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## Genres as Self-organizing Systems

PETER BØGH ANDERSEN

### Abstract

The notion of ‘downwards causation’ is an old acquaintance in the humanities, for example in the notion of the hermeneutic circle, where textual parts and wholes mutually influence each other’s interpretation. The phenomenon of genres is chosen as a possible example of downwards causation (genre constraints). A computer model is constructed on the basis of genre theory and run under various conditions. The model accounts well for the formation and bifurcation of genres, but could not be made to generate the well-known oscillations from the history of literature. The original model is replaced by another one that contains two mutually perturbing systems which can be made to oscillate. This final model does not invite an interpretation in terms of downwards causation; instead an interpretation hinging on semiosis between two systems on different scales is suggested.

### 1. Introduction

The basic question I want to discuss in this paper is whether genres only exist in the eye of the literary beholder (the nominalist position) or whether they are real existing entities with causal powers (the realist position); and, if the latter position is adopted, what it means for genres to possess causal powers.

Genre theory<sup>1</sup> has always had difficulty choosing between these two positions:

1. *Nominalism*: genres are merely collections of texts with a certain likeness which we have chosen to give a name. Genres only exist in the mind of the beholders and can therefore have no causal effect on the texts. Genres are historical and change when literary conditions change.

<sup>1</sup> I thank the students attending my genre course of Fall 1995 for the good discussions and references.

2. *Realism*: genres are real existing entities that embody eternal laws governing the production of texts. Texts cannot be constructed freely, and the genres define the permissible/possible ways of writing texts.

Support and criticism are not difficult to find for both cases. Against the nominalist view speaks the fact that at least mass communication falls in classes whose members share so many characteristics that it is sometimes difficult to tell one from the other: detective, spy and police novels; fantasy and science fiction books; cowboy films, war films, action films, adventure films; television series, such as melodramas and comedy. There exist written recipes for some genres, and any reader or viewer can tell the different species from each other and give them a name; and if they are a bit unsure, they are offered ample help from marketing

which potentially includes discursive though non-cinematic elements such as advertising strategies, posters, stills, trade review, trade synopses, reviewing and so on.

*Neale 1983: 14*

And in fact there are obvious causes for such consistency: genres help the consumer reduce complexity and make choices easier; we do not have to search all the thousands of books in a bookstore, but can go directly to the shelf labelled 'crime' and make our choice from, say, a hundred books there. Furthermore, since we know the contract underlying the individual genre, consuming is made easier. We know how to interpret the clues given in a detective novel, and are rightly disappointed if the author does not keep his part of the agreement and fails to collect all loose ends in the last pages.

Genres may be defined as patterns/forms/styles/structures which transcend individual films, and which supervise both their construction by the film maker, and their reading by an audience.

*Tom Ryall, quoted in Neale 1983: 7*

If genres supervise construction as well as reading, they must be said to possess causal powers. In addition, there are clearly constraints as to which components can actually be combined in a worthwhile book or film. Not all combinations are equally satisfying.

However, the realist view will not stand up to scrutiny either: genres change, disappear and are born, and combinations of old genres are quite possible. The repertoire of popular genres are to a certain degree historical, and relate to important social oppositions and problems. Science fiction is unthinkable without modern technology, and the *Bildungsroman* needs the capitalist background of individuality and dynamics to catch the readers' interest. These facts speak against the idea of genres as an embodiment of eternal aesthetic laws.

The problem of the causal powers of genres is the main topic of this paper. It is obvious that these powers cannot be attributed to a concrete agent. There has never been a managing director of literary styles that can set up the rules for gen-

res and control that they are obeyed. How are causal powers of emergent patterns possible without concrete agents to wield the power?

The literary genres are just an example of a much more general phenomenon, namely how it is possible to create complex, stable, and self-perpetuating systems from small interactions between the parts of the system. Hurricanes and dust-devils are examples from the physical world (Salthe 93: 51), biological ontogenesis is a biological example, and social systems, such as conversations, exemplify the phenomenon in the social domain.

In this paper I have borrowed concepts from non-linear dynamic systems theory. Here I shall introduce some key concepts from this domain (see Bøgh Andersen 1994, 1996 for a fuller version). The basic descriptive concept is a *dynamic phase space*. A phase-space is a representation of selected properties of a system. It consists of one or more dimensions that represent the attributes of the system. The values of the attributes are represented by a point in the corresponding dimension, so the state of the system itself is represented by a point in the total phase-space. For example, we can characterize physical matter by means of two dimensions, temperature and pressure (Fig. 1.1). This defines a two-dimensional plane, and the state of the system is a point in this plane (the 'representative point').

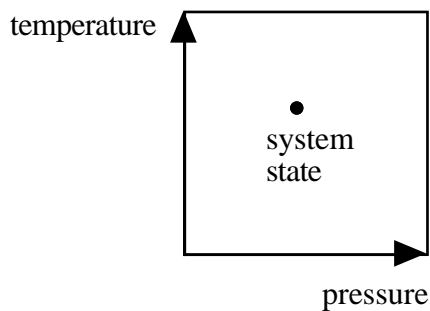


Fig. 1.1. Physical system.

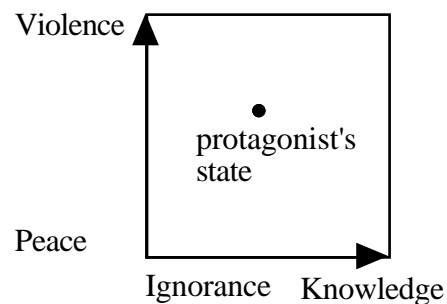


Fig. 1.2. Fictional system.

Another example is the plot of a fictional product, e.g., a detective movie (Fig. 1.2). Two important dimensions here are Peace/Violence versus Knowledge/Ignorance: there can be no detective movie without violence, e.g., a murder, and the plot of the movie is about the detective's state of knowledge. The actual state of the plot can thus be characterized by a point in the plane defined by the Violence/Peace and Knowledge/Ignorance axes.

A *dynamic* phase-space is a phase-space in which the representative point moves, i.e. a space that depicts a changing system. The movement of the point is called the *trajectory* of the system. Trajectories are assumed to follow rules; in the physical example, the rules are the laws of nature, in the fictional case the rules belong to the genre. A typical trajectory in a detective movie (Fig. 1.3) will start in the Peace-Ignorance part of the plane; a murder sends it vertically upwards to the

violence part, and the actions of the detective are a trajectory leading from Ignorance to Knowledge.

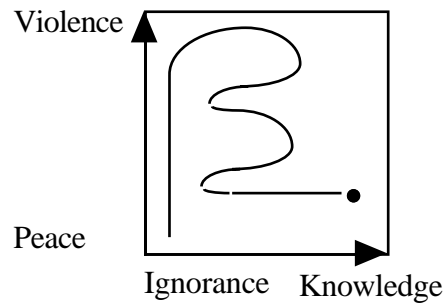


Fig. 1.3. Typical trajectory of detective movie.

Systems can undergo qualitative abrupt changes along the trajectory. In the physical example, the physical matter may change from a solid to a liquid state (ice melts) when the temperature is raised. In the movie example, we will very often have a climax where the detective reveals who dunnit; the revelation is often surprising and causes the viewer to revise his expectations in a fundamental way.

The system may gravitate towards a point or area of the phase-space and stay there on arrival. Such areas or points are called *attractors*. Attractors come in many types. In this paper I only distinguish between *fixed-point* attractors and *limit-cycle* attractors. The former consist of one point, the latter of a set of points. Most mainstream movies have a fixed-point attractor, i.e. there is one point that is felt as the natural ending of the movie. For example, detective movies must end in the knowledgeable state.

More sophisticated movies may have a limit-cycle attractor, i.e. they do not present a fixed solution to their problem, but oscillate between several possibilities. An example is a detective movie that ends without selecting one particular explanation of the crime.

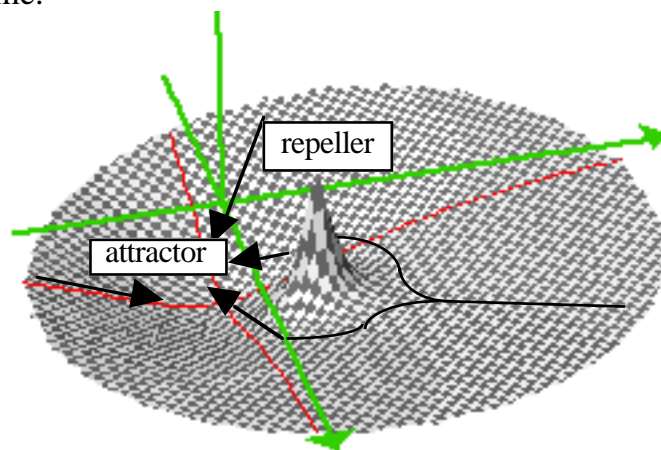


Fig. 1.4. An attractor and a repeller.

The trajectory can be specified in many ways. In this paper I use genetic algorithms, but often illustrate the dynamics by potential functions in the manner of *catastrophe theory*. The potential functions can be understood as an energy landscape. The system is located in this landscape; it is influenced by the gradients of the valleys and hills and will seek downwards towards the lowest position, i.e. towards the lowest level of energy. See Fig. 1.4.

If the equation defining Fig. 1.4 has a parameter in it, we can change the landscape by changing the parameter. If the change alters the number of attractors and repellers, i.e. changes the equilibrium conditions of the system, we call it a *catastrophe*. A new landscape will cause the trajectory of the system to run in a different direction.

We shall restrict our attention to *recursive systems*, i.e. systems in which the new state is calculated from the preceding state. In Fig. 1.4 the location of the system  $x_t$  is calculated from  $x_{t-1}$  by subtracting the gradient of  $x_{t-1}$  from  $x_{t-1}$ . If the rule is parameterized we call the system a *perturbed recursive system*. The parameters of the system describe its boundary conditions, i.e. the conditions that must be fulfilled in order for the system to generate a certain set of trajectories. The reason for concentrating on recursive systems is that examples of such systems are often mentioned as generators of emergent complexity (for chemical examples, see Prigogine & Stengers 1984: 134; mathematical examples are the Mandelbrot set and other fractal shapes (Peitgen, Jürgens & Saupe 1992); biological examples are given in Lindenmeyer 1968; cellular automata and genetic algorithms are also recursive systems, Davis 1996).

We can let two systems influence each other by letting the state of one system act as the parameter of the other system, and vice versa. This means that we describe the systems as environments of each other. They *mutually perturb* each other.

Ontologically the above ideas are heavily influenced by the theory of autopoiesis (Maturana & Varela 1980), especially in the sociological variant developed by Niklas Luhmann (Luhmann 1984, 1990). The main point is that autopoietic systems are operationally closed, that is, the maintenance and development of autopoietic systems are their own doing and cannot be interfered with by their environment. Autopoietic systems can be formalized as perturbed recursive systems. The interaction between autopoietic systems and their environment is a two-step process: the environment first perturbs the system by changing the parameters of the recursive process which changes its internal dynamics; then the system compensates for the perturbation by changing itself according to the new dynamics. This is for instance true of communication: the speaker cannot directly change the beliefs of the listener, but only indicate that the speaker intends to make the listener believe something. The actual adoption of the new belief is entirely up to the listener.

Now that these preliminaries are covered, let us return to the main problem of the paper, the nominalist/realist controversy.

## 2. Genres and self-organization

In this paper I shall explore a different conception that transcends the nominalist/realist dichotomy. I shall argue that genres are the result of self-organizing processes among texts, readers and writers, and as such are entities at a level above the individual text. However, even if genres emerge from interactions between texts, writers and readers at the level below, they are not merely sets of texts without causal effect. On the contrary, once stabilized in a loose form, they influence and constrain the possible new texts, and in this way may reinforce and maintain their own existence. Thus, genres are patterns of similarities of individual texts (the nominalist position), *but* they have causal powers controlling the same type of texts from which they were abstracted (the realist position).

In the following sections I shall argue that dynamic phase spaces can be used for defining genres, and I shall introduce and define the notion of levels and emergence.

### 2.1. Genres

When we use phase spaces to describe the driving force of whole texts or genres, the representative point can of course be a character, in which case the phase-space represents properties of that character, but it can also be the narrator or the reader.



Fig. 2.1. Spatial phase-space of a travel novel.

In the first case, if the phase-space is the three Euclidean dimensions, the entity is a character, and the location of the character in the space represents his location in Euclidean space. A travel novel, for example, often follows the main character on a journey from home to foreign countries and back home (Handesten 1992). This composition can be represented by a trajectory of the character in the space (Fig. 2.1).

The second case, where the representative point represents attitudes of the reader, can be found in Todorov's analysis of the fantastic genres discussed below. Here the reader is continually oscillating between belief and disbelief in the supernatural.

Finally, we can define two main genres, *narrative* and *description*, by means of a four-dimensional phase-space, consisting of the three spatial dimensions plus time (Togeby 1982: 67 ff.), where the representative point is the author's or reader's consciousness. If it moves in time, the genre is narrative, whereas the genre is description if it moves in space but not in time.

