S2, S3} is such an equilibrium underlying a state of relative stability. The pay-offs {U1*, U2*} could, for example, be equal to the respective utilities of the two entities in point C in figure 2.

Figure 3: Nash Equilibrium

		Entity 2		
		S1	**S2**	**S3**
Entity 1	**S1**	U_1^1 , U_2^1	U_1^2 , U_2^2	U_1^3 , U_2^3
	S2	U_1^4 , U_2^4	U_1^5 , U_2^5	U_1^* , U_2^*

$$U_1^* > U_1^3 \quad \text{and} \quad U_2^* > U_2^5 \quad , U_2^* > U_2^4$$

Clearly with the given strategy spaces for the two entities neither one can improve its utility by a change of strategy. Since prisoner-dilemma games are ruled out by the assumption made in the last paragraph, even simultaneous changes cannot lead to Pareto improvements. This leads to the following definition of a contradiction in reality:

Any relatively stable power constellation of social entities, described as a Nash equilibrium in given strategy spaces, which leads to a point of a conflict curve in the struggle for a set of finite resources is called a *contradiction in reality*.

The interesting point in this definition evidently is the concept of *relative stability* of a power constellation. It is a situation where dynamic forces aiming at a change of the current state not only exist but indeed are building up. Nevertheless during this process of accumulation of dynamic force nothing happens, power relations are strong enough to freeze the current state until a certain threshold is reached. The movement towards the threshold is what we call 'state of relative stability'. Implicit in the notion of a social entity thus is the in-build characteristic of social model builders to *plan* a change of power relations by the use of their models. This is where the inner dynamics accumulate. But only if their models used as strategies in a forecoming conflict, are able to lead to a deviation from the current Nash equilibrium, only then changes in reality occur. Evidently the concept of relative stability is based on a link between the information sphere and 'reality'.

[10]) For a proper definition of Nash equilibrium see for example [Harsanyi, 1977, pp.141-166].

Elaborating this crucial concept leads directly to our main argument, namely that contradictions can be creative. This idea will be taken up again in section 4. But before this can be done a closer look at the battle in the information sphere has to be taken.

3 Learning and manipulating - conflicts in the information sphere

3.1 Major arguments reconsidered

In the last section we developed the concept of the inner dynamics of a contradiction in reality, which lead us back to the information sphere. Indeed a conflict in reality always is a conflict in the information sphere too. The models of entities compete and influence each other, learning and manipulation take place. From a certain perspective these interactions in the information sphere are just different ways of building up or contending the above mentioned inner dynamics.

A systematic way to structure the types of action on the battleground of information can easily be derived from our formalization in section 2.1. On a very basic level of argumentation one can distinguish between actions of an entity which aim at a change of its own model and actions which aim at a change of other entities' models. In the first case one could call the corresponding actions '*learning*', while in the second case one could call them '*manipulating*'. We first deal with learning.

Looking at figure 1 makes clear that learning can again be divided into two types of learning: An entity can improve its model either by the use of historical realizations, sometimes called instances of the 'true model', or by using parts or the whole of other entities' models.

The first sub-case often is labelled '*learning from history*' and covers such diverse areas as parts of scientific research[11], parts of learning behaviour of little children and learning of some political groups. Sometimes it includes the possibility to take part in the production of history, namely by the design of experiments, which enhances this type of learning dramatically: One has no longer to wait till the most interesting historical instances appear at random - they can be produced by will[12]. For this sub-case it is not immediately evident that in general a contradiction in reality is the underlying motivating force for learning. Indeed in some cases 'contradiction in reality' has to be somewhat extended to include the contradiction between a social entity and 'nature'. Though the latter is not a social entity, in these cases it is conceived of as such. The struggle against nature by learning from the past becomes a struggle against a fictitious 'social entity'. Nevertheless these cases are exceptions and one should keep in mind that most learning of this type is based on the regular case: two social entities proper[13]. For reasons to be obvious soon 'learning from history' is also called '*primary learning*'.

