Communication and work on maritime bridges

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1   The problem

This paper presents some theoretical reflections on an empirical project on maritime work and communication conducted at the Danish Center for Man Machine Interaction. The data stem from a European roundtrip on board the carrier M/S Sally Mærsk during spring 1999. It consists of 60 hours videotape of which 16 hours are used in this paper.

A part of the project consisted in producing a description of work and communication on the bridge, but this turned out to be harder than expected. It was easy enough to produce one description of communication and another one of work. But communication and work were highly intertwined, one depending upon the other, so a need for understanding the relation and interplay between communication and work arose.

Although some parts of communication were temporally removed from the action they controlled, e.g. in planning conversations, other parts alternated quickly with purely physical actions. This is true of rudder and course commands addressed to the helmsman: when he receives a command, he immediately turns the wheel.

In addition, it turned out that communication and tool usage substitute smoothly and regularly. For example, in the harbor the ship was steered by the pilot giving orders to the helmsman; outside harbor the helmsman was dismissed and the captain did the steering by means of a steering dial. The mixed chain *Pilot orders helmsman + helmsman turns wheel* was regularly replaced by *Captain turns steering dial.*

In fact, much technology aboard the ships are a result of a historical replacement of this kind: the machine telegraph was originally a communication device from the officer of the watch to engineer but is now a remote control allowing the captain to directly control the engine. Similarly, in some ships the communication between the officer and the lookout is now replaced

by remotely controlled video cameras. These replacements have halved the size of the crew in recent decades (Lee & Sanquist 1996).

Thus, physical processes with no symbolic functions interact and functionally alternate with processes with symbolic function.

In order to describe this interplay, a common conceptual framework for understanding both phenomena and their interrelations was highly needed. However, although communication and work interact and substitute in practice, they are normally considered to have opposite properties. The difference between physical and symbolic processes is nicely captured in a number of papers by H. H. Pattee (Pattee 1996a, 1996b, XXX).

According to Pattee, symbolic processes are physical processes with a special function and a special mode of control. Physics can describe processes as rate-dependent transformations of energy and mass (many physical laws take the form of differential equations), the laws of physics are global and inexorable, and they assume processes to be deterministic and coherent (contiguous) in space and time.

In opposition to this, symbolic processes are rate-independent (long sentences do not necessary produce a large impact, many linguistic rules are conventional and arbitrary), they imply choice (the term *port to port* about the manner two ships pass one another (Text 5.3) only makes sense because we know that *port to starboard* is possible too), the symbolic process and its referent can be displaced in space and time (one can plan the entrance to a harbor many hours ahead), and semiotic rules are local and changeable (the maritime vocabulary is only used by the maritime profession, and it changes historically as ships and waterways change). Finally, symbols always cause some kind of classification and simplification by *focusing* only a few features of the environment to measure and *backgrounding* the rest—they cut up the hyper-complex continuous world into simplified discontinuous segments (the continuous scale of possible speeds are cut up into a few segments, *full a head, half ahead, slow, dead slow, full stop*).

The special mode of symbolic control has evolved in all higher organisms because it has survival value: it enables to the organism to better control its environment (the special maritime jargon has clearly evolved to provide the seaman with distinctions that help him avoid grounding, colliding or getting lost).

In spite of these differences, Pattee is not a dualist but insists that semiotic processes cannot escape the laws of physics. Semiotic and physical explanations are complementary ways of dealing with the same subject:

My position is that no complete physical description of these material structures, although correct in all details, will tell us all we need to know about their symbolic

function. Briefly, this is because symbol function, like all biological function, is not an intrinsic or law-based property of the material symbol vehicles but a selective survival property of the populations of individuals that use the symbols for material construction and control in a particular environment...An alternative, complementary model is necessary.   Pattee xxx: 2.

This position is not controversial in linguistics that traditionally distinguishes between *etic* and *emic* disciplines. Phonetics, for example, provides a physical or physiological description of the sounds, whereas phonemics describe the same sounds but with respect to their distinctive functions in a linguistic system.

To Pattee's characterization we can add the fact that communicative "causation" is always indirect, whereas physical causation is direct. Posner (1993) describes the attempts of Britta, the Kindergarden teacher, to silence the children:

She indicates to the children that she wants them to do something, and if she is successful, the children will understand that she wants them to do something, but they will not necessarily feel moved to do it.
How can Britta nevertheless reach her goal of making the children who glance at her be silent and pay attention? Strictly speaking, she has no behavioural resources of her own that she could utilize for that purpose. She depends entirely on the insight and good will of the children. She can only wait for the children to become "understanding" and "sensible", as she likes to say.   Posner 1993: 234

This idea of indirectness recurs in Posner's analysis of speech acts, for example directives:

```
Directive:
Do(b,f)
and
Intends(b, Occur(f)
   Believe(a, Do(b,f) and
     Intend(b, Occur(f)    Do(a,r))))
and
Believe(b, (Occur(f)
 Believe(a,   Do(b,f) and
    Intend(b, Occur(f)    Do(a,r))))
  )

  (Occur(f)    Do(a,r)))
```

Text 1.1. Analysis of the directive speech act

The formula says the following: B does something f, intending that f will cause A to believe that B has done it and that B intended f to cause A to do some action r; and B believes furthermore that this insight of A will in fact cause A to do r when f happens.

In short: the speaker intends the listener to understand his intention, and hopes that this understanding will make the listener comply.

I think that Pattee's description incorporates many of the commonly accepted attempts to characterize symbolic processes. For example, the function of backgrounding most of the environment and only selecting a few important distinctions is commonplace in structural semantics, and has recently been emphasized as a basic property of human meaning by the late German sociologist Niklas Luhmann: although always filled with a specific actual content, human experience is still aware of the possible contents that are left out:

> Experience experiences itself as variable [...]. It does not find itself closed and self-contained, not restricted to itself, but is always referring to something that is at the moment not its actual content. [...] The problem of integrating the actuality of experience with the transcendence of its other possibilities remains inescapable, and inescapable, too, is the form of experience processing that accomplishes this. It is this that I call meaning.   *Luhmann* 1990: 25

A linguist would say that meaning is structured into paradigms only one member of which can be chosen, while the rest of the paradigm is present for the consciousness and affects its actual contents, cf. the *port-to-port* example above.

Meaning is also characterized by its immense complexity that cannot be handled by the individual system, making reduction of complexity a major semiotic operation:

> The most important feature of the differentiation between Actuality and Potentiality found in experience resides in the character of the overabundance of possibilities, which by far exceeds what can be realized through action or actualized in experience.   Luhmann 1990: 26

The operation of classification—turning the continuous world into discontinuous segments—has always been recognized as basic in linguistics, and some decades ago a mathematical description was proposed by French mathematician Rene Thom (Thom 1983, 1989, 1990) in his catastrophe theory.