Intuitively, narrative elements are those that contribute to the advancement of the plot, while nonnarrative elements flesh out the narrative universe and make it more vivid, without moving the plot forward. *Ryan 1991: 125*

Text 1 contains examples of narrative and descriptive elements. It is a narrative about work incidents recorded by Klaus B. Bærentsen at a Danish power plant (Bærentsen 1996).<sup>2</sup> It starts as a narrative, then stops time and moves around in the plant, and finally goes on with the plot.

*Narration:* A couple of months ago we got a report from [tape change] insulation that had come off.

*Description:* It is a sort of a foam rubber, or something like that, sitting at the inside of the screw compressors we have. Sort of a silencer, on the casing, there is sort of a foam rubber that is rather heavy [...]

*Narration:* Then was, ... , then the plastic, the rubber came off. And then it had gone into something hot, then the card caught fire, and everything smelled awfully bad. And the compressor ran [...].

*Text 1. Klaus B. Bærentsen: Interviews of machinists about incidents during work. Dept. of Psychology, 1988. Memory 4, Interview 20.*

Fig. 2.2 shows a phase-space representation of the story.

The first paragraph tells about the initial incident, that some insulation fell off. The next one explains the location and function of the insulation, and the third one continues the narration.

<sup>2</sup>

*Narration:* For nogle måneder siden, da fik vi en melding fra [tape change] isolering, der er røget af.  
*Description:* Det er sådan noget skumgummi, eller sådan noget stads, der sidder på indersiden af de skruekompressorer vi har. Sådan for lyddæmpning så sidder der inde på casingen, der sidder sådan noget skumgummi, som er ret svær i det. [...] *Narration:* Så var ... gik der plastik, det der skumgummi af. Og så var det gået ind på en eller anden varm ting, så der var gået ild i kortet og det hele lugtede noget så forfærdeligt. Og kompressoren kørte [...]

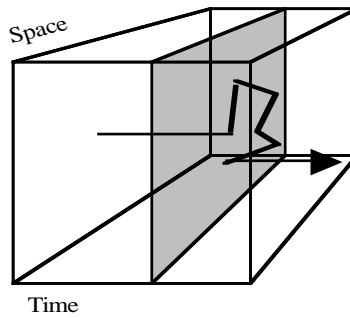


Fig. 2.2. Narration and description.

Dynamic phase-spaces seem suitable for representing the genre-concepts developed in Neale (1983), who bases his classification of film genres on the following basic understanding of narrative:

Narrative is always a process of transformation of the balance of elements that constitute its pretext: the interruption of an initial equilibrium and the tracing of the dispersal and refiguration of its components [in such a way that the] elements finally [are] replaced in a new equilibrium whose achievement is the condition of narrative closure. *Neale 1983: 20.*

This analysis works with two types of dimensions, namely the dimensions of perturbation and the dimensions defining equilibrium conditions. Thus, the theory seems to be an instance of the perturbed recursive system from Section 1 (Fig. 2.3).

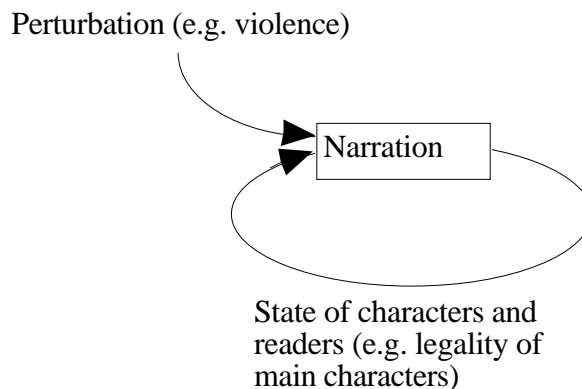


Fig. 2.3. Perturbed recursion as a narrative schema.

The genre itself is defined as a particular combination of the dimensions of perturbation and equilibrium (called ‘discourse types’ by Neale).

In each case, the marks of generic specificity as such are produced by an articulation that is always constructed in terms of particular combinations of particular types or categories of discourse. *Neale 1983: 21*

For example, according to Neale, both gangster films and horror films use violence as the perturbator, but whereas the refiguration of equilibrium takes place in the discourse of Law (legal - illegal, presence - absence of legal institutions) in gang-

ster movies, the trajectory of the horror movie lives in the dimension of the Monstrous with 'human' and 'natural' as opposites (Fig. 2.4 - 2.5).

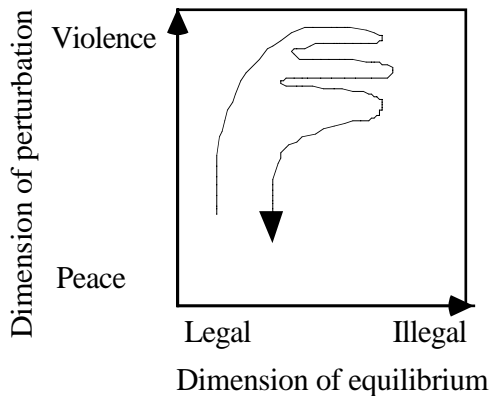


Fig. 2.4. The trajectory of gangster movies.

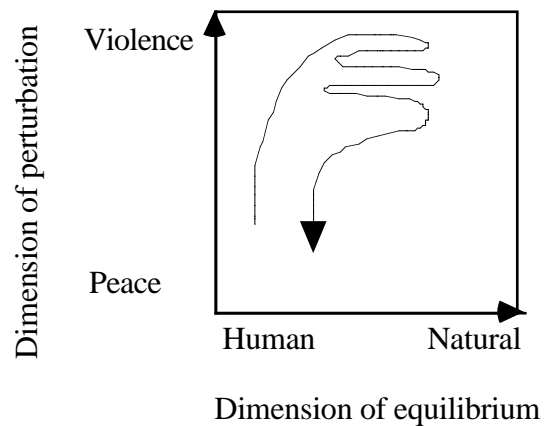


Fig. 2.5. The trajectory of horror movies.

On the other hand, whereas gangster and detective film both use violence as the perturbator, detective films are mostly concerned with the dimension of Meaning (Fig. 2.6):

In the detective film, the detective *and* the audience have to make sense of a set of disparate events, signs and clues. The 'risk' for the detective being represented in the narrative is a risk of violence and death. The risk for the audience is a loss of sense of meaning, the loss of a position of mastery. *Neale 1983: 21*

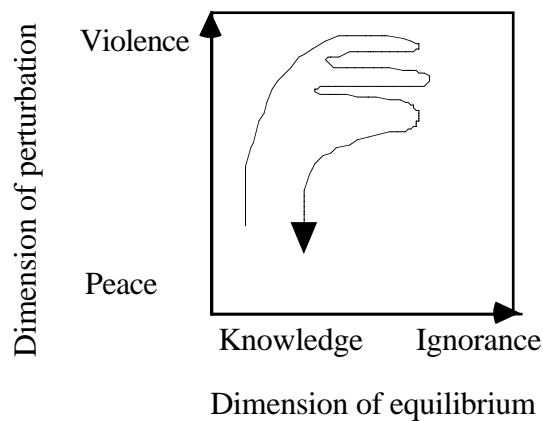


Fig. 2.6. The trajectory of detective movies.

But the space can also be a semiotic space, as in crazy comedies where the equilibrium dimension is the semiotic code articulated into *order* versus *disorder*, as in Marx Brothers films:



In the latter task we can get help from the classification of possible trajectories from Section 1. For example, the mainstream film genres defined by Neale all have closure, i.e. they return to a state of equilibrium after having gone through

a series of oscillations that never exceed the limits of ‘dramatic conflict’ (that never, therefore, exceed the limits of the possibility of resolution). *Neale 1983: 25*

We recall from Section 1 that a state or sequence of states which the system will enter after a certain amount of time, is called an attractor. If the attractor only comprises one state it is a fixed point attractor, whereas it is called a limit cycle if it contains more than one state. Fig. 2.9 shows the typical dynamics of Neale’s mainstream movies: we start in a situation where the positive location begins to develop a repeller and thereby become an unstable equilibrium. If it is a gangster movie, the hero’s legal status is jeopardized, and he starts sliding in the direction of crime and illegality. However, due to his actions, the situation changes, and the legal state once more acquires its status as a stable equilibrium.

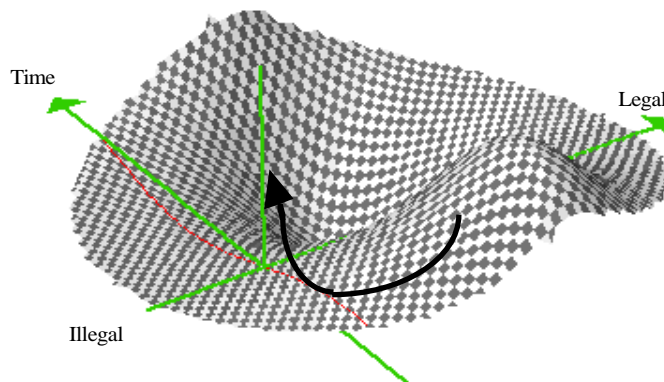


Fig. 2.9. The dynamics of gangster movies.

The initial inequilibrium of narratives must obviously be the result of a bifurcation causing the system to move towards the new point of equilibrium. In gangster and horror movies, the increase in violence is the boundary condition that makes the situation unstable and causes the story to begin. No liquidation, no retaliation, no gangster movie. No blood-sucking, no fear, no attempt to demolish monster, no Dracula movie.

It thus seems possible to define genres by means of the attractor type of the individual texts: the Fantastic genre must contain a limit cycle, whereas most of Neale’s mainstream film genres must contain a fixed point attractor.

Let us now pass from the dynamics of the individual text to the dynamics of the genre, i.e. the collection of texts. According to Neale, genres ensure that the consumers of popular films or books can have both repetition and difference:

Genres, then, are not systems: they are processes of systematization. It is only as such that they can perform the role allotted them by the cinematic institution. It is only as such that they can function to provide, simultaneously, both regulation and variety. *Neale 1983: 51*

The reason why this is desirable lies in the nature of — desire:

Desire is always a function of both repetition and difference ... Desire is [] founded on the urge to repeat and the impossibility of ever being able to do so. The reproduction of the signifier allows satisfaction, but it is a satisfaction marked by the gap between signifier and experience. The existence of the gap is the reason for the inexhaustibility of desire, but it also allows whatever satisfaction is attainable to be renewed. [...]

The mainstream narrative is nothing if not a ‘text of pleasure’: a text that regulates the subject’s desire for pleasure, that functions, therefore, according to a precise economy of difference (the movement of desire, the subject ceaselessly in process) and of repetition (the containment of that movement, its repletion, the subject ceaselessly closed through the recuperation of difference in figures of tightly bound symmetry). *Neale 1983: 48-9*

The key point here is that the media market is caught in a conflict if it is to satisfy the desire of the consumers: on the one hand it must provide stability and repetition because the radically new is discomfoting and produces no immediate satisfaction; on the other hand, repetition produces boredom and a craving for the new.

In the preceding, the *contents* of novels and movies were described by means of the perturbed recursion schema. The relation between reader and text, i.e. the reading process, can be analyzed in a similar way. See Fig. 2.10.

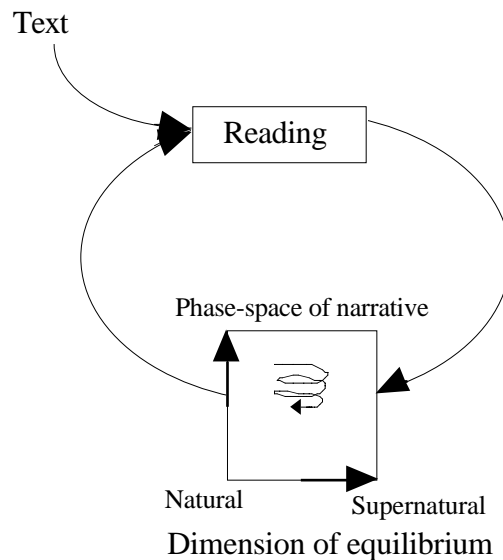


Fig. 2.10. The reading process.

The perturbator of the reading process is the text in its capacity as a series of visual and auditory elements. The iterator of the process is the phase-space, including its perturbator and iterator dimensions, its current trajectory, and its dynamics.

Thus, reading a text or viewing a movie builds up the proper dimensions and their dynamics. In addition, the reading process includes the enacting of this dynamic space: the reading process is seen as a constructive process, where the text informs the building and enacting of dynamic spaces. This model explains why many narrative processes are not explicitly represented in the text, but interpolated by the reader: when the reader, guided by the text, has set up a dynamic space, this space takes over and executes trajectories that follow from the dynamics although they are not stated in the text. For example, it is enough that the film editor displays a shot showing the protagonist entering a plane followed by a shot showing the plane landing. We enact the middle part of the trajectory ourselves (cf. Bordwell 1985).