In the second sub-case learning means to appropriate parts, or even the whole of another entities model. Of course, this other entity can have borrowed its model from a third entity and so on. But at some point in this chain an entity must have derived its model

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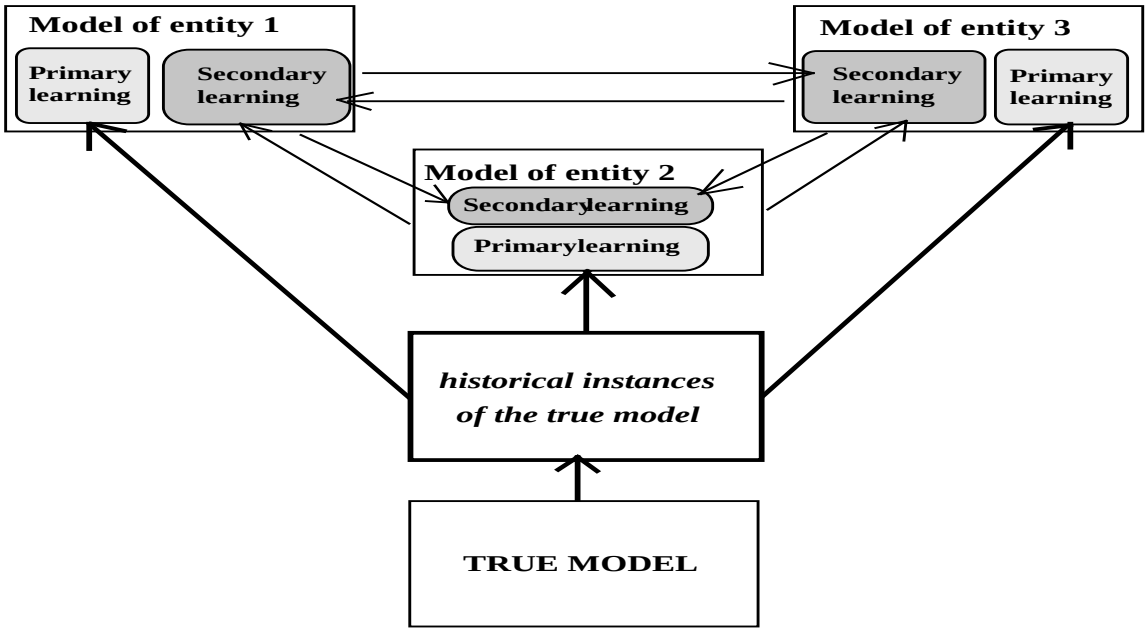
[11]) Astronomy, econometrics, ethnology ... - the list is almost inexhaustible - fall under this category.

[12]) An interesting treatment of this type of learning was introduced by the economist Kenneth Arrow who used for it the label 'learning by doing'.

[13]) Think for example of productivity increases due to research activities in competing countries. The underlying motivation clearly is the contradiction between the countries although learning from nature might be part of research.

by primary learning: in the end all science is derived from history[14]. A proper name for this other type of learning is '*secondary learning*'. Figure 4 shows the two types of learning.

Figure 4: Types of learning



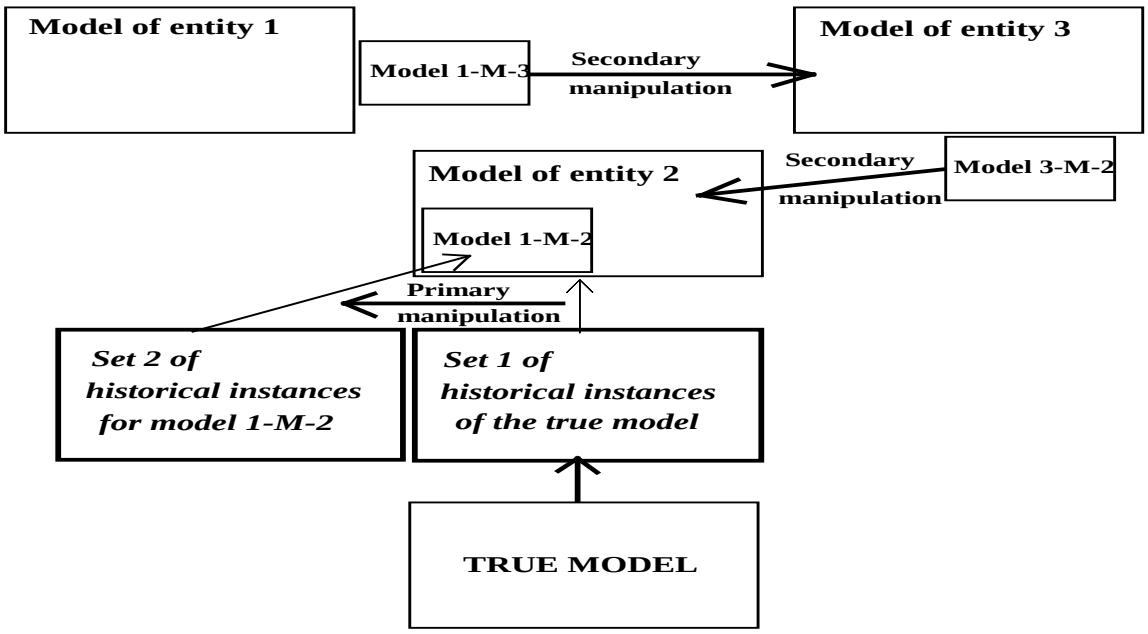
The motivating contradiction could either be to use an opponents model to arrive at a more sophisticated evaluation of strategies or to use models of entities which have the same opponent as the entity under consideration. The first case comes up to spying out the other entity, and as a consequence will be encountered by measures to keep the one model secret - basically to be described by contexts of 'privacy'. The second case on the other hand will lead to the notion of 'solidarity' directed against a common opponent. This latter case therefore implies the idea of a 'growth of social entities' as the models of previously smaller ones, who share a common enemy, converge.