To sum up:

1   Semiotic processes (communication) *alternate and interact* with ordinary physical processes (maneuvering the ship).
2   Semiotic processes are also physical processes, and all physical laws are valid for semiotic processes.
3   Semiotic rules imply *rate-independence, displacement, alternatives and choices, classification* and *segmentation*, *backgrounding* and *reduction of complexity, indirect causation*, and *local, changeable rules.*

4   Physical laws *imply rate-dependence, contiguity, determinism, invariance,* and *direct causation.*

How is (1) and (2) possible in view of (3) and (4)? In this paper I shall only deal with four of these problems in a systematic fashion: the notion of *choice*, the notion of *segmentation*, the problem of understanding the *interaction* between semiotic and non-semiotic processes, and the understanding of the *differences and similarities* between these two types of processes. The choice of solutions is practically motivated: they must be operational and applicable to authentic data. Therefore the paper contains many descriptive examples illustrating the use of the concepts.

The main purpose of this paper is descriptive and empirical, since it grew out of field work. However, Section 6 presents a short sketch of the underlying theoretical ideas; Andersen (forthcoming) gives a fuller exposition.

2   Interaction between semiotic and non-semiotic processes

In order to be able to describe how semiotic and non-semiotic processes interact and alternate, four conditions must be fulfilled. We must

- view them as specializations of the same class of phenomena, since if the two kinds of processes belonged to categorically different worlds (e.g. the spiritual and the material word) we would not be able to indicate how they interact,
- be able to describe the difference between the two species,
- develop an understanding of how they can influence and replace each other,
- operationalize the models so that they can be applied to authentic data.

The basic idea is that signs cause their users to view their surroundings, including the signs themselves, as consisting of alternatives, i.e. the environment is divided into an *actual* world and a set of *virtual*, possible worlds. Based on evidence from literary analysis, Ryan 1991 suggests that the virtual worlds come in four types:

- the knowledge-world (the epistemic world: what the actor believe),
- the obligation-world (the deontic world: the obligations and rights of the actor),
- the wish-world (the axiological world: how the actor evaluates events and objects),
- the intention-world (the intentional world: what the actor intends to accomplish).

Referring back to Posner, we can say that communication does not directly change the actual world as signals do, it only changes one or more of the listener's virtual worlds, which may then, possibly, make the listener change the actual world.

As emphasized by Pattee, the basic ability of signs is their power to *displace* phenomena. They create a basic distinction between what is here now, and what is not here now. The sign itself is here now, but its reference may be displaced in space (we cannot see it), in time (long ago, in the future) or in reality (it might have existed but actually does not). This displacement increases complexity enormously, and in order for us to cope with this increased complexity, the displacement has to take a special form, namely as a distinction between the default, *backgrounded* aspects of the situation, and its *focused* aspects. Each action, therefore, consists of four states (cf. Ryan 1991: xxx):

- The initial state.
- The *active* projection: the state which results from the action.
- The *passive* projection. The default state which would obtain, had the action not been performed.
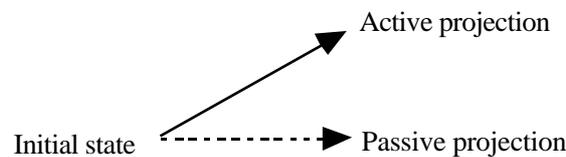- The *Goal:* The ultimate goal state.

Fig. 2.1. Producing or destroying at state

This gives us three main classes of action (cf. Lind 1994 building on von Wright): if the active and passive projections are different, then, provided the passive projection does not change the initial situation (Fig. 2.1), the active projection *produces* or *destroys* a state; however, if the passive projection is different from the initial state Fig. 2.2), the active projection *suppresses* or *maintains* a state. Finally, if the passive projection is equal or similar to the active projection, then we *help* or *let* a state emerge or persist (Fig. 2.3). Dashed line means "passive projection", full line "active projection".
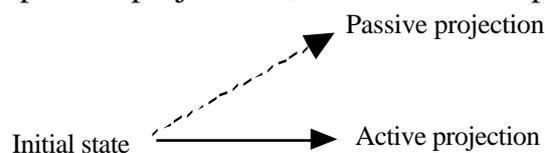

Fig. 2.2. Maintaining or suppressing a state

Initial state ----------▶ Passive = active projection

Fig. 2.3. Helping or letting a state appear.

The claim that counterfactual modal versions of the actual world are fundamental in our perception of actions can be found in many places. It appears in Bremond's narrative analyses (Bremond 1966, 1970) and in Leonard Talmy's analyses of the closed word classes of language (Talmy 1988).

These six types can be used to classify both communicative and non-communicative processes:

Communicative processes, here maritime communication, influencing virtual worlds.
 (1)   Prevent(suppress, avoid): if I hadn't said it, then an undesirable opinion would have developed. Preventing the dangerous effect of authoritarian suppression as advocated in the guidelines in Section 3.8.
 (2)   Maintain: if I hadn't said it, then a desirable opinion would have disappeared. Reminding the 2nd officer of his duty to call the pilot in Text 3.4.
 (3)   Help: a positive opinion would have developed anyway, but I/something made it happen faster/more efficiently. Captain and pilot cooperating about planning the correct maneuvers into the harbor.
 (4)   Create(produce): if I hadn't said it, the opinion wouldn't have appeared. Captain commenting on new ships he notices, Text 5.1 – 5.2.
 (5)   Destroy(remove): if I hadn't said it, an undesired opinion would have persisted. Captain criticizing bad habits.
 (6)   Let: it will happen even if I don't do anything. The speaker keeps silent because he agrees to the lines of arguments so far.

Because semiotic processes influence virtual worlds, they automatically construct all actions, including physical maritime maneuvers, as having an actual and a virtual, counterfactual part:

Non-communicative processes, here maritime maneuvers, influencing a physical state.
 (1)   Prevent(suppress, avoid): if I hadn't done it, then a undesirable state would have developed. Example: Prevent drifting by using auxiliary rudder.
 (2)   Maintain: if I hadn't done it, then a desirable state would have disappeared. Example: Maintain course.

(3)   Help: a positive state would have developed anyway, but I made it happen faster/more efficiently. Example: The wind helped the thrusters moving the ship to quay.

(4)   Create(produce): if I hadn't done it, it wouldn't have happened. Example: Turn on the thrusters.

(5)   Destroy(remove): if I hadn't done it, a (nondesirable) state would have persisted. Example: Stop engine.

(6)   Let: it will happen even if I don't do anything. Example: Let the ship slide into berth without using power.

If we look closer at the six control actions we discover that they imply different sets of auxiliary forces. *Produce* and *destroy* (Figs. 2.7-2.8) are actions that change the world into a state that would not had obtained, had we not intervened. They therefore imply that certain means are employed to cause this change. In this case we assume that an aspect of the world will stay the same if we do not act, even if we may know that other aspects will change or that constancy is really maintained by a complex set of forces. Only the action in question is focused, and all the rest is backgrounded to reduce complexity.

   Maintain and *avoid* (Fig. 2.9-2.10) make the opposite assumption, namely that there are forces in the world that will change it if we do not do something. In this case, we need to posit two forces: the autonomous forces (our obstacle) changing the world, and the means we employ to counteract them.

   Fig. 2.4-2.6 suggest a graphical notation for depicting the more elaborated situations.

   Fig. 2.4 depicts the basic idea of counterfactuals. The solid line signifies the active projection and the dashed line the passive one. The pointed arrow in Fig. 2.5 denotes a force that furthers or enhances something, and the blunt arrow in Fig. 2.6 has the opposite meaning.

Fig. 2.4. A changes into B unless an action is performed which will result in the outcome C.