In this analysis, the perturbed recursion schema has a fractal self-similar geometry: the ‘outer version’ — the reading process — creates an inner version — the contents — with the same structure, namely a perturbator influencing a recursive process. And indeed, most symbolic processes do in fact exhibit a fractal self-similar structure: a text can embed other texts inside it (Ryan 1991), e.g., as a written dialogue, and a movie can itself refer to (fictive) movies. In Section 4.4 we shall elaborate further on the notion of self-similarity.

## 2.2. The dynamics of the art system

Whereas Neale offers a psychoanalytic explanation for the oscillation between repetition and difference, Yuri Lotman sees the pattern as a general mode of behavior for whole cultures (Lotman 1990).

His basic concept of a *semiosphere* seems close to the notion of a phase space. The semiosphere is ‘the whole semiotic space of the culture’ (Lotman 1990: 125), filled up with a diversity of languages and sublanguages. Lotman sees the semiosphere as a semiotic interpretation of the real physical space in which a culture lives;

The semiotics of space has an exceptionally important, perhaps even overriding significance in a culture’s world-picture. And this world-picture is linked to the specifics of actual space.

*Lotman 1990: 150*

and describes the semiosphere as an abstract property-space, quoting the mathematician A.D. Aleksandrow:

When studying topological qualities we again are faced with the possibility of conceptualizing an abstract totality of objects having only those qualities. We term this totality abstract topological space.

*Lotman 1990: 150*

And further:

If by isolating a certain quality a set of continuously contiguous elements is formed, then we can speak of an abstract space of that quality. In this way we can talk of the space of ethics, of color, of myth. In this sense spatial modeling becomes a language in which non-spatial ideas can be expressed.

*Lotman 1990: 150*

The spatial notion enables Lotman to formulate many useful ideas for cultural analysis: a semiosphere is a real sphere with a center and a boundary. The center is the ruling culture defined by producing meta-descriptions intended to cover own practice as well as the practice of deviant cultures. Whereas the center strives towards consistency and harmony, inconsistency and conflict emerge as we travel towards the periphery. The boundary itself serves to give the culture its identity, dividing the world into a space of norms (us) surrounded by a space of normlessness (them):

Every culture begins by dividing the world into 'its own' internal space and 'their' external space ... The actual division is one of the human culture universals. The boundary may separate the living from the dead, settled peoples from nomadic ones, the town from the plains ...

*Lotman 1990: 131*

One can see the dynamics of a culture as a current running from the periphery to the center. Close to the boundary, the current is turbulent and disruptive, but as it draws closer to the center, its movements slow down and in the center of the culture, it reaches an equilibrium, stabilizes and freezes to ice.

A similar account is given by Nöth 1983. In opposition to language that strives towards states of equilibrium, Nöth considers the textual genres to be basically unstable. He quotes J. Tynjanov for the following account of literary code development:

- 1 In contrast to the automatic construction principle, a new opposed principle arises dialectically;
- 2 The new principle finds acceptance;
- 3 Its applicability expands, it becomes popular;
- 4 It becomes automatic and provokes opposed construction principles.

and continues

According to this model each new, opposed construction principle is a disturbance in the system of literature. The expansion of the principle is a process of negative [must be positive, PBA] feedback by which the disturbance is strengthened and the system finally changed, once it becomes automatic. Only during the process of automatization is the system in a state of equilibrium. But the new equilibrium is itself unstable, because a new phase of innovation must follow, and that means a new state of disequilibrium [...] literary codes have as their goal not equilibrium but the maintenance of the innovation process and thus of disequilibrium.

*Nöth 1983: 119*

We again see the same struggle between repetition/stability/automatization on the one hand, and difference/instability/creativity on the other.

The history of literature is a story of this battle: the age of Enlightenment in the 18th century rebelled against the orthodoxy of the baroque period, pitting reason and science against religion and superstition. New genres, like the encyclopedia, the essay, the satire (Swift), and the sentimental bourgeois novel (Fielding, Richardson) emerged from this battle. But to the romanticists of the 19th century, these genres appeared more and more soul-less and barren, keeping its public from emotional insights into the deep secrets of life. New genres appeared: the gothic tale (Hoffmann, Shelley), fairy tales (Grimm), folk poetry (Ossian), speculative philosophy (Schelling), the romantic poem (Blake, Burns, Coleridge, Byron).

But a new generation soon reacted to these genres under the banner of science and rationality, and we got the naturalistic novel, exemplified by Zola's novels, which was again opposed by the fin de siècle symbolism (Verlaine, Rimbaud, Mallarmé), and so on and so forth.

Oscillations like these have probably not always existed. In fact, Luhmann (1990) claims that they are caused by the differentiation of the art system as an autonomous social system in the 18th century. Only when art begins to free itself from direct influence from the church and patrons, and an educated public has been created, can an autopoietic art system organize itself.

Like the other writers, Luhmann emphasizes the craving for newness and the phenomenon of fluctuations — fashions, trends, schools — as characteristic of the art system:

The work of art is both the condition and obstacle for the autopoiesis of art. Without works of art there would be no art and without the prospect of new works of art no social system of art (but only museums and their visitors). 'New' means here, as it has since the seventeenth century, not only another example, but rather something that diverges from the foregoing and thus surprises. Genius lies in the accomplishment of discontinuity and it is clear that this temporal discontinuity presupposes a social discontinuity, i.e. the differentiation of art from the tutelage of other, above all religious and political interests.

*Luhmann 1990: 195*

But because of the inherent self-destruction of the concept of 'new-ness,' the art system is threatened by dissolution:

For whatever has to be new has for this reason no future. It cannot remain new. It can only be admired as that which was new. The social system of art is thus faced from this point on with the problem of the continual disappearance of newness.

*Luhmann 1990: 195*

Luhmann offers the concept of *style* as a remedy against this danger.

The particular qualities of the aesthetic form are functional for the organization of the experience of and communication about art. They are dysfunctional for the autopoiesis of the system of art itself. For how is it to continue? [...] Where does the 'organization' of autopoiesis

lie if the work of art must put value on its own isolation? [...]. The question can be answered with the aid of the concept of style. [...] The function of style is to organize the contribution of the work of art to the autopoiesis of art, and in fact in a certain sense against the intention of the work of art, which aims for self-containment. *Luhmann 1990: 196-97*

Like genres, style is a means of ensuring the continuity of the autopoiesis of art, i.e. that one work of art can generate another work of art:

Style is thus, we may say, what joins work of art to work of art and thereby makes the autopoiesis of art possible. *Luhmann 1990: 203*

However, in order still to produce newness, the style/genres themselves must be subject to fluctuations:

The historicization of styles in the second half of the eighteenth century finally breaks with the traditional conceptions of time which had always allowed the unity of the beautiful, the true, and the good to be thought of as the acme of perfection. Only now can the work of art fully lay claim to its own singularity: for the individual uniqueness of the work of art is the surest guarantee that art always produces something new. *Luhmann 1990: 202*

And this finally produces the accelerating change of styles we witness in this century:

Certainly the tempo of change has increased — so much that change of style can no longer be explained by generational change. *Luhmann 1990: 209*

The argument is thus, as I understand it, that the characteristic of art lies in the production of newness and surprises. As emphasized by Neale, difference is a *sine qua non* of the work of art. But unlimited discontinuity will dissolve the art system as a social system, because there is no guarantee that the next work of art can be produced. Therefore styles/genres emerge that ensure a certain degree of continuity, but because of the demand for newness, style and genres cannot be eternal Platonic forms, as they were conceived in the Middle Ages. They must become historical and changeable.

The existence of styles and genres presupposes that the demand of originality be relaxed, so that copying is allowed to a certain degree (Luhmann 1990: 198). In fact, in most genres a set of prototypical products can be identified. They are prototypical in several senses: on the one hand they embody the properties that are considered characteristic of the genre, and on the other, they have in fact been actual models for many members of the genre. For example, ‘2001’ and ‘Starwars’ are typical science fiction films, ‘The Stagecoach’ a typical cowboy film, and ‘Gone with the Wind’ exemplifies the prototypical filmic melodrama.

The next assumption I want to make is that the literary system is perturbed by social and cultural conflicts of both a historical and more general nature. The literary works of the Enlightenment, for example, responded to the social struggle between the feudal society and the rising bourgeois class, and the Romantic move-

ment that followed reacted against the calculatory and materialistic world views of the rising capitalist society. Modernist schools in the middle of this century were concerned with the loss of values and meaning which followed in the wake of triumphant capitalism.

But since the art system is an autonomous system, it is not a mere reflection of the conflicts of society as some Marxist critics have suggested. The art system has its own inner logic that can be perturbed but not controlled by other systems. This enables the art system to pursue problems of a more general nature. Thus, although the travel novel can contain concrete political criticism of political systems, it can also discuss more existential problems. The theme of many of these novels, for example, is a basic feeling of non-belonging at home and a search for a new authentic identity abroad. In many cases, however, the problem cannot be solved, because, as tourists we do not belong to the places we visit, and, once there, the authentic life has moved on to another place.

The last assumption is that authors cannot pre-calculate the meaning assigned to a text by its audience. Although some authors guess better than others, the fact remains that textual interpretation emerges during the consumption process beyond the direct control of the producers. In this sense, the production process can be seen as a trial-and-error type of problem-solving process in a fuzzy and ill-defined problem area, where problems are defined by attempts to solve them. Furthermore, no person has direct access to new relevant themes (if such clairvoyants existed, they would be extremely rich). The social conflicts only reveal themselves through the trial-and-error process of writing texts about them.

This concludes the theory of genres and the literary market I would like to understand.

### **2.3. The dynamics of genre formation**

The theory of genres following from these considerations can be summarized as follows:

1. The main process is a circular process whereby new texts are produced by recombinations of old ones. No writer or filmmaker starts from scratch but borrows some elements and varies others; any book or film enters a network of intertextuality with overt or hidden references to other texts.
2. However, this circle is perturbed by societal changes that outdate some problems and themes and actualize others. No person has direct access to the relevant problems and themes before they are written about.
3. Authors cannot pre-calculate the meaning assigned to a text by its audience.

4. There exist more or less clear prototypes that are quite often used as models for new variations. A prototype is viewed as typical of the genre. Prototypes are in some sense ‘central’ with respect to their genre.
5. There exist unsolvable contradictions generated by the general human condition and by specific historical circumstances (cf. 2) that authors still try to understand, come to grips with or even solve.
6. Models for new texts are primarily selected from the set of prototypes in combination with their relevance for the unsolvable contradiction as perceived by the author.
7. However, not all cultural production can be explained as recombinations of older texts. Evidently, revolutionary new ideas are created from time to time; in happy circumstances, these new ideas can themselves become the centers of new genres or replace old centers and thereby cause the genres to move.

Clearly, this theory needs further elaboration. For example, point 1 claims that ‘new texts are produced by recombinations of old ones’ but says nothing about the details of this process. For example, which elements are borrowed? Sentences? Themes? Characters? Endings?

I claim, however, that, elaborated appropriately, this model can explain important properties of genres, namely:

- i how they spontaneously emerge through the self-organizing processes of the individual texts, writers, and audiences;
- ii how they can stabilize themselves to such an extent that they prevent novelties from appearing;
- iii how changes in the dilemmas create new genres, make old genres die out or bifurcate into subgenres that may become main genres as they drift apart;
- iv how a genre in the course of history may move to a new position and gradually change all of its former characteristics.

In short: how genres can be both dynamic and stable; how they can be both a result of an interaction between individual texts and able to constrain and change the texts that caused their existence.

How can I claim that points 1 - 7 explain phenomena i - iv? Well, I can’t. One of the main reasons is that the theory only concerns local interactions among parts, whereas the claim concerns emergent properties of the whole. However, emergent properties are often difficult or impossible to predict from interactions of the parts; in addition, the domain of texts and genres is so large and complicated that it probably makes no sense to look for data that will prove our point. Instead of trying to prove that 1 - 7 in fact explains phenomena i - iv, I can set myself an easier task, namely to prove that 1 - 7 is a member of a larger class of theories — let us call them recursive theories (Fig. 2.11) — that has other members for which the

claim can be proved. These members must be computational (Fig. 2.12), since I shall not be able to present analytical proofs, partly because I lack the skills, partly because techniques for such proofs may not exist (on use of computer models for understanding interacting distributed phenomena, see e.g., Casti 1997).

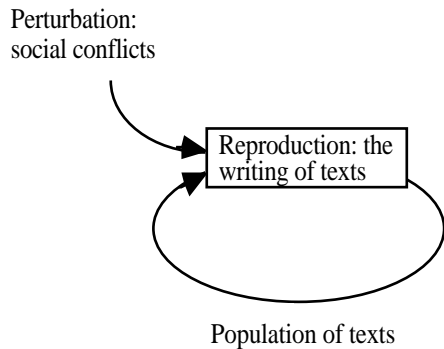


Fig. 2.11. The theory of genres as member of the general class of perturbed reproduction theories.