Now turn to the case of manipulation. Like with learning, we also can distinguish two cases by the use of figure 1. But now the difference is not between manipulating other entities' models and 'realities' model' - 'reality' doesn't have a model. The counterpart to the manipulation of other entities' models is the possibility to shift the focus of other entities.
So the first sub-case of manipulation looks very much alike to secondary learning - instead of using other entities' models for ones own modelling, one could try to change the model used by the opponent. This is why we call this type of manipulation '*secondary manipulation*'. If directed against an entity standing in real contradiction the motivating force evidently is to confuse the enemy. If directed to partners in a conflict with a common opponent such activities can be circumscribed as 'enlightenment' of the others. In the latter case secondary learning and secondary manipulating might look like a competitive struggle for the correct model between basically solidarian partners.

[14]) Technically spoken, all knowledge of social entities hinges on the capability to develop and use 'memories'.

As by now can easily be guessed, the second sub-case of manipulation will be labelled '*primary manipulation*'. In this case an entity tries to shift the focus of the model of another entity towards another 'true model'. Figure 5 shows the two types of manipulation.

Figure 5: Types of manipulation



In the case shown in figure 5 entity 1 tries to manipulate entity 3 by the use of secondary manipulation, that is, it produces an 'ideological' model 1-M-3 (stands for '1 manipulates 3') and tries to make entity 3 believe that this is the true model[15]. Entity 3 wants to do the same, i.e. secondary manipulation, with a model 3-M-2 used with respect to entity 2. Contrary to these efforts of secondary manipulation entity 1 also tries to exert some influence via primary manipulation of entity 2. It does so by making entity 2 believe that the set 2 of historical instances is the one which is relevant for the construction of the true model. Due to this shift in relevance of historical observations from set 1 to set 2 in case of successful primary manipulation, entity 2 might well construct its model without influence from outside and will still arrive at model 1-M-2, what is precisely the aim of entity 1.

The story behind figure 5 thus could be as follows: There are two underlying real contradictions, the first between entity 1 and entity 3 and the second between entity 1 and entity 2. Entity 1, being the most powerful entity, tries to calm its two opponents by different types of manipulation. With respect to entity 3 it lets the latter use the correct, that is, relevant historical data set but confuses this entity by propagating model 1-M-3 and disturbing model building (secondary manipulation). With respect to entity 2 entity 1's strategy is to concentrate on a shift of the attention of entity 2. If entity 2 uses the irrelevant historical data set 2 it need not be manipulated in model-building (primary manipulation). The choice of manipulation strategy of entity 1 therefore in the first place could have been guided by its expectations on how good each of them will work with each of the two opponents. As a last interpretation consider the case that entity 3

[15]) An important question is if entity 1 believes in its own ideology, if the model 1-M-3 is identical to the model of entity 1.

finds out about some of entity 1's efforts of confusion. Furthermore entity 3 could realize that, like itself, entity 2 is in opposition to entity 1. Concluding from its own experience entity 3 will suspect that entity 1 uses secondary manipulation to get entity 2 to believe in model 1-M-2. As a consequence entity 3 will try to help entity 2 by influencing it with model 3-M-2, probably identical to its own model. Unfortunately entity 2 will not be convinced easily since model 3-M-2 does not fit to its 'confused' focus on relevance - an effect entity 1 might have foreseen. And so on.

To get an adequate impression of which types of learning and manipulating are going on in the information sphere of a specific situation where social entities are tied to each other by various contradictions in reality - and arising coalitions, i.e. growth of social entities - the respective figures 4 and 5 have to be overlaid.

3.2 The influence of new IC-technologies

Narrowing down the scope of our considerations from the more abstract, general features to some concrete historical experiences opens up the possibility to highlight the influence of new information and communication technologies (IC-technologies) on conflicts in the information sphere.