Fig. 2.5. A enhances the emergence of state B or the proper working of object B

Fig. 2.6. A counteracts the emergence of state B or the proper working of object

   Figs. 2.7-2.12 displays the six action types by means of this notation.

Presence
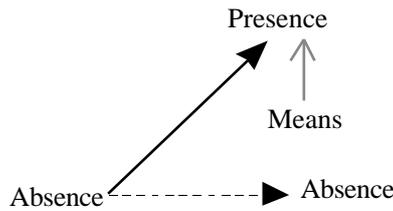
Means

Absence ----→ Absence

Fig. 2.7. Produce or create something

Something desirable is not present and will not come forth by itself. Therefore we apply a means to make it appear.
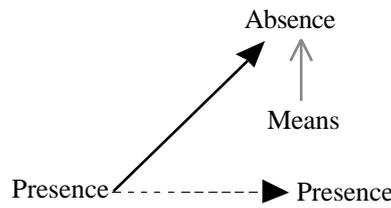
Absence

Means

Presence ----→ Presence

Fig. 2.8. Destroy or remove

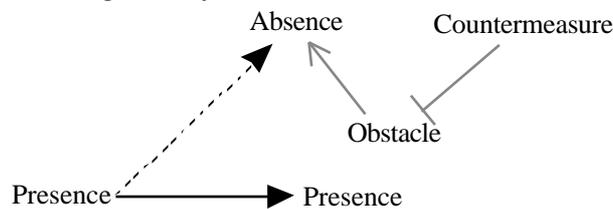Something non-desirable is present and will not go away itself. We apply some means to make it go away.

Absence   Countermeasure

Obstacle

Presence ——→ Presence

Fig. 2.9. Maintain P

Something desirable is present but some force (an obstacle) threatens to make it go away. We apply a countermeasure to the obstacle. Countermeasures can either influence the obstacle or the passive projection. Suppose we want to maintain "situation awareness" (an important task in maritime work, see Section 3.8). "Situation awareness" is threatened by the mere progression of the ship: conditions change as we sail along and keep making our beliefs obsolete. We can counter this in two ways: either by communicating and observing the new features of the situation, or by stopping the ship. In the former case, we counteract "absence of situation awareness" directly, in the latter case we counteract the obstacle, the progress of the ship, that caused the lack of situation awareness (this will only happen in cases of emergency).
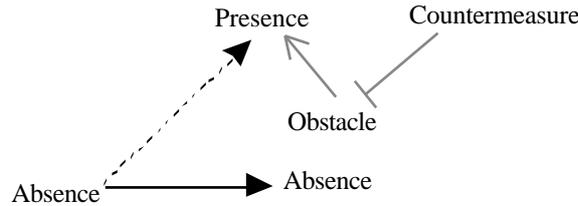
Fig. 2.10. Suppress or prevent the occurrence of something

Something non-desired is absent and we want it to stay that way. However, it threatens to come into existence, because of some force (an obstacle to our purpose), and we therefore apply a countermeasure to prevent this from happening.
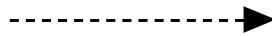
Fig. 2.11. Let something happen.

Some state is appearing or disappearing or is remaining constant by itself. Since this outcome is desired, we do not do anything.
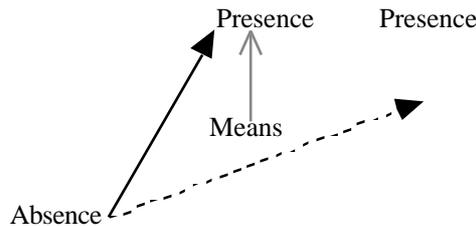
Fig. 2.12. Help something happen.

Something is happening by itself and we apply some means to make it happen faster.

Note that the distinction between *produce* and *destroy*, and between *maintain* and *suppress*, can only be made within a specific interpretation. For example, maintaining stability is logically the same as suppressing instability, and producing quiet the same as removing noise. The choice depends upon which features of the situation are focused, and which ones are treated as background. If noise is focused, then quiet is the absence of noise, whereas noise is the absence of quiet if noise is focused.

The *let* and *help* cases are different from the rest in that the active and passive projections go in the same direction. In the *let* case, we do not do anything, but just let the world change as it wishes, since the outcome of this change coincides with our own goal. In the *help* case, our action moves the world in the same direction as it would move if left alone, but the change becomes faster and more efficient when we intervene.

The concepts presented are similar to those in Talmy 1988. Talmy uses two basic concepts:

- The agonist with an inherent propensity for rest or movement.
- The antagonist who tries to influence the agonist in the opposite direction and who can be stronger or weaker than the agonist. In the former case, a resting agonist begins to move, or a moving agonist stops.

The main difference between the two analyses is that Talmy's is based on objects with inherent forces, whereas this paper is based on a process perspective. However, the six action types above translate into Talmy's notation by assigning states and forces to objects as follows (cf. Petersen draft).

- The state is the agonist's state.
- The passive projection (the agonist left to itself) and the countermeasures belong to the agonist.
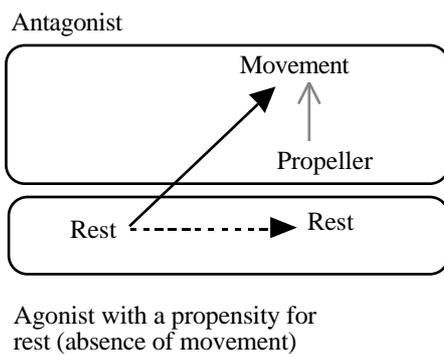- The active projection, the means and the obstacles belong to the antagonist.

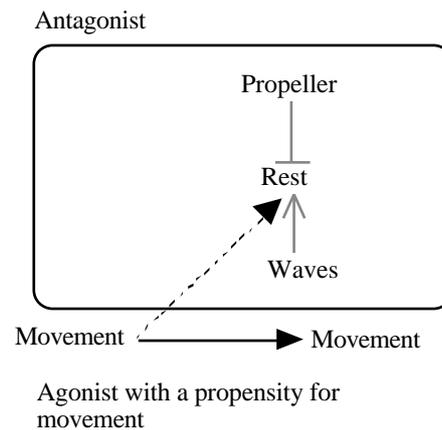Fig. 2.13. Onset causation. The propeller made the ship move.

Fig. 2.14. Extended causation. The ship kept moving despite the rough sea.

One difference between the two notations is that Talmy always interpolates two opposing forces, which is not done here in the *produce* and *destroy* cases. In Fig. 2.13, Talmy would describe the passive projection as a result of an inherent force too. He may be right in this—inertia would be a candidate—but there is a linguistic difference between Fig. 2.14 that explicitly opposes two combatants and Fig 2.13 that does not. In Section 4.4, I suggest the operation of backgrounding to resolve this disagreement.

If we compare our concepts to Ryan's theory, we can say that the active projection is a reflection of intentions or obligations, the passive projection a sign of the current beliefs of the actor.

In the next two sections we shall analyze examples of maritime communication and maneuvers by means of these concepts.

3 Maritime communication

We can apply the concepts to two classical levels of linguistic description: the level of *speech acts and conversations*, and the level of *words and phrases* (syntax). Let us look at the conversation level first.