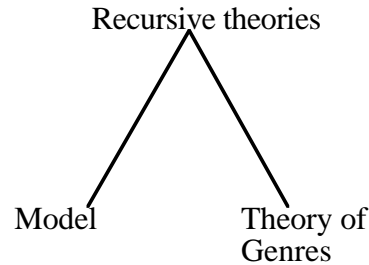


Fig. 2.12. Model, Class of theories, and Theory of Genres.

The goal of this paper is therefore very modest: to argue that the theory presented is a member of a more general class of theories that contains at least one member for which the claim can be proved. The goal is thus to prove that the theory is a possible theory.<sup>3</sup>

### 3. The model

In this section I describe the actual running model. Point (1) claimed that the main process was ‘a circular process whereby new texts are produced by recombinations of old ones’. This indicates that the processes described by genetic algorithms (Davidor 1991, Davis 1996) could be relevant to the representation of the reproductive process in the computer program.

In the model the texts are represented by arbitrary sequences of 0’s and 1’s. Texts can be created in two ways, by *genetic recombination* and by *mutation*. Let us first illustrate *recombination*. Look at the two strings below:

- (1) 00100000011
- (2) 11100000001

Recombination means that we choose a section of the two strings and exchange them. Suppose we choose the section consisting of characters 2-3 in both strings. We then divide the two strings as shown in (3) and exchange the middle sections, which gives us (4).

<sup>3</sup> Biologists have a similar problem, namely to explain the emergence of different species and their amazing variety. See Todd & Miller (1997) and Werner (1997).

- (3) 1-01-000000001 0-11-000000011  
 (4) 1-11-000000001 0-01-000000011

Finally, the two new strings are added to the population of strings.

*Mutation* merely means that we exchange an arbitrary 1 for 0 or vice versa.

Point (3) claimed that ‘authors cannot pre-calculate the meaning assigned to a text by its audience’. This is concretized by defining the interpretation of the strings to be completely unrelated to their production process.

We divide each string into two halves and interpret each half as an integer. For example (2) is divided into 001000-000011, of which each half is interpreted as an integer. This gives us two numbers, 8 and 3. These numbers represent the *interpretation* or *value* of the string. Note that the construction of the string (recombination) analyses the string in a completely different way than the interpretation. In this way we represent the non-identity between construction and interpretation. The constructive process knows absolutely nothing about the ensuing interpretation.

The two numbers of the interpretation represent the location of the string in a two-dimensional phase space, cf. Section 2.1. The plane itself defines the set of possible themes, and the numbers locate the string in this continuum. However, the theory set forth in Section 2.1, namely that ‘genre can be defined by specifying the dimensions of the phase-space and the possible trajectories in it’, has been simplified somewhat. In the model the possible trajectories in phase spaces are reduced to a point in the phase-space representing the theme of the genre. Thus, the fantastic genre is defined by the location of its theme in the middle of the Natural/Supernatural dimension. This means that we can no longer distinguish between the Fantastic, the Shocking and the Wonderful. The reason for this simplification is not that the criterion cannot be implemented, but rather that it is more difficult and does not seem relevant to the main issues i-iv, which is the birth, differentiation and death of genres.

The theory of genres in i-iv now claims that texts are not distributed randomly in a thematic space but cluster together in certain areas. *Such clusters are the genres.*

Therefore, the first question is: can genres emerge if we start with a completely random distribution in the thematic space? The answer is: yes.

The secret lies in the requirement that central strings are more frequently used as parents to new strings than non-central ones. If this is the case, then it is an amazing fact that strings will cluster within specific areas even if the construction process knows nothing about the interpretation at all.

The program itself conforms to general schema for genetic algorithms and is an instance of the perturbed recursion schema:

```

Create initial population
repeat until some criterion is met
  choose two members of the population
  according to their value
  make two new recombined offsprings as
  indicated in 3-4.
  evaluate the offsprings
  choose two members of the population
  and kill them
  enter the offsprings into the population
end repeat

```

Code 3.1

The population of the algorithm is our texts. We are first required to find two good parents, and according to point (4) this search must be based on the prototypicality of the strings. In order to get a formal definition of this concept, we calculate the *isolation* of the strings. The isolation of a string  $x$ ,  $I(x)$ , is the mean distance between the string and its neighbors, e.g., the eight closest strings.

Since, according to (6), we want to reproduce central strings more often than non-central ones, we require that the probability of reproduction of string  $x$  and  $y$ ,  $P(x)$  and  $P(y)$ , must be inversely related to their isolation: the smaller the mean distance to its neighbors, the greater its chances for becoming a parent. Similarly, we calculate  $Q(x)$  and  $Q(y)$ , which are their chances of getting killed, i.e. forgotten. These probabilities must be proportional to their isolation: the more isolated, the more likely it is to be forgotten.

The detailed construction of the formulas for  $P(x)$  and  $Q(x)$  is given in appendix A. The result is formulas (5-6), where  $K$  and  $L$  are constants depending upon the distribution of the total set of strings.

$$(5) \quad P(j) = \frac{K}{I(j)}$$

The probability of string  $j$  becoming a parent is inversely proportional to its isolation. The less isolated, the more chances of producing children.

$$(6) \quad Q(j) = L * I(j)$$

The probability of string  $j$  getting killed is proportional to its isolation. The more it is isolated, the greater chance it has of being the last of its kind.

### 3.1. Simulations

In the following I shall display some simulations that generate phenomena i-iv postulated in Section 2.4, but before presenting the results there are a couple of decisions made in the program that require comment.

*The strings have the same length.* This does not agree with our actual domain where texts have different lengths, and the decision is only motivated by ease of programming.

*The number of strings is kept constant.* Whenever a new central string is created, an old non-central string must die. To a certain degree this is motivated, since books do become obsolete and lose their significance for the literary process. However, the decision to use a constant population of strings is *not* motivated by the domain.

*The system is based on concurrent processes.* This is motivated since writers write in parallel, not sequentially, so that for example twenty new books may be written and published at the same time.

The isolation of a text is not necessarily calculated over the whole population but may use a smaller subset of the closest neighbors. For example, the isolation may be calculated as the mean distance to the five closest neighbors. This subset is called the *neighborhood*. This seems motivated by the domain. Neither writer nor reader can use the total set of books to interpret a book, since this presupposes a perfect knowledge of the market and unrealistic abilities to cope with the corresponding complexity.

Finally, the need for ‘newness’ (cf. Section 2.1) may prevent a certain central book which has been the parent of many books from being elected in the next period: as familiarity increases, boredom does too. To represent this we use a *familiarity* variable that is increased each time the strings are elected and decreased when they are not. Thus, instead of using (Appendix A)

$$(1) \quad \text{Random}\left(\frac{100}{P(j)}\right) = 1$$

to select new parents, we use

$$(2) \quad \text{Random}\left(\frac{100}{P(j)} + \text{familiarity}\right) = 1$$

For example, if  $P(j)$  — the chance of  $j$  becoming a parent — is 33%, then the program chooses it each time  $\text{Random}(3) = 1$ . However, if the familiarity value is 10, then it is chosen when  $\text{Random}(13) = 1$ . The corresponding probability has decreased to 7.7% chance of getting elected. Thus, increased familiarity counteracts the centrality of the string.

*Run One.* The first diagram in Fig. 3.1. very clearly shows that a random population of strings quickly clusters in one place, in fact after only 6 iterations.

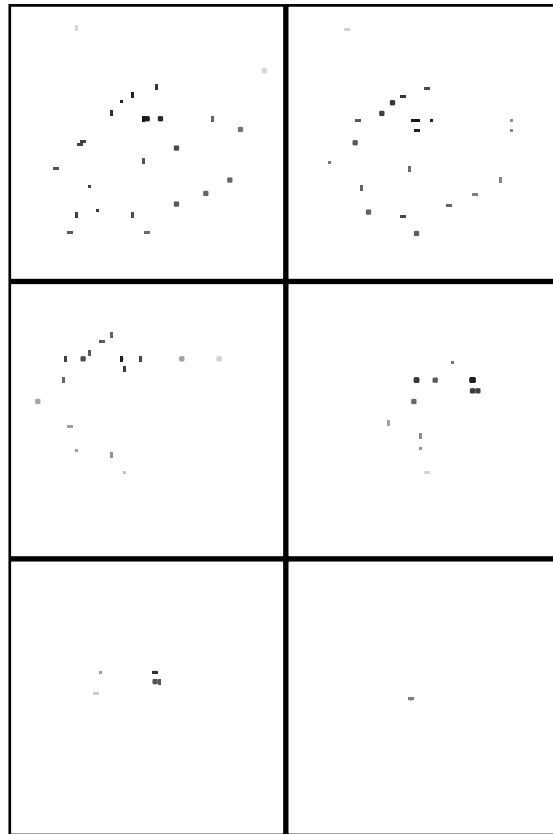


Fig. 3.1. Run 1. Dynamic diagram with a strong fixed point attractor.

We have a strong fixed-point attractor. The parameters of the diagram are shown in Table 3.1.

Length of strings	12
Number of strings	25
Number of iterations	10
Number of concurrent recombinations	5
Mutation rate	0.1%
Neighborhood	8
Increase in Familiarity	0
Decrease in Familiarity	0

Table 3.1. Parameters of Run 1.

The strings were 12 characters long, their number totaled 25, the number of iterations was 10 and in each iteration 5 concurrent recombinations were made. The mutation rate was very small (in fact no mutations took place), and the neighborhood used to calculate the isolation of the strings was 8. No increases in familiarity were used. If no new offsprings can be produced after a certain number of trials, the system begins to produce mutations.

The mean isolation of all strings decreased monotonely by a factor of 2.5.

*Conclusion of first run:* on the one hand, we have certainly proved point (i) in Section 2.4, but a little too much compared to reality: in the real literary market, we never end by reproducing copies of a single masterpiece! It seems as if the hardest problem is not — as we believed — to account for genre formation (regulation), but instead to account for the variety of genres!

In the next runs I experimented with various parameters. Here are the main results:

- In run two parenthood increased familiarity by 10, so that if a text had been the parent of another text it was less likely to beget children in the subsequent iterations. This medicine was not strong enough, since the strong attractor remained.
- In run three copying was prevented, so that children were always required to be different from their parents. This is well motivated, both for aesthetic and legal reasons. In this run, three clusters appeared and lived for a while, but eventually one of the groups won. The system ended in a state where no new texts could be produced; it went into an endless loop and had to be stopped by hand. The isolation measure no longer decreased monotonely. We seem to have proved claim ii: in the theoretical framework, genres can stabilize themselves to such an extent that they prevent any generation of new texts! Can the emergence of new genres be due to this type of literary indigestion?
- In run four the neighborhood was increased to 10, and the increase of familiarity remained at 10. Increasing the neighborhood is expected to slow down the growth of central strings. In this case we ended again in a situation with one cluster, but now the cluster stayed alive: there were no problems with generating new texts, and the cluster covered a regular space inside which it changed like an amoebae. By increasing the number of texts that are perceived as relating to each other and by maintaining the demand for novel texts, genres can be kept active while still constituting a coherent genre.

### 3.2. Social perturbations

In the previous runs we have only experimented with the *reproductive* function. Now we look at possible *perturbations*. We are interested in the stability of genres vis à vis social changes. For example, can well-established genres prevent new problems and dilemmas from being thematized in literature? And if they are thematized, can old genres move slowly to the new problem location or can new genres grow up around them?

By a dilemma I mean two antonyms (concepts that do not overlap) that both are attractive to authors and audience. The opposition between the natural and supernatural explanations of the Fantastic genre is a good example. As members of a secular society whose survival depends upon the natural sciences, we must endorse natural explanations in order to preserve our social reputation. On the other hand, natural explanations are boring and do not stimulate many people's imagination; faced with the dismal problems of the present society we all secretly hope that an unseen wonderful world may eventually reveal itself. Our brain and desire of social survival attracts us to natural explanations; but our heart and hopes for a better life move us in the opposite direction.

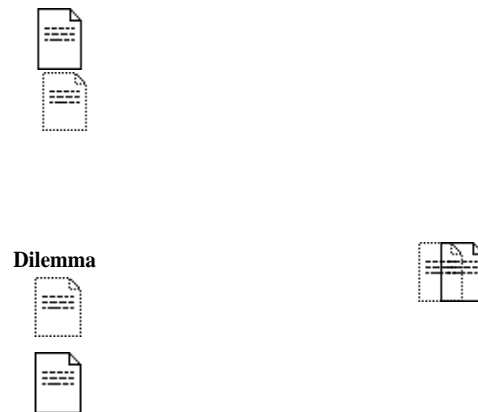


Fig. 3.2. Representation of dilemmas as distortions of a phase-space. Unbroken version: location in phase space without distortion. Dotted version: perceived location under the influence of the dilemma.