In a sense the French enlightenment was the historical event which started the enduring upraise in the reputation of 'learning'. Instead of believing in some God-made order learning from nature, what we called primary learning, became the essence of the big project called *science*. At the same time, given the political impetus of the French revolution, the emerging knowledge was thought to be distributed over all people. It is evident how this vogue of secondary learning was enhanced by the new IC-technologies of making books and newspapers, providing public schools, experimenting with political organisational forms and the like. But as soon as the material channels through which learning flows are installed, they are prone to be used for manipulation. As the example in the last section showed 'manipulation' does not always earn its negative connotation. If it is a solidarian action against a common opponent it might turn out to be a good thing for a social entity to be manipulated by another one. The struggle of ideologies which developed over the last two centuries in many fields gives an excellent picture of the intermingled role played by learning and manipulating.

During this time social entities did grow from the level of towns and cities via regions and nation states to the contemporary continental blocks, the so-called triangle, sooner or later to be melted in one big social entity called global human society. Clearly the IC-technologies necessary to manage the information sphere had to grow accordingly. Nowadays these technologies evidently belong to what is called infrastructure and basically are owned by a few monopolistic firms whose major concern therefore must be to achieve arrangements with national governments.

Finally it has to be insisted that manipulation is winning the game against learning not only on a macro-level but also on the micro-level of firms and households. Consider for example new firm strategies launching so-called 'corporate identify'-programs to increase labour intensity of employees without having to pay for it.

The manipulation potential of IC-technologies lays in the technical opportunity to offer receivers more pre-selected information. Furthermore 'information' is not anymore data concerning facts but more and more it consists of models and interpretation schemes. Since it is the supplier of information, who determines what is worth to be presented,

which aspects are highlighted and how the information is prepared, it is also the supplier's model and interpretation schemata which are received by others (Hanappi/ Egger, 1993b).

A historical treatment of production techniques would show that there also is a parallel history of information systems accompanying them[16]. Starting from more or less mechanical systems recording the activities of workers up to the highly developed measurement tools of contemporary factories[17]. These straight forward applications of modern technology to the old field of work discipline and rationalization do have high aspirations of being 'intelligent', which obviously stems from its newly developed faster feedback features. While information systems in the past only reported the behaviour of workers and machines, leading to a lagged reactions of owners when they became aware of these reports, modern information systems are able to react on certain malfunctions without any intervention of a manager. This type of extended and accelerated feedback becomes profitable as far as it exploits the specific characteristics of workers[18].
Substituting surveilling managers by direct feedback of information systems to economize on expenditures for management does not make such information systems more 'intelligent' than ordinary data bases. Even expert systems are just an extreme example of this type of application. The flavour of intelligence only arises from the amount of data used as knowledge base and not from the type of procedures and man-machine-interactions involved.

Note that till now the IC-technologies are designed mainly for the use of managerial tasks. AI-techniques made the information systems more sophisticated in terms of information acquisition and retrieval. Furthermore they offer decision support by structuring the decision making process and by simulating decisions and their consequences. From a game theoretic point of view the introduction of IC-technologies is equivalent to the appearance of a new strategy. According to our argument concerning the asymmetry in power it will be a strategy of the firm owners. The old Nash equilibrium evidently will be called into question. In this situation the suppliers of information - clearly in this case the firm owners - are able to manipulate their counter parts (compare section 3.1) by 'feeding' them with an appropriate model. If they succeed a point on the conflict curve even more favourable for firm owners will be the result.

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16) 'Those who occupy supervisory and coordinating positions have an immense organizational superiority over the others. The interaction and communication networks actually centre on their function, as can be seen easily enough in the organization chart possessed by every modern firm'. [M. Mann, 1986, p.7]

17) And they still grow: 'The distinctive feature of applications software systems in large organizations is that *after* they are put into operation they usually grow by about 10 percent a year.' [A. Stinchcombe, 1990, p.81]

18) 'Because the regulatory mechanisms are there to meet disturbances from the environment, and because they must counteract these disturbances, they must, in some sense, obey the *Parallel Principle*: A regulator must be 'like'` the environment it regulates.' [G. Weinberg, D. Weinberg, 1979, p.206]

In such a gloomy perspective small social entities really would be lost if there were not these most astonishing features of human behaviour which arise from unresolved contradictions in reality: destructive innovation and creativity. Therefore the question will be if IC-technologies can be used to support innovation and creativity, too.