3.1 Background and focus

The classification in Section 2 gives us 6 kinds of speech acts, but they can be further refined if we apply the background/focus distinction from Section 1 to the utterances. For example, if the actor and the time is focused and everything else is backgrounded, we have the communicative function of *work distribution*: *who* is going to do it *when*? If, on the other hand, all items except the manner are backgrounded, we recognize the function of *instruction*: *how* is he going to do it. Finally, in *scheduling* only the time is focused: *when* is he going to do it? The backgrounded items are a symptom of reduction of complexity since they are assumed to be fixed or irrelevant (Andersen 1997). Consider a simple example:

	Subject	Modality	Verb	Object	Manner	Time, place
A	*Who*	are going	to do	the dishes		
B	*He*	is				
C	No, *she*	is going	to do	them		

Text 3.1. About dish-washing.

In this example the subject slot is the focus since it is stressed and because it contains different material with different references (*who, he, she*). The other slots are backgrounded: some are empty since default values are assumed (the *Time* is now and the *Place* is in the kitchen) or irrelevant (*Manner*) while others repeat unstressed words with the same reference (*Object*: the dishes, them; *Verb*: to do).

Thus, the focus/background distinction is operational and can be determined in actual texts: focus slots are slots that are normally stressed and whose contents change as the conversation progresses. Backgrounded slots are unstressed or may not even be filled out with anything. Backgrounded noun slots are typically filled with pronouns or definite nouns with identical references.

Different sentence types contain different kinds of slots (cf. Halliday 1994 that defines six main types types of processes). In the following we are concerned with physical actions and use the categories of *subject, modality, verb, object, manner, time* and *place*.

3.2   Speech acts: Simple examples

Schema 3.1 analyzes rudder commands, and claims that only the manner slot is focused (marked by boldface), whereas all other slots are backgrounded; in this case it means that they are not filled in. We neither have to bother with the subject (the helmsman does it), the time (it is now), the action (turn), the object (the wheel), so complexity is reduced to the manner slot with a few degrees of freedom (1-30 degrees to each side). Text 3.2 shows an example: clearly, syntactically it is the manner adverbials that are communicated. This analysis is related to traditional grammatical categories such as theme/rheme, and old/new information.

Subject	Modality	Verb	Object	Manner	Time, place
Helmsman	should	turn	wheel	**starboard or port , 1-30**	Now, at the helm stand

Schema 3.1 Rudder commands. Instruction: how should he do it?

Pilot	Starboard twenty
Helmsm	What?
Pilot	Starboard twenty
Helmsm	Starboard twenty

Text. 3.2. Rudder commands.

The situation can be diagrammed as in Fig. 3.1. If nothing is done, the rudder angle will stay the same, since the helmsman will not turn the wheel without being ordered.
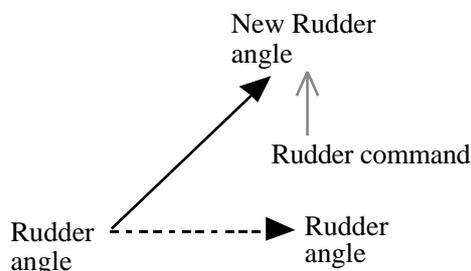

Fig. 3.1. The level of conversation and speech acts with helmsman backgrounded. Rudder commands used to produce new rudder angle.

Although Posner claims that the pilot ultimately must rely on the good-will of the helmsman to make the wheel turn, I never experienced any objections on his part—although this particular crew member was known to sometimes question the rationality of the given orders!
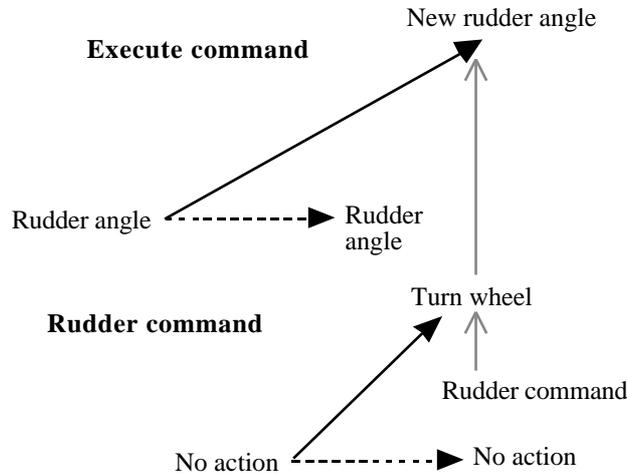

Fig. 3.2. The level of conversation and speech acts. More details.

Both Fig. 3.1 and 3.2 describe rudder orders at the level of speech acts. The difference between them is that in Fig. 3.1 the helmsman is backgrounded: we are only interested in the result of the command (a new rudder angle), not in the manner in which it is executed. In Fig. 3.2 the execution of the command has been added.

Fig. 3.1 is a *production* action: the new angle would not have appeared, had the order not been given. Fig. 3.2 is a double production action: the helmsman would not have turned the wheel without the command, and the new rudder angle would not have appeared without the helmsman's action.
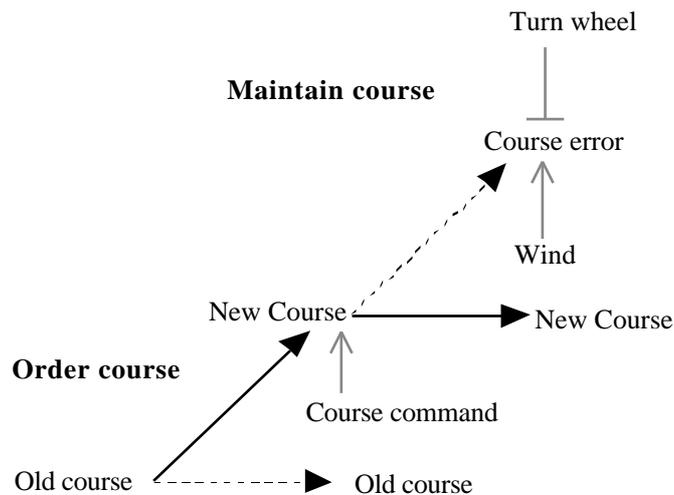

Fig. 3.3. The level of conversation and speech acts. Course commands.

Course commands are treated differently: they are still instructions, but concern a state which the helmsman must *maintain*. Course commands *produce* the steered course, and the helmsman's job is to keep (*maintain*) the course made good identical to the steered course: production combined with maintenance. Course commands produce the initial state for the subsequent course corrections.

But we can go into even finer details: what is the detailed link between the turning operation and the command in Fig. 3.3? To answer this question, we have to inspect the interior of the course command, i.e. we move into the realm of syntax. But first a few comments of the notion of indirectness.

3.3   *Virtual worlds*

According to the authorities quoted above, the command and the actual turning of the wheel is mediated by the virtual world of the helmsman's obligations: his obligations change from maintaining one course to maintaining a new one. One way of making the obligation world react as desired is to assume that is consists of *protocols* (Andersen 2000: 91 ff.) or *norms* (Chong & Liu 2000) or formulas of the Posner type (Section 1). Below are given examples of protocols

(1)   If the helmsman receive a rudder command then he is obliged to turn the rudder to the indicated position

(2)   If the helmsman receive a course command then he is obliged to maintain the indicated course.