The hypothesis is that genres congeal around dilemmas generated by society, but that the actual position of the dilemmas is only revealed through discursive praxis. It cannot be observed directly through our senses but is gradually disclosed by trying to write about it.

In the model I have chosen to implement the force of dilemmas as a *distortion* in the phase-space: dilemmas are placed in the phase-space in the same way as texts are, but they only reveal their presence by shortening the distance to the surrounding texts (Fig. 3.2).

Dilemmas distort the interpretation of texts by attracting interpretations of neighboring texts to itself. This theory does not presuppose an objective interpretation of texts; it merely claims that dominant contemporary dilemmas bias the interpretation in a certain way. This explains why classics receive new — modern — interpretations in each historical era, and it explains why texts that have no relationship to each other in one period are viewed as having a common theme in another period: the semantic distances between texts are distorted by the dominant dilemmas of each era.

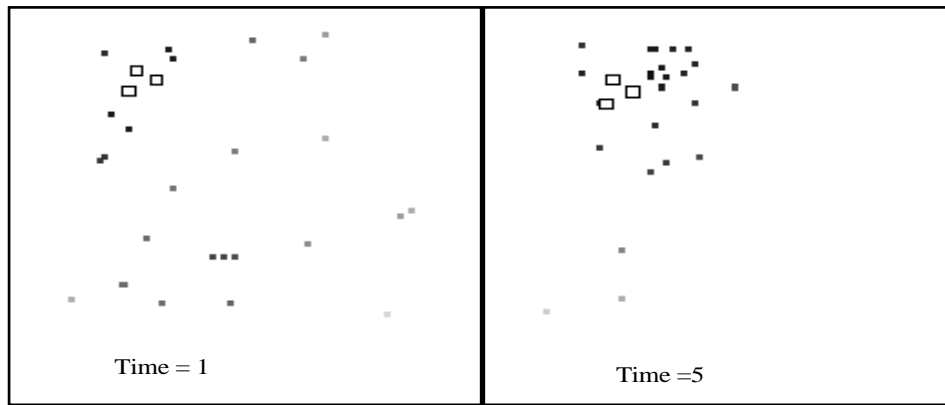


Fig. 3.3. Initial situation. The dilemma is represented by the three white boxes in the upper left quadrant.

Fig. 3.4. Clustering around the dilemma.

Run 5 showed a clear clustering around the dilemmas (Fig. 3.3 - 3.4). When I moved the dilemmas downwards, the original genre bifurcated into two: one stayed at the old location, another formed around the new dilemma (Fig. 3.5). However, after 29 iterations the new genres disappeared again and let the old genre reign supreme.

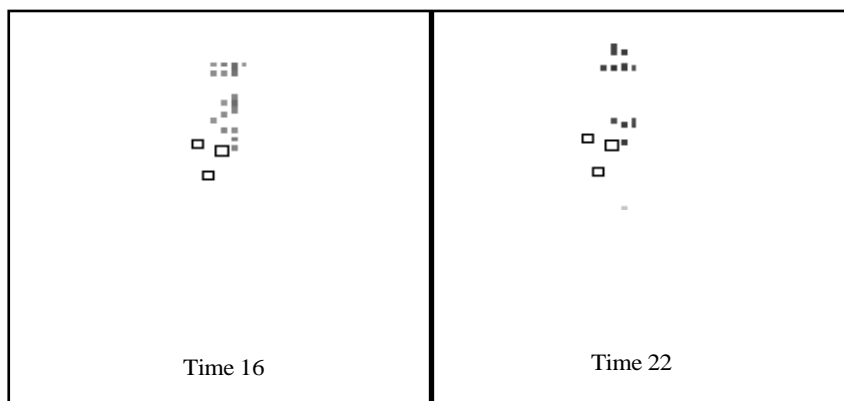


Fig. 3.5. Bifurcation of old genre as a result of a movement of the dominant dilemma.

A possible interpretation in terms of real texts is that after a change of social dilemmas, it is possible for a genre to bifurcate so that a new (sub) genre emerges around the new dilemma while the old genre still lives its normal life, although now devoid of social relevance. The immoral ending of this run is that obsolete tradition can have so much force that it kills its rival and re-establishes itself as the ruling genre.

We seem to have proved part of claim (iii), namely that in the chosen model genres can bifurcate into subgenres.

The model will also generate examples of perturbations that have no effect whatsoever on the existing genres. If we had moved the dilemmas to the bottom of the space, there would be no texts there to be influenced by the dilemma, the

new distortion of the phase-space would have no effect on the isolation of the texts, and would therefore never be noticed by the literary market at all. In order for new dilemmas to be noticed, they must emerge in an area where they can cause re-interpretations of old texts.

### 3.3. Variety and repetition

In run 6 we add the constraint that no offspring may be equal to any of the old generation.

In a sense, this is not realistic, since an author does not have access to the whole population of texts. On the other hand, it stresses the demand for textual originality which grew in 19th century Romanticism. Each new text should be unique.

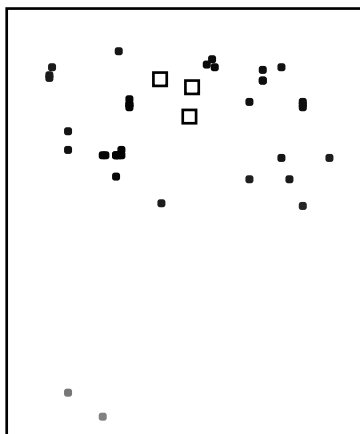


Fig. 3.6. Weak clustering around dilemma.

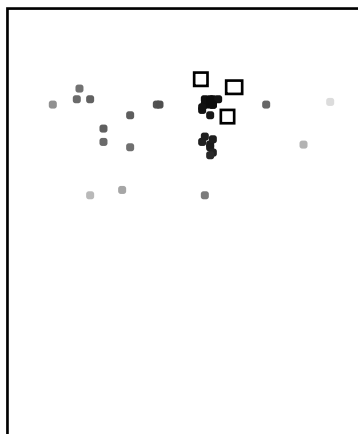


Fig. 3.7. Clustering around dilemma.

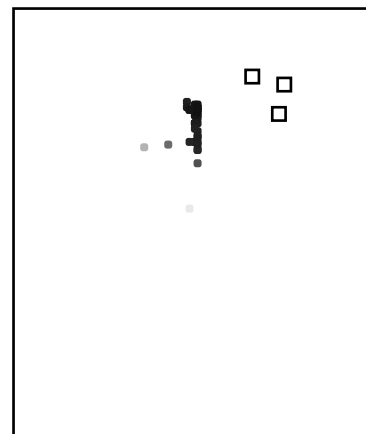


Fig. 3.8. Genre is left behind.

The constraint allows us to investigate the possible dynamics of authors caught in the dilemma of variety and repetition: on the one hand, the market demands repetition in the shape of genres; on the other hand, it expects every new text to be unique. Are the two opposing forces, regulation versus variety, irreconcilable, or is there a solution? A solution must consist in a collection of texts that are all distinct, but still cluster in the same area of the space. A set of texts that resemble each other but exhibit subtle shades of difference.

It turns out that there is a solution, but it certainly takes time to find it. Only in the 16th generation did texts begin to cluster, and it took 30 generations before two close-knit clusters formed.

In run 7 (Figs. 3.6-3.8) we move the attractors to the right and upwards for each iteration. In the beginning the texts clustered around the dilemmas, but the clustering seemed to be all too strong: although the dilemmas kept moving towards the right, the clusters stayed put. The genre was 'left behind' the social development! I could not simulate point (iv).

This example has made it abundantly clear that our theoretical framework has difficulty accounting for the ability of genres to adapt to new problem settings. When genre clusters have reached a certain critical size, they become insensitive to perturbations. The reason is threefold:

1. They become self-sufficient. All strings lie in a confined cozy neighborhood so that their isolation is very low, and the distortion of the attractors plays a marginal role.
2. Variety is insufficient. Close strings are similar; if all strings cluster in a small space, all strings are similar, and recombinations cannot produce offsprings that are markedly different from their parents.
3. If mutations are isolated, they die too quickly to give rise to offsprings.

### 3.4. Chronic inequilibrium

In the preceding we have succeeded in describing patterns of genre formation based on local textual processes, but we overdid it: the genres turned out to be all too stable. I could not make the model sufficiently sensitive to changing social perturbations, nor create the internal chronic instability suggested by Nöth and Luhmann. Although this does not mean that no versions of the model can be made to accomplish this, it motivated the experiments with the following modification of the model.

The new idea is that literary codes keep oscillating between two phases, corresponding to two *cultural climates*: an innovative phase where old traditions are challenged and dissolved, and a stabilizing phase where the new ideas themselves become stabilized and standardized.

The preceding experiments provide a plausible reason for this oscillation: the important themes and contradictions of a cultural change as a result of changes in the rest of society — technology changes, commerce changes and the families' living conditions change — but although the themes are real, they are not floating around just waiting to be discovered. They need to be written about in order to become visible and socially accessible. Since they cannot be observed except at the moment of writing, the question is: how can we ensure that a social system discovers its own problems? Our experiments certainly showed that this cannot be taken for granted. On the contrary, it is easy to set up conditions that make genres so stable that they will not move when the problems move. Thus, situations where writers continue writing about problems that have become obsolete, and neglect problems that are pressing, can easily occur.

A built-in oscillation which forces the literary market into innovative, experimental climates could be one way to enhance self-reference.

The conjecture is that the class of theories we called theories of perturbed recursion does not seem to possess the desired properties. In the following we look at theories that involve two or more mutually perturbing systems.

The following model consists of two mutually perturbing systems, the literary market as we know it and the *Cultural Climate*. Both systems are controlled by processes with perturbators that can be influenced by the other system (Fig. 3.9).

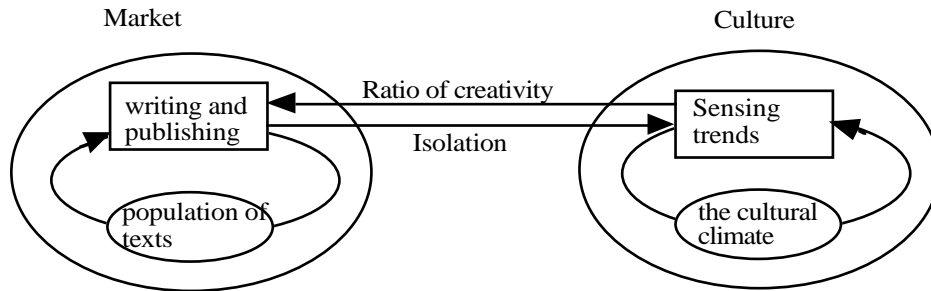


Fig. 3.9. The coupled systems model.

The two systems are autonomous in the sense that they do not directly interfere with each other: one produces texts, the other produces a general Cultural Climate (placing us in an innovative phase (e.g., the early seventies) or in one where the most important task is stabilization of previously destroyed norms (e.g., the eighties). This means that writers do not take the temperature of the Cultural Climate and use that directly as a recipe for writing, nor can the public read books as explicit symptoms of cultural trends. The relationship between culture and the literary market is more indirect.

The writing process is basically concerned with creating new texts inspired by old texts, and is only perturbed by the Cultural Climate. In our model, the Cultural Climate determines the ratio of creativity, i.e. the ratio between recombinations and mutations, and not the concrete themes taken up by texts.

Similarly, the change of the Cultural Climate is mainly a function of the existing climate, but is perturbed by the actual main isolation (the variety) of the market.

Can this theoretical revision help us understand the real dynamics? In line with our methodology, we first check whether there are varieties of this theory that can describe the desired type of oscillations. And since the theory belongs to the non-linear type, we look again for a formal variation that can be experimented with on a computer.

Now let us return to developing the model.

In order to create a formal model, let  $N$  denote the number of new texts in each iteration. Then let  $R$  denote the number of texts produced by recombination, let  $M$  denote the number of texts produced by mutation, and let  $I$  denote the mean isolation of the texts, i.e. the mean distance of the texts to their neighborhoods.

We know that  $R + M$  must equal  $N$

$$(1) \quad N = R + M$$

and in addition we assume the R and M are related to I: the larger the isolation (variety) the larger the number of recombinations, and the smaller the number of mutations. See (2). In the following we use a function of I, C(I) the *Cultural Climate*, that is inversely related to I, so that larger I's give smaller functional values. This means that the larger I, the smaller C(I), and the larger the number of recombinations. Therefore, M is proportional to C(I) and R is inversely proportional. See (3).

$$(2) \quad \frac{R}{M} \approx I$$

$$(3) \quad \frac{M}{R} \approx C(I)$$

On the one hand, the more isolated and scattered the texts are, the more recombinations will take place, causing the literary texts to contract into fixed and localized genres. On the other hand, the less isolated the texts are, the more mutations will occur, causing the fixed genres to scatter into the whole problem space.