4 The roots of innovation - conflicts in reality

4.1 Creative contradictions in organizations - a sketch

Taking into account that contrary to the simple models presented in this paper real world situations usually involve a larger number of social entities with different, sometimes very sophisticated information policies it is hard to believe that the emerging confusion is not greater than it already can be observed to be. The reason for that is the property of social entities to use their own *practice* as a shelter against information overloads: It is their own practice, the use of a model, more precisely the evaluation of the results of actions based on this model, which proves a model to be true for this entity. In the argument developed here this means that one has to trace backwards first how models translate into actions and, second, how the latter cause movements on the conflict curve. In short, how successful models are as tools in conflicts over contradictions in reality, as defined above, is an indicator for the *truth* of a model[19]. This truth plays a major part in model selection, i.e. discarding and maintaining models, which in turn became an ever more urgent task as information technologies became cheap and the information flood rose.

Proceeding with the above mentioned step 1, one has to specify what is meant by a set of actions based on a model. Again a game-theoretic concept, namely 'strategy', can be used. Given the goal variables and the instrumental variables of a model and taking into account some knowledge about the opponents models, goals and instruments, strategies can evaluated with respect to their expected performance. In the light of the former argument the practical problem is that a complete enumeration of strategies has never been feasible and with increasing confusion is accepted as such. One way out propagated by practitioners in game theoretic applications is the use of *behavioural strategies*[20].

The use of behavioural strategies hinges on the possibility to find some simplifying principles in the empirically observed historical record, which allow for a classification - and thereby a reduction of the number - of all possible strategies to a manageable set. Since a strategy is defined as a sequence of actions, this idea could also be expressed as the possibility to make judgements about the value of a single action without knowing which other actions precede it, that is, without knowing which strategy actually is played[21]. In other words a behavioural strategy is some kind of rule which enables an entity to choose between possible actions *at a certain point in time* - a rule which replaces the optimal choice of the whole sequence of actions called strategy. So while behavioural strategies do allow entities to forget about history when decisions have to

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[19]) Note that this type of truth is different from the usual notion of truth of statements in formal languages. Following Kant's distinction of judgements one could name this truth synthetic truth, combining the two levels of contradictions, as compared to analytic truth, evaluating the consistency of a language.

[20]) An introduction to this concept can be found in [Owen, 1982, p.87].

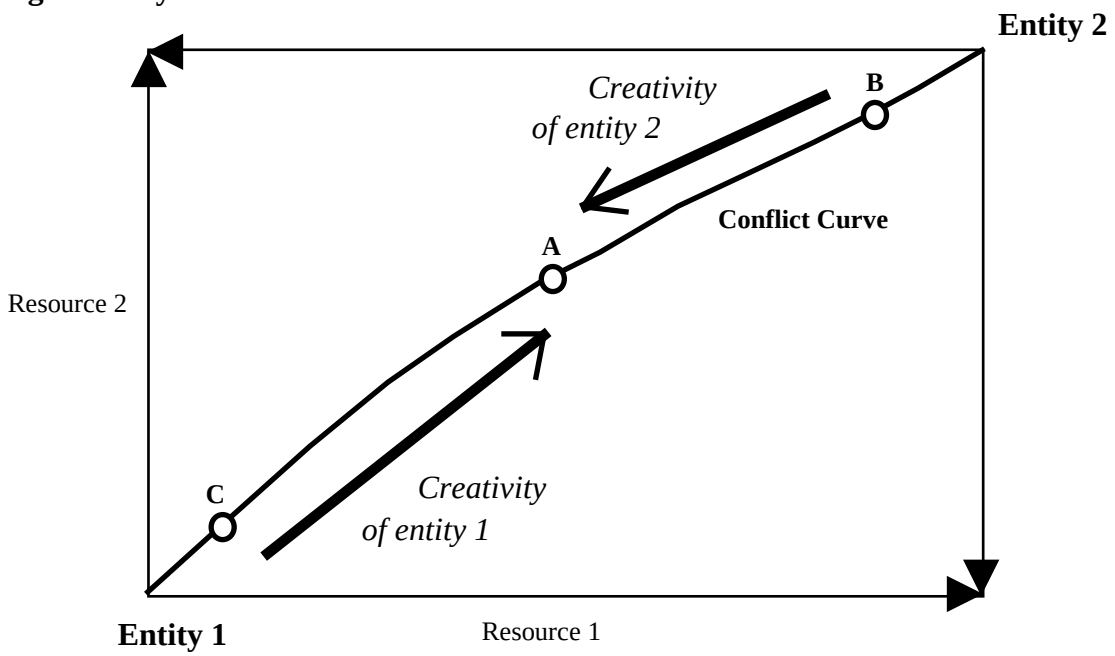
[21]) As Owen points out, a consequence is that not all possible strategies can be formulated as behavioural strategies. In particular optimal strategies might be unreachable if entities use behavioural strategies.

be made, they also rely on the historical experience from which the necessary rules are derived[22]. Following our argument of increasing information overload we conclude that in most real life decision problems social entities are forced to use behavioural strategies.