The protocols of the obligation world fills out all backgrounded (cf. the frame concept) slot in rudder and course commands and only the unspecified manner slot needs to be focused. The states in question here are states of the four virtual worlds, and the changes are changes of obligations, beliefs, intentions and values. In our example the change of obligations and intentions show up as a new active projection.

However, sentences are not virtual worlds, so what do states and state-changes in communicative systems consist of? The states here are simply the sentential schemas and the way they are filled, in particular their division into focus and background paradigms.

Thus, applied to the syntactic level, the passive projection describes the consensus of the conversation that will persist if no counter argument is uttered. Since this assumed consensus is not open to argument at the moment, it will appear as the backgrounded slots of the sentences, or not appear at all. The active projection, consequently, is represented by the focus slots—the

slots whose values change since they are under debate. Fig. 3.4 depicts this. The underlying schema is assumed to be "The helmsman should maintain *which course* at the helmstand now".

Object = a new course

↑

Noun phrase denoting a course

Subject = Helmsman
Modality = should
Verb = maintain
Object = Old course
Place = helmstand
Time = now

Subject = Helmsman
Modality = should
Verb = maintain
Object = Old course
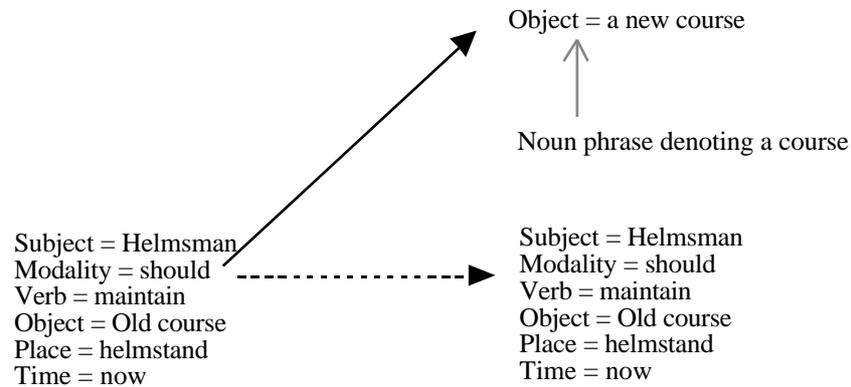Place = helmstand
Time = now

Fig. 3.4. The level of syntax. Issuing rudder commands to change the focused manner slot.

3.4   Syntax

At the syntactic level, the two actions of producing and maintaining are well-known in the so-called functional sentence perspective.

Fig. 3.5. "Ferry coming in there"

Maintenance is performed by all those parts of speech that serves to transfer information from previous sentences to the current ones: definite articles and anaphors of all kinds.

Production, on the other hand, is accomplished by sentence parts that are intended to produce new items of information.

Destruction actions are used to remove references and assumptions no longer valid. Take Text 3.3 as an example. Captain and pilot are on their way out of Felixstowe harbor and the captain has just begun to plot traffic ships. Both pilot and captain keep lookout for traffic via the radar and the window (Fig. 3.5 and Text 3.3).

1	L	Okay ... ferry coming in there
2	C	Yeah, he is right here
3	L	Small ship there...
4	C	Yeah
5	L	...and the dredger
6	C	No, that is the dredger..
7	L	That is the dredger, and there's a small ship coming in
8	C	Yes

Text. 3.3. Handling references.

In (1) the pilot *creates* an association between a vessel type and a reference (possibly by pointing). In (2) the captain *maintains* this reference by means of the pronoun *he*, and confirms the observation. In (3) the pilot *creates* yet another reference, and in (5) the pilot *maintains* a reference from a previous conversation by means of the definite article (the dredger—unfortunately, I can't find the introduction of the dredger on the tape). However, in (6) the captain *suppresses* this reference again: the ship is not the dredger. The latter two operations are displayed in Fig. 3.6. The interpretation is that first the captain wants to remind himself and the pilot of the previous identification of the dredger that may have been jeopardized by forgetfulness. The pilot thinks that this is a misidentification that should not be allowed to live on, and he therefore suppresses it.
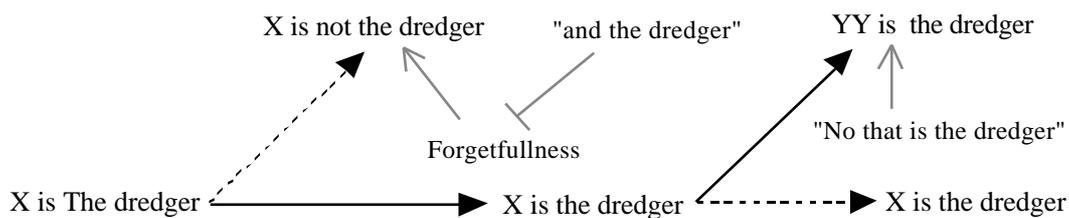

Fig. 3.6. Maintaining and destroying references.

3.5   Speech acts and syntax

Let us take a few more authentic examples. Text 3.4 takes place at 5.45 in the morning while leaving Felixstowe. The chief officer discusses the mode of entry in the harbor of Rotterdam 9 hours later.

B	(...) Hvad plejer du ved ankomst Rotterdam kører du lige ned i Beerkanalen og så bakker den ... [What do you usually do when arriving at Rotterdam, do you run straight down into the Beer canal and back it ...]
C	Ja, vi vender den udenfor der, og så bakker den ind ... hele vejen ind [Yes, we turn it outside there, and then back it in. ... the whole way in.]

Text. 3.4. Chief officer and captain planning entrance to Rotterdam at 5.45.

In this situation, the background paradigms are: Subject = Sally Maersk, Place = Rotterdam. The focus paradigm is the verb, the choices being *back* or *go straight into the basin*: turn outside the basin and back in, or go straight in and turn inside. At this point of time, the two options seem to have been already opened, and the purpose of the officer is to close the paradigm by choosing one of them. See Fig. 3.7.
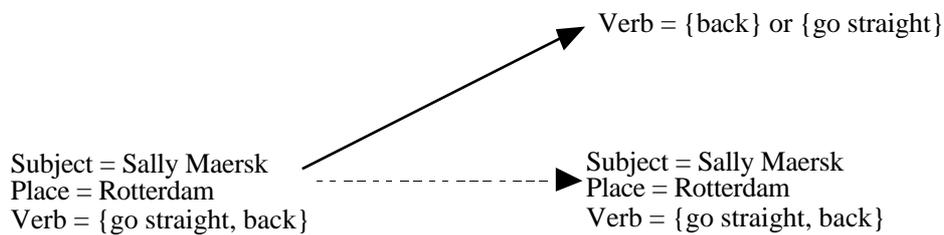