Solving (1) and (3) for R and M gives us

$$(4) \quad M = N \frac{C(I)}{C(I) + 1}$$

$$(5) \quad R = N \frac{1}{C(I) + 1}$$

Now we only need to determine how to calculate the Cultural Climate. The Climate must be a function that essentially yields values in intervals corresponding to the two phases: if Isolation is small (texts clot) then Recombination should be small, and if it is large (texts are scattered), Mutation should be small. Between the two intervals a small interval should exist where the Climate quickly moves from one value to another. One possibility would be to use catastrophe theory to do the job, cf. Section 1. In the following, we shall use the popular cusp:

$$(6) \quad y = x^4 + ax^2 + bx$$

The cusp family of equations has two parameters, *a* and *b*. By varying the *b* parameter, we can change the number and location of attractors, as shown in Figs. 3.10 to 3.12.

The idea is now to place an object inside the curve and let it be influenced by the negative of the gradient of the curve. If placed on a slope it will roll down into the nearest minimum, where it will stay. The location of this object is used to provide the values of the Climate controlling the ratio between Recombination and Mutation. If the object is placed in the minimum of Fig. 3.10, it will stay there as we increase *b*. It will rest in the right minimum during Fig. 3.11, and only begin to

change position in Fig. 3.12 for a sufficiently large  $b$ . The Isolation of the texts perturbs the cultural system by being used as the  $b$ -parameter, so it is the Isolation that causes the catastrophes in the cultural system.

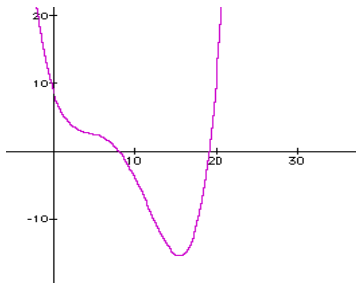


Fig. 3.10 .  $b$  negative.

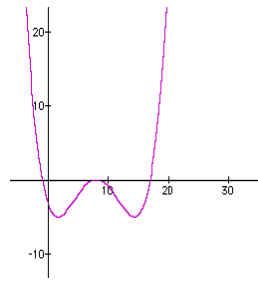


Fig. 3.11.  $b = 0$ .

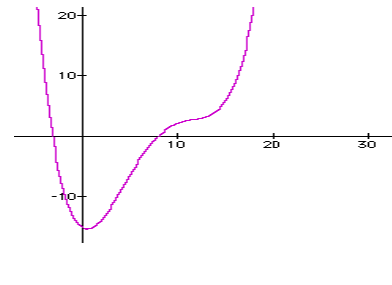


Fig. 3.12.  $b$  positive.

In this way we convert a continuous change — the change of the Isolation of the texts — into a discrete change — a catastrophe — namely the change of Cultural Climate that controls the proportion of expansion and contraction. In addition, the location of the change when we go from expansion to contraction is different from the location of the catastrophe when we travel in the opposite direction, from contraction to expansion.

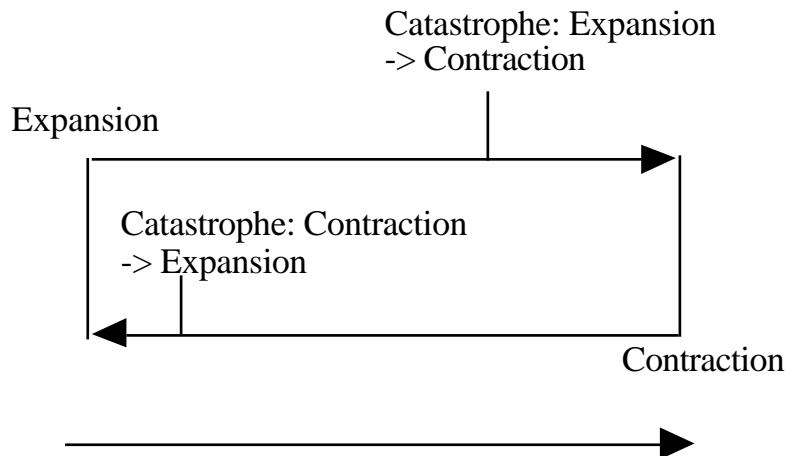


Fig. 3.13. The literary cycle.

When we move to the right in Fig. 3.13 (top trajectory), we are in a phase of renewal and dissolution. At the point to the right, the catastrophe occurs, and the ratio of mutation and recombinations is changed to the benefit of Recombination. The texts begin to clot and the isolation of texts decreases: we have entered the phase of stabilization (bottom trajectory).

This phase will continue beyond the point of the first catastrophe. When the next catastrophe eventually does occur to the left of the middle, the genres have had sufficient time to clot, and the cycle can now repeat itself. Thus, there is a

built-in conservatism in the literary market, and it is in fact this conservatism that generates the oscillation.

After having chosen appropriate dimensions for the potential function and scaled the  $I$  in a suitable way, we let the new Cultural Climate  $C$  depend upon its own previous state and the isolation of the text of the market as shown in (7).

$$(7) \quad c_t = c_{t-1} - f'(c_{t-1}, I_{t-1}).$$

(7) expresses the dynamics, i.e. the mode of development, of the Cultural Climate. It says that the climate moves towards the nearest attractor and that the nature of this attractor is determined by the isolation (density) of the products of the literary market.

The systems are of the kind Thom classifies as metabolic: the internal state of one system is used to perturb the other system, whose internal state again is used to control the first system.

A possible philosophical interpretation of this description is that the structure we experience in our world is the result of our own doing, that is: structures are the result of self-organizing processes. Even if a writer may complain of a hopeless Cultural Climate and feel it as heavy fetters around his neck, he has in fact himself participated in creating those fetters by his previous contributions to the market. But since the relation between his practical actions and their effects is non-linear, it is difficult for him to see that his chains are all of his own making: there are no eternal, mysterious laws of culture that govern the fate of civilizations and cultures.

The next examples verify that the formal system behaves as desired. Fig. 3.14 shows a typical run. The market starts in a scattered state, but it contracts quickly. The contraction reaches its maximum after 5 iterations, and then slowly begins to build up diversity again. The diversity reaches its maximum at iteration 25, and starts contracting again.

This proves that the type of theory we are working with has formal variants which do in fact produce the dynamics desired. But again: it does not prove that the theory is a correct theory of the actual domain of cultural innovation, only that it is a *possible* theory.

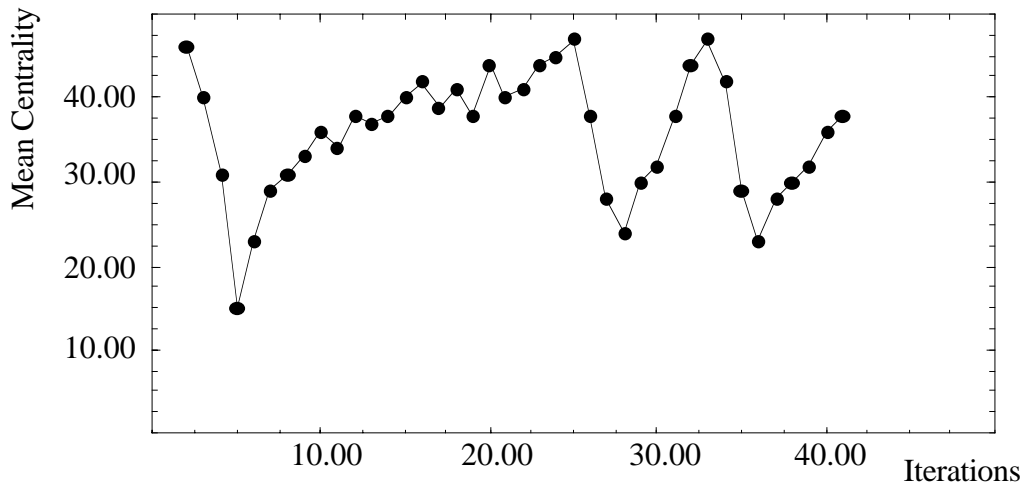


Fig. 3.14. Oscillation between contraction and expansion.

#### 4. Types of causation

In this section we shall discuss two interpretations of the arguments in the preceding sections. The first interpretation uses the three types of downward causation described in Emmeche, Køppe & Stjernfelt (this volume). The second one exploits the notion of heterogeneous scales presented in Lemke (this volume).

##### 4.1. Autonomous levels in texts

Let us first look at the notions of upwards and downwards causation as they occur in the human sciences. *Upwards causation* means that global patterns are created by the interaction of many parts, *downwards causation* means that these patterns can constrain and possibly change the self-same interactions that caused the patterns to emerge in the first place.

It is not unusual in the cultural sciences to assign some kind of autonomy to the superordinate levels. One reason is that if some kind of autonomy of levels did not exist, we would not be able to account for the actual literary battles and controversies of which text history is so full. If genres only existed in the eyes of the beholder, then it ought to be easy to break with the past literary styles and genres. One could just write a new text. But this is not how it works. On the contrary, new literary styles are nearly always accompanied by aggressive attempts from the new generation to free itself from the fetters of the old tradition. Therefore something must exist that needs to be fought. An account that only uses upwards causation ascribes too little stability and too much flexibility to genres.

We have the same problem in accounting for ideology. From a materialistic point of view, ideology can be considered an emergent property of the interactions of a

group of human beings, of their material living conditions. If conditions are changed beyond a critical limit, the ideology changes too. Feudal society goes hand in hand with a hierarchical and static way of thinking, whereas capitalist society gives rise to ideas of dynamics and equality. Rich soil yields soft religion, poor soil engenders fundamentalism.

The problem is, however, that even if there is some truth in this idea, ideology seems to be all too stable for this explanation to hold. Romantic ideas that emerged in the 19th century still hold their grip on modern man. Obsolete ideology is the rule rather than the exception.

Furthermore, ideology exerts downward causation, i.e. it changes the material conditions from which it emerged. The clearest example is political ideology: the notion of equality, inherent in capitalism, may constrain the equal exchange of market economies in order to enhance equality in the consumer section of society (the welfare state).

This autonomy of levels is in fact an important ingredient in the *hermeneutic circle* which is assumed to occur during any kind of semiosis: reading the individual words helps create the global meaning of the sentences, and, conversely, the global meaning modifies the meaning of the individual words. This kind of mutual modification of parts and wholes does not stop at the sentence level but continues throughout the whole text (cf. the notion of *backward causation* in Togeby (this volume). In the beginning, the word 'rose' may mean a flower, but in the ending it may have acquired an elaborate non-standard metaphorical meaning.

In the hermeneutic circle one may say that the reader's interaction with the whole continuously modifies the rules by which he interacts with its parts. In addition, it is hard to point to external variables during the reading process that change boundary conditions. So during the individual reading of a novel or viewing of a film, we seem to have a closed loop where part and whole mutually reorganize each other.

That the level of texts and the level of sentences indeed form two autonomous levels can be seen from the practice of textual analysis. On the one hand, it is certainly possible to write a concise description of sentence patterns in a language, and on the other hand it is also possible to describe global patterns of textual organization (Propp 1975, van Dijk 1980, Johnson and Mandler 1980).

A simple sentence grammar could look like this:

SENTENCE	->	NP AUX PREDPH
NP	->	DET (ADJPH)* N (S)*
		S
PREDPH	->	VP (PREPPH)*
VP	->	AUX V (NP) (NP)
V	->	give see run

N -> boy|girl|ice| eat  
 DET -> the|a  
 ....

which, with appropriate additions, would generate sentences such as ‘The girl gave the boy the ice’, ‘The boy saw the ice’, ‘The girl runs’, ‘The boy saw the girl that ate the ice’, etc.

An example of a text grammar is given in Johnson and Mandler 1980:

STORY -> Setting and EPISODE  
 EPISODE -> {Beginning event Cause DEVELOPMENT}\*  
 Cause ENDING  
 DEVELOPMENT -> COMPLEX REACTION Cause GOAL PATH |  
 DEVELOPMENT Cause DEVELOPMENT  
 COMPLEX REACTION -> Simple Reaction Cause Goal  
 GOAL PATH -> Attempt Cause OUTCOME  
 OUTCOME -> Outcome Event | EPISODE  
 ENDING EVENT -> Ending Event | EPISODE

Note that these formally identical descriptions use completely different types of categories. Whereas the grammar categories are mainly defined by distribution criteria of morpheme classes, are eventually rewritten as actual morphemes, and involve only vague reference to meaning, the categories of story grammar denote global meanings that are assigned to larger stretches of sentences, they do not refer to specific grammatical structures, and they are not rewritten as actual morphemes. In fact, the terminal symbols of the text grammar (Setting, Beginning event, etc.) may cover whole pages in the text.