This idea leads to a more detailed understanding of models and strategies. Models basically are sets of rules, partially supported by pieces of formal theoretical arguments. The degree of sophistication of a model is fundamentally limited by the limitedness of the rationality - now understood as its limited information processing - of the social entity under consideration. To get a certain behavioural strategy out of a model, a social entity simply has to feed the necessary conditions, the state variables of this point in time into the model and apply the rule set. Learning thus basically concerns learning of rules and of formal language. On the other hand we now can consider the strategies in figure 3 as behavioural strategies. As they are played, that is as these actions actually take place in reality, a certain point in the Edgeworth box in figure 2 is effectuated.

Returning to the notion of relative stability in section 2.2 we now can specify clearer what we consider to be the typical dynamics of contradictions. Consider again point C in figure 6. Evidently entity 2 is more powerful with respect to entity 1 as a distribution like point A would indicate.

Figure 6: Dynamics of contradictions



Since C is relatively stable, this means that the corresponding pair of behavioural strategies of the entities constitutes a Nash equilibrium: For a *given set* of strategies of the opponent *as well as of the entity itself* a change of strategy will not improve an entities pay-off. This is exactly the reason why point C will be stable *as long as the strategy sets are given*. But considering now that strategy sets are *derived* from the rather unstable battle waging in the information sphere, it becomes clear that stability might end if *new* behavioural strategies are *created*. In particular, entity 1 will be especially creative in a situation like point C, where its pay-off with given strategies is

[22]) Clearly there is a close relation between the concept of Herbert Simon's notion of 'bounded rationally' and the specification of behavioural strategies [Simon, 1982].

so unfavourable. The same is true for entity 2 in point B. Since it is very unlikely that a powerless entity, say entity 1 in point C, can exert a strong manipulative force in the information sphere and change the opponents strategy set[23], the only possibility is to modify its own strategy set. Useless strategies, like S1 in figure 3, will have to be discarded and new ones will have to be experimented with. Entity 1 will add new rows to the pay-off matrix in figure 3. Creativity will be greatest as dispair reaches its maximum - this is what the arrows in figure 6 shall indicate. Successful innovation, of course, will lead to a shift on the conflict curve. This is more likely to happen the more unfavourable the point of departure is. This is our basic explanation of the emergence of innovative behaviour.

As the relatively stable contradictions in reality break up, call this process the emergence of 'conflict', and as power relations start to oscillate between the points C and B, there will be a continuous parallel process of creation and destruction of behavioural strategies[24]. Add the growth of social entities mentioned in the preceding section and rather complicated patterns of the dynamics of contradictions will arise. Since we are still arguing on the level of a well-defined social organization of the entities under consideration - remember that we have ruled out Pareto-improvements by assuming an appropriate institutional setting (see section 2) - contradictions, conflicts and innovations have to be described *for this social organization* to arrive at an adequate description of the organization as life form. To do so, e.g. for typical production units (firms) or nation states, goes far beyond the scope of this section - all we could do was to provide a brief sketch.

4.2 IC-technologies as response and promise

Creativity, in the sense the word was used in the previous section, is a process which takes place in the information sphere. Nevertheless its success is determined by practice, by experimenting with new behavioural strategies. Can the same technologies which nowadays at least partly are used to manipulate, to hinder the powerless social entities to develop their creativity, be exploited by the latter? Or is the contemporary stalemate in social evolution, the fall-back of social doctrines (and corresponding realities) to the standards of early Manchester liberalism a sign of a final stop of the creative oscillations of power relations?

From a historical perspective 20th century's IC-technologies could be interpreted as a response to the upsurge of the labour movement at the turn of the century. The integrative force of these technologies helped to disguise the underlying contradictions by transforming the creative potential into a destructive 'national identity' directed against ever more obscure 'enemies'[25]. Again analogue processes on the micro-level can easily be found: Corporations characterized by extreme and inflexible power relations often direct their efforts against competitors cultivating more civilized forms of creative conflict resolution within the firm - the record of hostile take-overs in the last decade is telling. Interestingly enough, in many of these cases the increase in power of those already in power, that is the restoration of strict hierarchical organization, often is accompanied by an increase of pseudo-decision making and irrelevant communication

[23]) 'The ruling ideology will be the ideology of the ruling entity', as one could paraphrase a famous man.

[24]) Consider the contradiction between the entity 'mankind' and the entity 'nature', vulgo the 'struggle for life', and you will arrive at Schumpeter's notion of innovation.

[25]) Anti-Semitism is just an extreme example for this manipulation strategy.

at all levels. In a sense 'noise' has been discovered as a very efficient tool for manipulation.