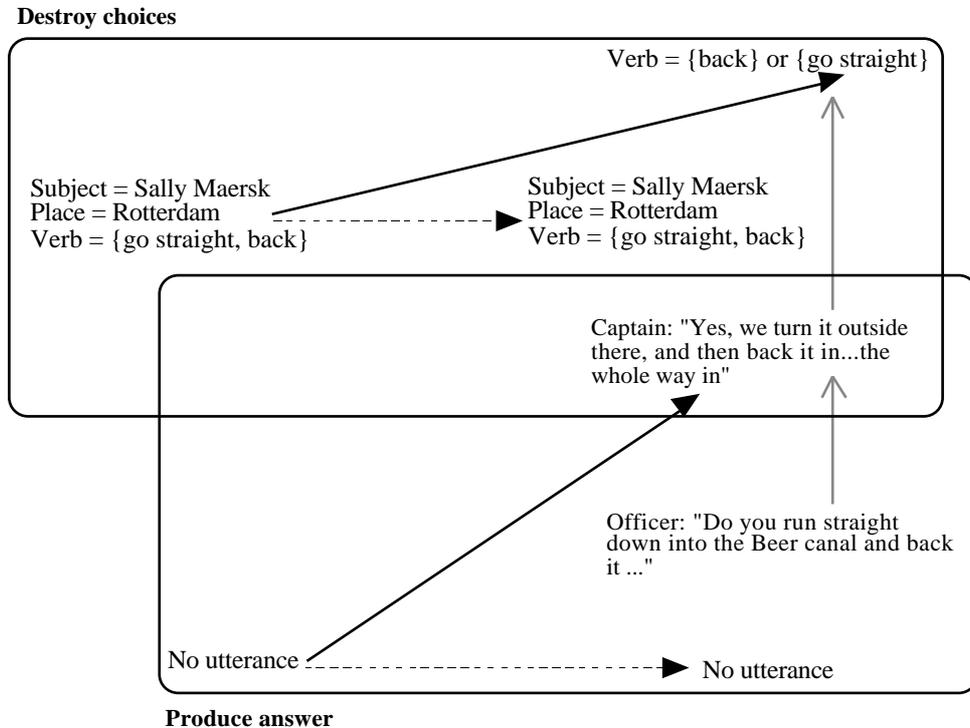Fig. 3.7. Backing or going straight in?

Fig. 3.8. Analysis of questions and answer.

The options of the focus paradigms will obviously not remove themselves, so the officer has to generate a destroy-action that will remove all but one of the options. However, this is outside his authority, since only the captain can make such decisions. Therefore, he produces a question which, he hopes, will trigger an answer that will do the job. See Fig. 3.8.

Note that the action is a destroy-action since the officer is only interested in reducing uncertainty, he seems to have no preferences for one or the other option. If he had preferred to go straight in, the action would have been a production-action: in that case, the officer might not have formed the question in a neutral way, but in favor of his preference, and if his goal were not reached, he might have presented counter-arguments. However, since it is a destroy-action, he has achieved his goal and is satisfied.

3.6 Linking speech acts

Note the various ways speech acts can be linked. In Fig. 3.8 the goal of one speech act (the question) is a means that increases the likelihood of another speech act (the answer) to happen and in the course command in Fig. 3.3 one speech act provided the initial situation for the next one. The latter type of linking is not only found in physical actions, but also communicative ones. One can maintain physical states but also communicative states. In Text 3.4, the chief officer first orders the 2nd officer to call the pilot, and quarter of an hour later reminds him to do it (Fig. 3.9): the chief officer creates an obligation in the 2nd officer which he later maintains by reminding.

($02.26.39)	1	(B)	Nå okay hvad hedder det, du øh A, du **skal kalde lodsen** på kanal 9 (radio) [Well, Okay, you, eh A, you **must call the pilot** on channel 9 (radio)]
		(A)	Ja det er jeg nu (radio) [Yes, I am there now]
		(B)	Øøh en halv time før (radio) [Eh, half an hour before (radio)]
		(A)	En halv time før, det vil sige det er kvart i (radio) [Half an hour before, that is, it is a quarter to (radio)]
		(B)	Ja det må det jo være, hvis lodsen ikke kan komme før kvart over (radio) [Yes, it must be, if the pilot cannot come before a quarter past (radio)]
		(A)	Ja det er jo det (radio) [Yes, that's it]
			(...)
($02.43.28)	2	(B)	A **har du snakket med lodsen** (radio) [A, **Have you talked to the pilot** (radio)]
		(A)	Nej, jeg skal til at kalde ham nu (radio) [No, I am about to call him now (radio)]
		(B)	Så **prøv lige at spørge**, hvad side de bruger lodskombinationen på udenfor (radio) [Then, try and ask what side they use for the pilot combination outside (radio)]
		(A)	Ja okay (radio) [Yes Okay]
		(A)	Og **så vil jeg kalde lodsen** [Then **I'll call the pilot**]

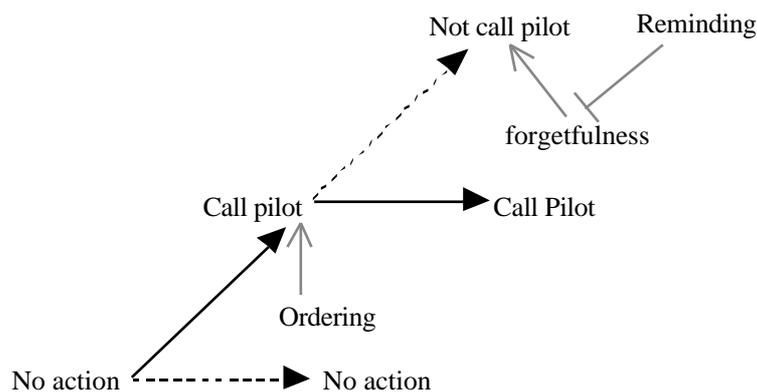Text 3.4. Creating and maintaining communicative obligation

Fig. 3.9. Creating and maintaining communicative obligation

3.7   Argumentation

Later in the conversation in Text 3.5 the captain produces arguments for his decisions:

C	Jeg har vendt dem indenfor, nej det var nu.. det var Knud, det var Knud Mærsk jeg vendte den indenfor, det kan man altså godt der .. der er masser af vand der, men hvis det så blæste og noget, dine marginaler er lidt små [I have turned the inside, no that was, it was Knud, it was Knud Mærsk I turned it inside, you can do that there...there is a lot of water there, but if a wind blew or something, your marginals are a bit small]
B	Jamen du .... du skal jo sådan set også kun dreje halvfems grader ved at dreje udenfor [Yes but you...you only have to turn ninety degrees by turning outside]
C	Ja udenfor [yes outside]
B	Hvorimod du skal dreje hundrede og firs ...[Whereas you have to turn a hundred and eighty...]
C	Hundrede og firs indenfor .. det er rigtigt ja ja [A hundred and eighty inside...that's right, yes yes]

Text. 3.5. Arguments for and against.