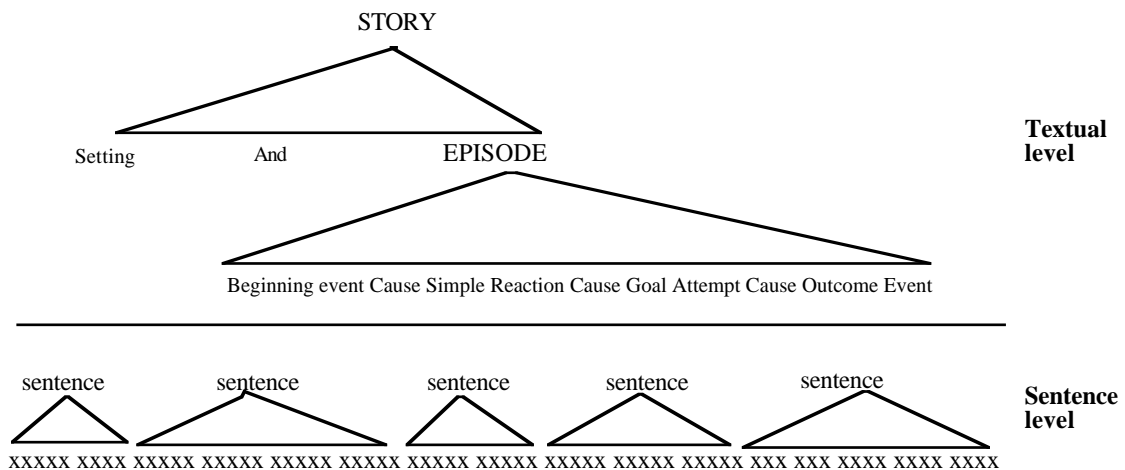


Fig. 4.1. The gap between text- and sentence grammars.

Thus, there are two levels, each with their own structure and categories, and separated by a deep chasm. As shown in Fig. 4.1, one can set up explicit descriptions

of the textual level and of the sentence level, but not of the relationship between the textual and the sentential level.

We find the same difference when we compare the actants of Greimas (1979) to the cases of case-grammar. The subject of the *story* — i.e. the actant that desires to acquire an object and which may be hindered by an Antagonist and helped by a Helper — need not be the subject of its *sentences*. For example in *The Tinder Box* (Togeby, this volume) the soldier is the subject of the narrative but not necessarily the subject of the sentences. For example, the witch utters the sentence ‘I’ll give you my blue checked apron to spread out on the floor.’ where the soldier is the recipient (dative). Still, the subject of the narrative in some genres may statistically tend to occur often as the subject of sentences, which in fact is the case in the quotation. The soldier *marches, meets a witch, and says things*.

What is certain, however, is that there is no simple logical relationship between the structure of the text and that of the sentence. One cannot derive one from the other in a simple fashion. Concepts like EPISODE, OUTCOME, Event are higher-level concepts that emerge from the reader’s interaction with the lower-level words and sentences but seem to possess an objective existence, for example in the sense that people normally do not remember the actual wordings of the text, only the textual ‘macrostructures’ (Folke Larsen 1981).

If we compare these observations with the three kinds of downward causation in Emmeche, Køppe & Stjernfelt (this volume), it seems as if we have a type of *strong* downward causation: ‘A given entity or process on a given level may causally inflict changes or effects on entities or processes on a lower level.’ The authors associate this thesis with two assumptions:

Ontologically or materially, a higher level entity is constituted by the lower level, but even if lower level entities are a necessary condition for the higher level, this higher level cannot be reduced to the form or organization of the constituents. Thus, the higher level must be said to constitute its own substance and it does not merely consist of its lower level constituents.

A higher level entity is defined by a substantial difference from lower level entities. The morphological or organizational aspect is a necessary but not sufficient condition of a higher level entity. By emergence, an ontological change in substance takes place.

As well-known examples of new entities in the textual domain, we can mention *reference* associated with the level of noun phrases, *truth* (and other illocutionary effects) associated with the level of sentences, and *coherence* and *cohesion* associated with the level of text.

#### 4.2. Signs as mediators between different scales

Although one can argue that semiosis involves strong downward causation, the coupled systems model in Section 3.4 does not fit well into this concept. In the model, the Cultural Climate must represent the upper level and the population of texts the lower level; each level is a closed system and upwards and downwards causation is represented by mutual perturbation between the systems.

However, the Cultural Climate does not have the texts as its parts, as should be the case if the two systems were to form a level structure. Rather than being part of a hierarchy, the two systems seem to be located at the same level but at two different scales. And even worse, the cultural institutions embodying the Cultural Climate, can be seen as a part of the literary market, since its products circulate in approximately the same channels as do the literary texts themselves and are read by overlapping groups of people. Thus, the level of the Cultural Climate is embodied as a part of the lower level from which it emerges! Something is clearly wrong here.

This motivates an alternative analysis that describes the relation between the two systems, not in terms of levels, but in terms of scales: the events of the market takes places on a lower scale than those of the Cultural Climate. To one change of climate corresponds many iterations on the literary market, and whereas the individual writer on the market can only observe a local and limited neighborhood of texts, the Cultural Climate observes average values of the whole population of texts. Thus, the Cultural Climate exists on a larger temporal and spatial scale than the literary market. Finally, we can point to social organizations that can be said to embody the Cultural Climate: the institution of literary criticism, publishers, schools and universities. The function of these institutions is to observe the development of texts over time-scales that may be rather large — hundreds or thousands of years, as in the case of the history of literature.

This makes Lemke's ideas of *scale heterogeneity* (this volume) attractive as an interpretation of the models. In this interpretation both the market and the Cultural Climate are social institutions that perturb one another, the difference between them being one of scale.

How is mutual perturbation possible between systems based on different scales? The question is relevant since there are many cases in which interaction between systems of different scales are impossible or difficult. For example, although I may observe and change properties of my arms or legs, it is very difficult for me to communicate with one of my cells; and although I know how to interact with a civil servant, I am not able to interact with his department as a whole.

The latter example shows one way of solving the problem of incommensurability of scales, namely by appointing representatives of scale  $i-1$  for systems of scale  $i$ . The civil servant belongs to the same scale as me but represents a department of larger scale, in the same way as presidents and kings represent the state they govern. The technique is based on the rhetorical figure of *Synecdoche*, pars pro toto, and is thus a semiotic technique where something (civil servant, president) stands for something else (department, state).

The hypothesis is now that this observation can be generalized, so that interaction between heterogeneous scales is always mediated by sign-processes. In order to see this we have to take a closer look at signs.

An important property of signs is that they impose one set of distinctions on a substance that may itself contain no sharp distinctions (e.g., colors) or may contain many distinctions. Put differently, signs are used to classify, to recognize and to produce patterns. Signs do this in two ways simultaneously: they impose semantic form onto the signified, e.g., classify humans into man, women, adults, and children, and they impose phonological form onto the signifier, e.g., classify vowels into /i/, /e/, /a/, etc.

However, whereas the scale of the *signifier* remains constant, the scale of the *signified* may vary greatly. For example, whereas the signifier of the word ‘now’ is always realized as a sound that takes less than a second to pronounce or write, its meaning can denote very different time scales (this second (‘Do it now’), this morning, this day, this year, this century (‘The old enmity between Denmark and Sweden is now replaced by peaceful competition’)). The word ‘here’ displays the same versatility with respect to location: it can mean ‘here, close to me’, ‘here, in this city’, ‘here, in this country’, and so on.

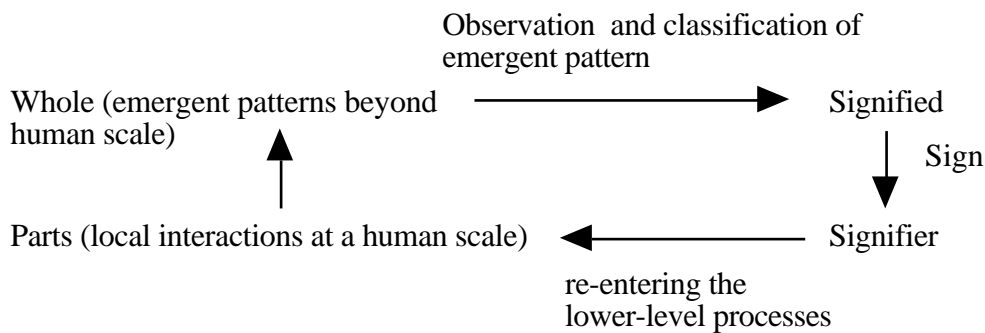


Fig. 4.2. The sign as realization of downwards causation.

Thus, although we cannot interact with the Tax Authority per se, we can certainly talk about it. Since, on the one hand, the scale of the signified can be of a size that precludes any human interaction and, on the other hand, the signifier is always on a scale which allows interaction with a human, *the locus of downward causation in scale-heterogeneous interaction is the sign*, i.e. in the relation between the signifier and the signified. The signified classifies emergent patterns of arbitrary

size and its signifier guarantees that these types of patterns acquire a form that can enter into the lower level processes that generated the emergent patterns, and thus serve to stabilize the patterns (Fig. 4.2). For example, texts written by literary historians can span centuries and continents, but they all end up as a physical form that can re-enter the literary recursion, and thereby stabilize the patterns.

How do language users classify continuous perturbations? One way of describing this faculty (the ‘categorical perception’ described by Clark & Clark 1977: 200) is offered by catastrophe theory (cf. Section 3.4). Consider the strip in Fig. 4.3.



Fig. 4.3. Female body gradually changing to male head. From Saunders (1990: 94).

If one shows this strip to people by slowly disclosing each frame at a time, they will experience a sudden ‘jump’ of interpretation somewhere near the middle. There is no phase where we see something in between the woman and the man. In addition, people tend to be conservative in their interpretation, so if we start from the left, the male face is only seen to the right of the middle, whereas the woman appears to the left of the middle if we start from the right side.

In our example, two descriptions compete

1. The drawing is a female body
2. The drawing is a male face.

Under some perceptual conditions, the subject, ‘the drawing’, combines with the predicate, ‘a female body’, under other conditions it combines with ‘a male face’. The experiment shows that as we continuously vary the perceptual features, the description changes abruptly, ‘catastrophically’. Language imposes a discrete form onto a continuous visual stream. If we describe the forces of attraction between subject and predicate by means of the parameterized potentials of catastrophe theory (Section 3.4), and if we let the visual stream be identical to the parameters, then we can account for categorical perception, as shown in Fig. 4.4. The internal variable of the system (the horizontal dimension) represents the syntagmatic dimension of language, i.e. the before/after relation of morphemes.

In (1) the subject ‘drawing’ is attracted to an equilibrium position (a basin) to the left of the predicate ‘female body’ and we get ‘The drawing is a female body’. In (2) the picture has become ambiguous, so two attractors exist, one with ‘female body’, another with ‘male head’, but since the location to the left of ‘female body’ is still an attractor, the subject stays there. In (3) the leftmost attractor has

disappeared, the subject jumps to the 'male face' predicate, and we utter the sentence 'The drawing is a male face'.

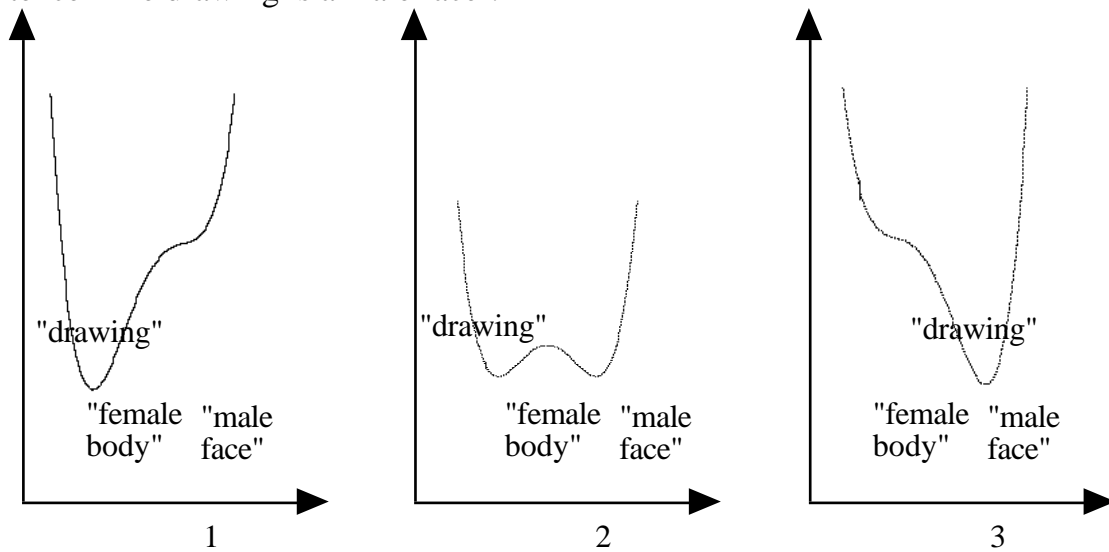


Fig. 4.4. Interpretation of visual stream.