On the other hand the new IC-technologies clearly are a prerequisite for a civilized and creative way to use the innovative potential of contradictions. Organizing models, rule sets, and finding analogues which could cristallize as new behavioural strategies surely could be supported by this technology. The whole inner organization, what we previously called the 'life' of an organization, necessarily has to be handled by information systems if the social entity grows beyond a critical size. The reason why this does not happen yet seems to be the fact that it only can be introduced *at once* at all levels and in all units. Otherwise the older and less civilized forms would always extinguish the (in the short-run) more expensive, less economically-minded new forms of organization. In our view this property of all-or-nothing is responsible for the current stalemate in social organization, despite the accumulation of promising IC-technologies.

The challenge to produce information systems which support powerless social entities does evolve in the economic sphere in a game-theoretic sense. Therefore the question is how AI-techniques can be implemented in order to support creativity.

In our understanding an information system can do so if it is able to simulate the interaction of different social entities with different world views - in form of models and their implicit strategies. 'Learning' with the help of IC-technologies is not restricted to cases where entities have the same goals - a special case what we called 'secondary learning' before, e.g. joint profit maximization. In particularly the cases of diverging or even opposite objectives of social entities[26] need simulation support. It is this property of simulating contradictions, of anticipating actions and opinions of others leading to these actions, which can be used to transform them to arrive at better solutions on the conflict curve. Therefore information systems can be used to verify models of social entities. To be precise, the social entities can be provided with data and with a causation structure linking this data[27]. Moreover these information systems should include decision trees of competing groups. Basing choices on a broader spectrum of relevant factors surely improves performance.

From the perspective of the weaker contrahent information systems will improve their choice of strategy by providing them with more objective data[28]. To make such systems intelligent they have to be augmented by the inclusion of models of the group in power. This means IC-technologies offer simulations of future games. Technical support consists of the computation of Nash equilibria and the choice of the most favourable one. Crucial for the final outcome will be the accuracy of the assessment of the contrahent's model and the manipulative force of the entities.

5 Conclusion: Linking spheres

[26]) We insist that these contradictions exist in reality and are not just different views which can be eliminated by communication as for example proposed by [N. Luhmann, 1984, pp.488-550].

[27]) We are aware that the notion of 'objective data' is problematic. `What is factual and what is conventional is a matter of degree. We cannot say, 'these and these elements of the world are the raw facts, the rest is the result of convention.'` [H. Putnam, 1988, p.113]

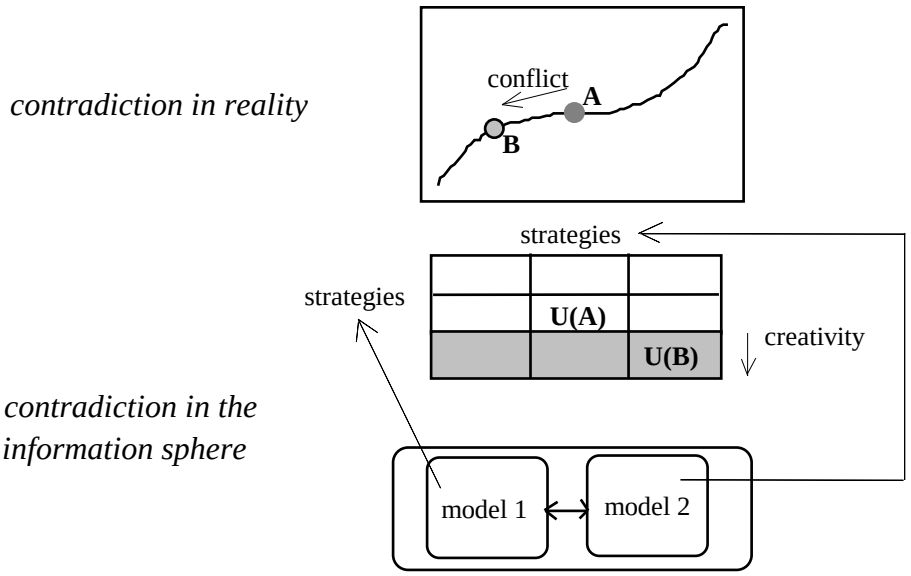
[28]) Voting systems supported by information technology (see [D. Held, C. Pollitt, 1986]) are first steps in that direction.

For didactic reasons we treated contradictions in the information sphere and contradictions in reality separately. As the arguement showed both contradictions are depending on each other. Since due to their different socialization social entities develop different world views, they will build different models. These can be logically contradictory (compare also section 2.1). At the same time contradictions in reality emerge due to diverging aims in organizations as we showed in section 2.2.