How should these arguments be entered into the formalism? As means and obstacles as indicated in the previous section. *There is a lot of water there* enhances the decision to go straight in and turn inside, whereas *your marginals are a bit small* and *you have to turn a hundred and eighty* support the option of turning outside and back in. The purpose is to choose one of the two items occupying the verb slot in a qualified way. One way to do this is to simulate both decisions and discuss which evidence supports the decision and which goes against it (Fig. 3.10).
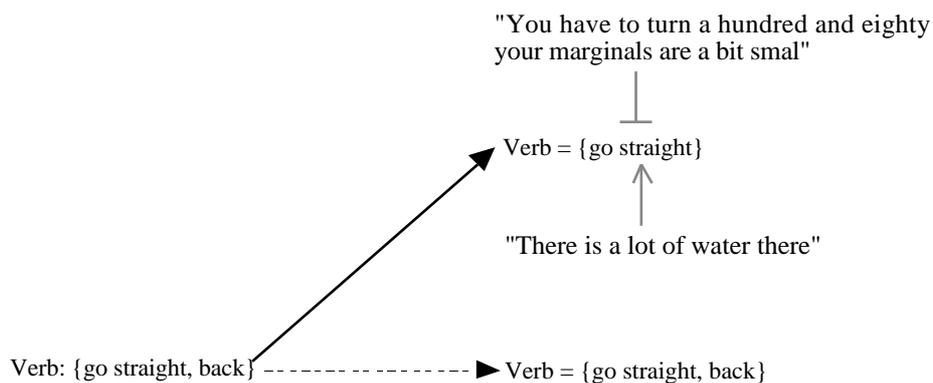
"You have to turn a hundred and eighty
your marginals are a bit smal"

⊥

Verb = {go straight}

↑

"There is a lot of water there"

Verb: {go straight, back} - - - - - - - - - - - ▶ Verb = {go straight, back}

Fig. 3.10. Arguments for and against a decision

3.8 Maintaining situation awareness

In opposition to the directives above that change the obligation world of the listener, other utterances change his belief world. A main feature of maritime communication is that it systematically aims at *maintaining* an updated overview of the state of affairs (Carstensen & Nielsen 1998, "situation awareness"). This is achieved by an extensive verbalisation of observations and actions. The officer must comment on relevant observations he makes, and he must verbalize his own actions, e.g. when he changes instrument settings.

B	Jeg har taget thruster og telegraf ind [I have taken thruster and telegraph in]
C	De er taget ind godt [they are taken in, good]

Text 3.6. Moving control to the center bridge.

B	Jeg har sat den op på hundrede og otte, vi ... [I have set it to a hundred and eight]
C	Hundrede og otte ja okay [a hundred a eight, yes, Okay]

Text 3.7. Setting course on autopilot

C	Jeg har lige kørt den ned på seks sømil [I have just run it down to six nautical miles]
D	Seks sømil okay [six nautical miles, Okay]

Text 3.8. About the radar setting

These examples can be analysed as indicated in Fig. 3.11. The voyage itself constantly invalidates the situation awareness, and this has to be counteracted by systematic verbalization.

This is probably how one would analyze constatives. It would not do merely to let a visual observation automatically trigger a description, since the crew only verbalizes a minute set of what they see. There must be some

kind of criterion for selecting the topic for conversation—in this case it is a threat to the desired situation awareness.

Verbalization

Obsolete knowledge

The movement of the ship

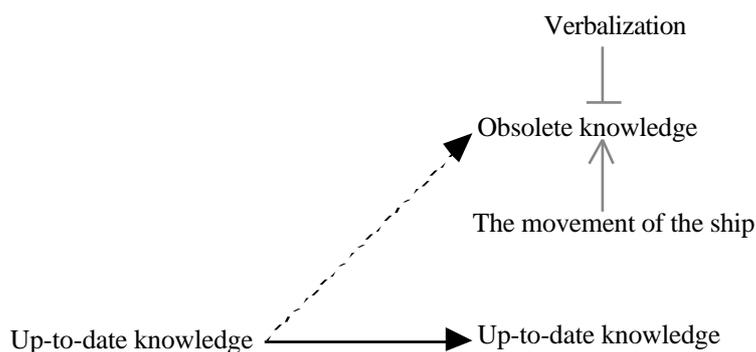Up-to-date knowledge   Up-to-date knowledge

Fig. 3.11. Maintaining situation awareness by communication.

The norm of verbalization is not unproblematic to implement because of the traditional hierarchical organization of the ship. In fact, the ship-owner's guidelines especially emphasizes that verbalization must not be suppressed by authority or fear of authority:

In case of queries regarding orders given the superior shall be conscious of the subordinate's sincere concern and shall not consider the subordinate to be disobedient or disrespectful.

In summary the Owners' require superiors as well as subordinate to be assertive and subordinates **MUST SEPAK UP** when orders in their considered opinion are contrary to rules and regulations or will obviously give results contrary to the superior's intent.   MAERSK 1999: *Section 2.02: 1-2.*

Authority

Speech   Guidelines

Knowledge

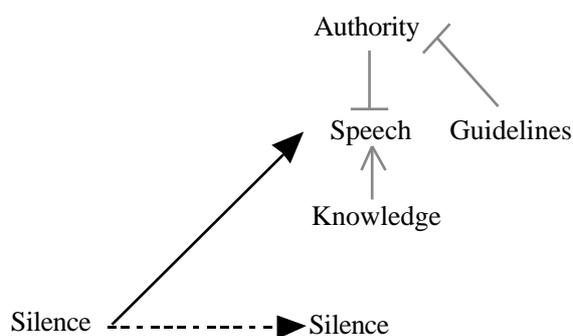Silence   Silence

Fig. 3.12. Preventing the suppressing effect of authority.

Fig. 3.12 analyzes the communicative function of the *Guidelines*: it claims that speech would be generated by the subordinate if in possession of relevant knowledge; however, this force is hampered by fear of authority, which is again counter-acted by the written ship-owner's guidelines.

If the rule of verbalization is violated, reprimands are inevitable:

| C | Og så synger du lige ud K, når du er på den nye, nye kurs ikke, (...)når den er der over, så sige du one one five, når den er der, så ved vi, så ved vi at den er der [Then |

	you sing out, K, when you are on the new course, right () when it is about there, then you say one one five, when it is there, then we know it is there]
K	Det sagde jeg også sidste gang [I said so that last time]
C	Nå, jeg hørte det bare ikke [Well, I just didn't hear]
K	(...)
C	(...) Okay (...) det er godt ... så bliv ved med det [Okay (...), that's fine, just keep doing it]

Text. 3.9. Maintaining the rule of verbalization.

What is this? It is a communication that aims at maintaining the norm of verbalization, i.e. at meta-action *maintaining* the norm of *maintaining*, threatened by sloppiness or forgetfulness.
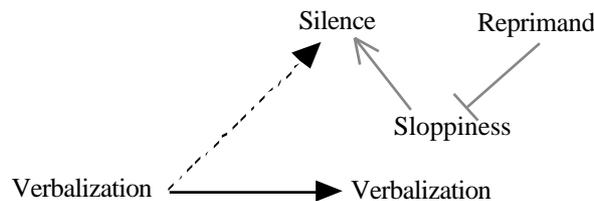

Fig. 3.13. Maintaining the rule of verbalization

The habit of verbalization should be kept intact, but can disappear due to sloppiness or forgetfulness. Reprimands counteract this.

3.9 *Preventing misunderstandings*

Finally, the many repetitions of commands and radio-messages is a prevention action, aiming at preventing misunderstandings that may be caused by noise or inattention:

L	And the bow to port please ()
C	Bow full to port
L	Yes ... dead slow astern
C	Dead slow astern
(P)	
L	Stop the engine please
C	Stop engines
(P)	
L	Dead slow astern
C	Dead slow astern ... and she is rolling
L	Okay

Text 3.10. Preventing misunderstanding by repetitions.

Th next text shows that the precaution is by no means superfluous. The command is "one two zero" but K hears it as "one two three". The error is discovered because K routinely repeats the command.