In fact, the same technique was used in the coupled systems model of Section 3.4. Only here the input was not visual but cultural observations. Instead of observing a changing picture, the Cultural Climate system observed continuous variations of textual production, and, at a critical point, underwent a catastrophe where one set of attractors was exchanged for another. In the same way as in the face/body example, the attractors are assumed to regulate linguistic processes, which in this case is self-description, since the critics and philosophers describe a cultural situation of which they are part too ('The climate is conservative'). See Fig. 4.5.

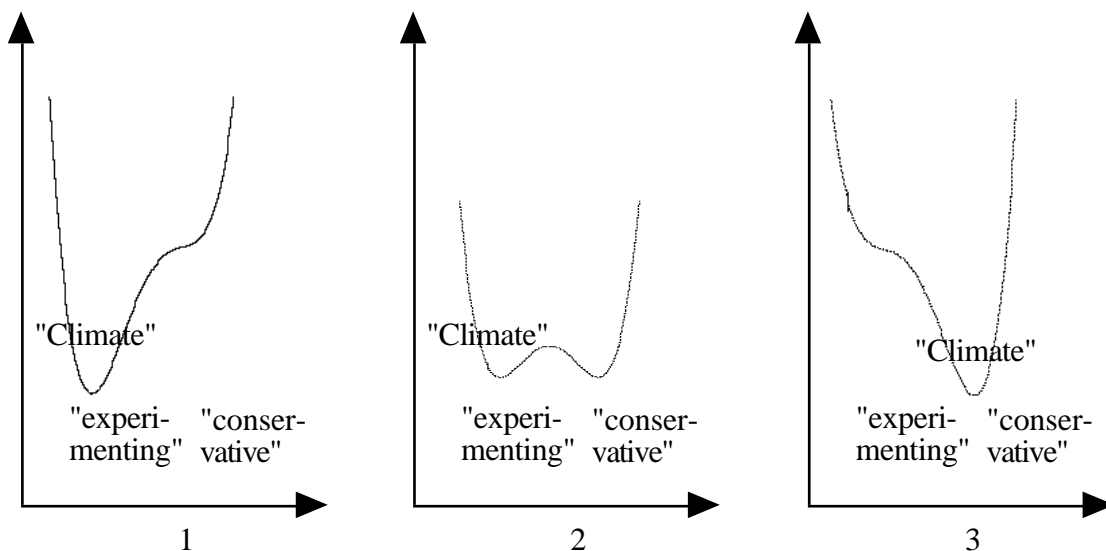


Fig. 4.5. Interpretation of a culture.

### 4.3. Observers and observees

In conclusion, we can generalize Fig. 3.9, which concerns the literary market, to Fig. 4.6 which encompasses all social processes.

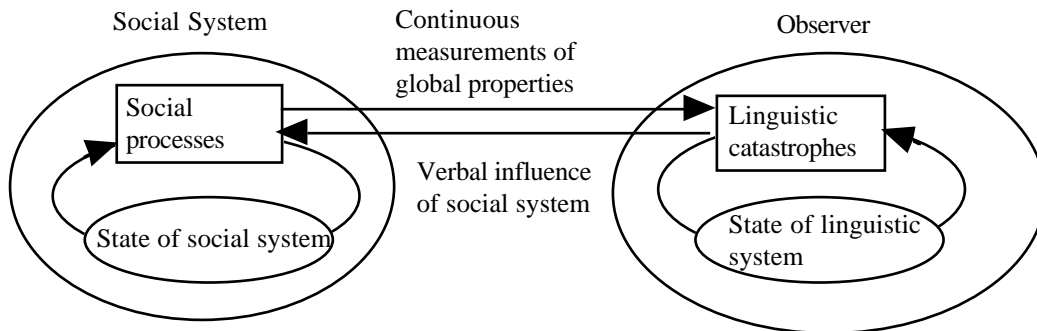


Fig. 4.6. General model of stabilization of levels.

The processes of a social system are iterative and strictly local. Normally we only perceive phenomena at our own scale, and we act according to this limited perspective. However, humans and their societies are capable of the paradoxical trick of observing themselves. The trick is paradoxical since in order to observe something one must (momentarily, at least) disentangle oneself from the object and keep a certain distance, but how does one disentangle oneself from oneself and keep a distance from oneself? In normal everyday work people simply stop working and begin discussing its problematic features (Andersen 1997: 406 ff). Or one can use a division of labor, so that one role observes another role, as when the coach observes the football players or management observes the economic development of the company. In these cases, emergent features are stabilized or changed by means of self-observation.

Lotman (1990) supports this argument. According to him, the stabilization of culture is due to self-description. The ruling culture in the center of the 'semiosphere' stabilizes itself by describing itself. Language is stabilized by grammars, and social norms by written laws and regulations.

The observer system, which is both part of the social system and (momentarily) distinct from it, is perturbed by continuous observations of higher-level emergent processes of the social system. Since the observer system is also a communicative system (which is also true of the social system itself), it converts the continuous inflow into discrete linguistic catastrophes, i.e. into general statements about emergent properties of the social system.

Since these statements are on a scale that can become a part of the state of the social system and thus can enter into its recursion, the observing system can re-influence the social system.

And since the observing system is assumed to be autonomous, the social system only perturbs it, that is, it only deflects the basic recursion of the observing system, but does not determine its precise course. Due to this autonomy of the observing system, we must assume that it performs many syntactical operations that cannot be seen as a direct result of the perturbation, and that properties of these sentences can be measured by the observed system. And indeed, the institution of literary criticism certainly does not stop at a cultural diagnostic, but normally also generates normative sentences that are intended to change the situation.

#### 4.4. The fractal self-similar structure of meaning

If we collect the various examples of the perturbed recursion schema in this chapter, we discover that it can be embedded. For example, the signifieds of novels or films were analyzed as perturbator processes that set the narrative in motion by creating instabilities, and iterator processes that define equilibrium conditions. But this dynamic space is itself embedded into the reading process where the text works as a perturbator of the psychic system in which the narrative is enacted. These interpretative processes are themselves parts of the large-scale dynamics of the literary market where new texts are evaluated. The literary market, in its turn, functions as an environment of the literary institutions that are perturbed by market trends and generate new texts on the same scale as the market products.

Name	Perturbator	Iterator	Dynamics	State
<i>Narrative (psychic system)</i>	disturbance of equilibrium, e.g., violence vs. peace	equilibrium dimension, e.g., ignorance vs. knowledge	narrative process	state of presupposed reader or protagonist
<i>Reading</i>	text or movie	<i>Narrative</i>	creation and execution of Narrative	state of reader
<i>Market (social system)</i>	social dilemmas + cultural climate	population of texts	recombination and mutation (borrowing and invention)	state of market
<i>Criticism</i>	scattering of texts of <i>Market</i>	cultural climate	analysis and criticism	verbal description of climate

The perturbed recursion schema is thus self-similar in the sense that parts of the schema may itself be perturbed recursion schemas.

## 5. Summary

The main point of this paper is that signs work as stabilizers (and perturbators) of emergent patterns. The hypothesis predicts that the stabilization of emergent complex patterns has a qualitatively new nature in sign-using systems (cf. Pattee, this volume and Pattee 1987: 331). In these cases, continuous properties of large-scale systems (the observed systems) perturb small scale-systems (the observer system), which may even be a part of the observed system. The observer system generates signs with the large scale patterns as their signified and a normal human-scale signifier. The human-scale signifier can enter into the human-scale interactions of the observed system and thereby either disturb or stabilize it.

The line of arguments leading to this conclusion can be retraced as follows.

The empirical subject of the paper is genres because genres seem to be a good example of emergent and rather stable patterns which need the notion of downward causation for their explanation.

We started by reviewing the literature on genre formation and found that some theories of genres could be formalized in terms of attractors and trajectories in a phase-space which represents the thematic space of the texts. The dynamics of the phase-space was represented by perturbed recursive processes.

A description of the literary market was turned into an informal theory that was used to build a computer model driven by a genetic algorithm. Each text was assigned a point in thematic space (which is a simplification of the idea of trajectories) and new texts were generated by means of recombination (intertextuality) and mutation (invention). Parts of the algorithm could be interpreted in terms of real literary processes, whereas other parts could not.

As the computer model was run, it turned out that genre formation was a natural effect of the model. Thus, the problem of accounting for emerging genres turned out to have a natural solution in the model, whereas the real problem, surprisingly enough, was to provide sufficient variety. However, under certain boundary conditions, genres could retain sufficient variety, and it was shown how changing the boundary conditions could make genres bifurcate and move.

However, I could not make the model generate the oscillations of which literature history is so full. I conjectured therefore that an isolated recursive system was not a possible theory of genres, and added another component to the literary market, the *Cultural Climate* described by literary institutions. The two systems perturb each other mutually, one system acting as the environment for the other. This model did in fact generate oscillations in the representation of the literary market, shifting between periods of expansion and contraction.

The cultural climate was formalized by means of catastrophe theory. The internal variables of the theory represent the syntagmatic dimension of language, and the attractor change in the system (caused by perturbations from the literary market) therefore represents the formation of sentences. The role of the cultural institutions is thus to observe and describe emergent patterns of the literary market. The model showed that this can explain the unrest of literary genres. Note the word *can*: the argument only proves that the model belongs to a class of possible theories.

The initial hypothesis, that downward causation is needed for explaining the stability of genres, was thus replaced by another hypothesis that uses the arbitrariness of the sign as its pivot. The two sides of the sign differ in their scalar variability. The signified allows large variation as to the scale of the signified contents, whereas the signifier is always at the same (human) scale. In the alternative explanation, stability and change is explained by a semiotic interaction between two social systems of different scales, the observed and the observer system. In the case where the observer system is a part of the observed system the semiosis is self-description.

### Appendix A. Calculation of selection probabilities

If  $P(x)$  denotes the probability of  $x$  becoming a parent, then we have that

$$(1) \quad P(x) = \frac{I(y)P(y)}{I(x)}$$

since probability is inversely related to the isolation. From the fact that the total probability of all strings must equal 100, given that one string must be chosen from the set, it follows that

$$(2) \quad 100 = \frac{I(j)P(j)}{I(1)} + \dots + \frac{I(j)P(j)}{I(i)} + \dots + \frac{I(j)P(j)}{I(n)}$$

Putting  $I(j)P(j)$  outside the parenthesis we get

$$(3) \quad 100 = I(j)P(j) \left( \frac{1}{I(1)} + \dots + \frac{1}{I(i)} + \dots + \frac{1}{I(n)} \right)$$

from which we can calculate  $P(j)$ , the probability of string  $j$  becoming a parent:

$$(4) \quad P(j) = \frac{100}{I(j) \left( \frac{1}{I(1)} + \dots + \frac{1}{I(i)} + \dots + \frac{1}{I(n)} \right)}$$

If we set

$$(5) \quad K = \frac{100}{\sum_{i=1}^n \frac{1}{I(i)}}$$

then we can write (4) as the simpler

$$(6) \quad P(j) = \frac{K}{I(j)}$$

Since we will want to kill the non-central strings, the probability Q of their being forgotten must be proportional to their isolation; the larger the isolation, the more they risk getting killed.

$$(7) \quad Q(x) = \frac{I(x)Q(y)}{I(y)}$$

This leads us to calculate Q as

$$(8) \quad Q(j) = \frac{100I(j)}{I(1)+\dots I(j)+\dots I(n)}$$

or putting  $L = \frac{100}{I(1)+\dots I(j)+\dots I(n)}$

$$(9) \quad Q(j) = L * I(j)$$

again assuming that one string out of the total population must be killed. We now let the choice of parents be controlled by their P-probabilities, and their death by their Q-probabilities. In the model, we perform the tests

$$(10) \quad \text{Random}\left(\frac{100}{P(j)}\right) = 1$$

$$(11) \quad \text{Random}\left(\frac{100}{Q(j)}\right) = 1$$

to decide whether j should be a parent or die. For example, if  $P(j) = 3$ , it means that j has a 3% chance of being a parent. We implement these 3% by choosing random numbers in the range from 1..100 and answering 'yes' if the number is in the interval 1..3. The same effect can be achieved faster if we produce numbers in the interval  $1 \dots \frac{100}{3} = 33,3$ , and answer yes each time the number is 1.

### Appendix B. Calculation of distortion

This concept is implemented by scaling distances between texts and dilemma by formula (1):

$$(1) \quad \text{scaling} = \frac{\left(\frac{d}{w}\right)^2 + h + 1}{\left(\frac{d}{w}\right)^2 + 1}$$

As Fig. B1 shows, the scaling is strong in the vicinity of the dilemma, but decreases quickly and settles at the value of 1 which is ‘no scaling.’

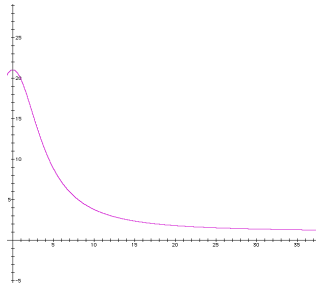


Fig. B1. Scaling with  $h = 20$  and  $w = 4$ .

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