Generically seen social learning takes place in the real world, the first step is to experience *contradictions in reality*. These experiences are transferred in a 'mental' model enabling social entities to assess possible strategies. This leads us exactly to the information sphere, contradictions there are abstractions derived from reality.

We tried to introduce methods of presenting and formalizing these conflicts in order to model organizational change which will be a result of a certain 'game' in an organization. In this sense we define *complete conflict* as the combination of contradictions in the real sphere and in the information sphere.

Figure 7: Complete conflict



Consider point A on the conflict curve. It represents a Nash equilibrium, which represents a contradiction in reality. If one of the player through experience in reality is induced to change his/her model, new strategies will emerge - we called this process creativity. As a consequence the other player is forced to react and to reconsider his/her choice best answer.

Technical support can lead to an improvement of the process just described, the choice of strategy will be more informed. If only one of the two opponents is in the position to use this support the induced conflict will shift the power relation in a direction in favour of the player (shift to point B).

As a matter of fact the new game sketched above in general will lead to a *new conflict curve.* This is so, because the impetus for a new game also will imply new preference orders. In the sense of bilateral negotiating usually the other concerned social entities in an organization will be invited to re-consider their preference orders - which were determined under other circumstances, too. As a consequence the old compromise (say point A in figure 7) will no more be Pareto optimal. That is, what we considered as a pre-condition in section 2, namely that the institutional setting already has exploited all possibilities for Pareto improvements, is not met: A new institutional setting has to be found. In other words, organizational change is necessary.

Evolving contradictions, linking - and in a sense even constituting - the two spheres, are the source of creativity and innovation (in particular in IC-technologies). This paper proposes a way to look at this process by the use of more formal tools.

References

Aristoteles, 1966, Metaphysik, Viertes Buch, München.

Caldwell B., 1982, Beyond Poitivsm, London.

Casti J./ Karlqvist A. (Eds.), 1992, Newton to Aristotle: Toward a Theory of Models for Living Systems, Boston/Basel/Berlin.

Colletti L., 1977, Marxismus und Dialektik, Frankfurt a. Main.

Descartes R. (1643), 1980, Ausgewählte Schriften, Leibzig.

Edgeworth F.Y., 1881, Mathematical Psychics, An Essay on the Application of Mathematics to the Moral Sciences, London.

Egger E./ Hanappi G., 1993, From Syntax to Semantics and Back: The Problem of Information Selection in GDSS, Proc. of the Conference on Human Computer Interaction International (HCI '93), Orlando (Florida, USA), August 1993.

Goedel K., Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme I., Mh.Math.Phys. 38, pp.175-198.

Hanappi G./ Egger E., 1993a, Intelligent Design versus Solving of Artificial Problems. Artificial Intelligence Research at the Cross-roads, Proc. of the 1993 IEEE region 10 International Conference on "Computers, Communication and Automation", October 19-21, Beijing, China.

Hanappi G./ Egger E., 1993b, Information Age-Deformation Age-Reformation Age, Prec. of EAEPE 1993 Conference, Barcelona.

Harsanyi J.C., 1977, Rational Behavior and Bargaining: Equilibrium in Games and Social Situations, Cambridge.

Hegel G.W.F. (1812), 1969, Wissenschaft der Logik I, Frankfurt a. Main.

Held D./ Pollitt C., 1986, New Forms of Democracy, London.

Kant I. (1763), 1980, Kritik der reinen Vernunft 1, Frankfurt a. Main.

Kesselring T., 1984, Die Produktivität der Antinomie, Frankfurt a. Main.

Krahl H.J., 1977, Konstitution und Klassenkampf, Frankfurt.

Kreps D.M., 1990, Microeconomic Theory, New York.

Luhmann N., 1984, Soziale Systeme, Frankfurt a. Main.

Mann M., 1986, The Sources of Social Power, New York.

Moss S./ Rae J., 1992, Artificial Intelligence and Economic Analysis. Prospects and Problems., London.

Moss S./ Rae J., 1992, Artificial Intelligence and Economic Analysis, London.

Owen G., 1982, Game Theory, New York/London.

Putnam H., 1988, Representation and Reality, Cambridge, Massachusetts.

Simon H., 1982, Models of Bounded Rationality, Cambridge.

Stinchcombe A., 1990, Information and Organization, Berkeley.

Tarski A., 1935, Der Wahrheitsbegriff in den formalisierten Sprachen, Studia phil. 1 (Leopolis), pp.261-405.

Weinberg G./ Weinberg D., 1979, General Principles of System Design, New York.

Williamson O.E., 1975, Markets and Hierarchies, London.

Ze Dong Mao (1937), 1972, Über Praxis und Widerspruch, Bielefeld.