(L)	One two zero

(K)	One two three
(L)	One two zero
(K)	One two zero

Text 3.11.. Preventing misunderstanding.

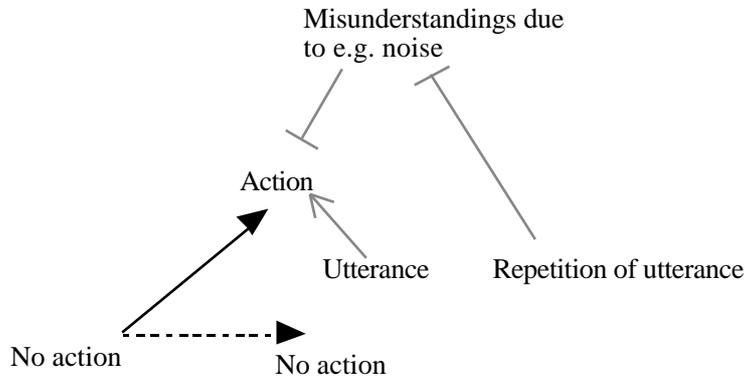The function of repetitions can be analyzed as shown in Fig. 3.14.

Fig. 3.14. Goal, means, side-effects, obstacles in communication.

The captain's actions on machine telegraph and thrusters in Text 3.10 would not occur, had the pilot not given the order. However, noise or misunderstandings may prevent the execution of the correct action, and repetition is a countermeasure against this liability.

4   Maritime tasks

In this section we shall look at maritime tasks and tools to see if they are amenable to the same type of analysis.

The purpose of bridge work is to move the ship from departure to destination in a safe and efficient way and with cargo intact. In terms of the actions from Section 2, we can say that it involves *creating* a new state (arriving at a new location) as well as *maintaining* (taking care of the goods, e.g. maintaining low temperature in freezer containers) and *prevention* (avoiding grounding and collision with other ships). Particularly *maintaining* and *preventing* are important maritime actions.

4.1   The structure of maneuvers

A particular maneuver can be described by categories such as the following: *goal, means, obstacles* for achieving the goal, *negative side-effects* of using the means, and *counter-measures* to obstacles and negative side-effects. For example, the goal may be to sail alongside a bank; an obstacle to this is the

cushion-suction effect that produces a turning moment away from the bank; and the natural counter-measure is to use permanent rudder (Table 4.1).

Goal	Steaming alongside bank	
Means	Propeller	
Obstacles	Cushion-suction	High pressure at bow and low pressure at stern produces a turning moment away from bank
Negative side-effect		
Counter-Measures	Permanent rudder	Rudder suppresses turning moment

Table 4.1. Cushion-suction effect. DMI 1997: Ch. 16, 1

An example of counter-measures to negative side-effects is maneuvering during a crash stop. A crash stop can be effected by setting the propeller in the reverse. This creates a turning moment which can be compensated by rudder or thrusters (Table 4.2).

Goal	To remove speed	
Means	Propeller.	The propellers are put full speed astern
Obstacles		
Negative side-effect	Turning moment	The reverse rotation of the propeller produces a turning moment.
Counter-Measures	Rudder or thruster.	Suppresses the turning moment.

Table 4.2. Crash stop maneuver. DMI 1997: Ch. 19, 1

The claim is that obstacles, negative side-effects and counter-measures are deeply embedded in maritime work procedures, instruments, and ship design. It is not enough to know what goal a certain means is designed to accomplish; one also has to know the possible obstacles and side-effects it is designed to avoid. For example, the purpose, "stop the engine" is not sufficient to explain the safety cover of the crash stop button in Fig. 4.1.

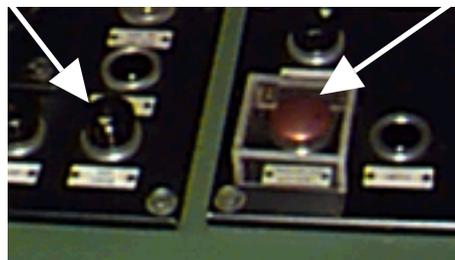Button for moving control   Crash stop button

Fig. 4.1. Crash stop button with shield preventing accidental activation.

One also has to know that using its neighboring buttons may produce an unintended negative side-effect, a crash stop, and that the shielding aims at preventing this effect.

4.2   Formalizing maneuver structure

It turns out that the general schema in Table 4.1 and Table 4.2 can in fact be analyzed as a structure of the concepts we have already introduced in Section 2 (Fig. 4.2). The *means* enhance the *goal* state plus the negative *side-effect*. The side-effect and the *obstacle* hinder the achievement of the goal, and the *countermeasures* weaken the effect of obstacle and side-effect.
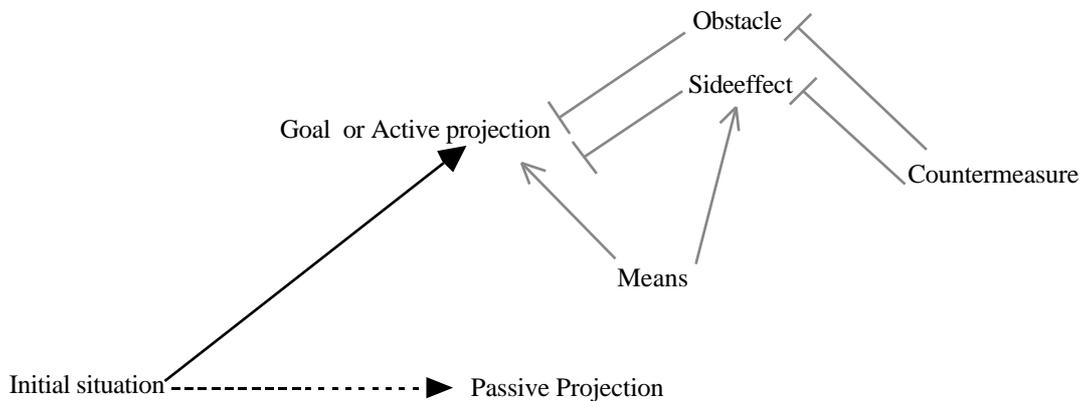
Fig. 4.2. Goal, means, side-effects, obstacles and countermeasure as a set of connected control actions.

In practice, there may be even more factors involved. Consider for example the maneuver discussed in Text 4.1.

C	Se nu skal du også passe på, se nu reducerer vi fart, ikke, se så får vinden mere magt på skibet og... [Now look, you must take care, look, we reduce speed, right, so the wind gets more power over the ship and...]
A	Ja [yes]
C	...og begynder så .. der er muligvis noget strøm også, så tag og giv den en, en fem graders afdrift til bagbord [...and then begins....there is possibly some current too, so give it five degree's drift to port]
A	Vi er allerede højt oppe, vi styrer halvfjers så [We are already high up, we steer seventy, so]
C	Ja [yes]
A	Og kursen i kortet hedder otte og halvfjers ... men den tog ved også ude i der, da jeg kom over Noordhinder [And the course in the map reads seventy eight...but it did take hold out there when I came over Noordhinder]
C	Ja, men det ændrer, det ændrer sig hele tiden her, ikke, men især, især når du så reducerer fart, så bliver du selvfølgelig mere ømfindtlig overfor [Yes but it changes all the time here, right, but especially when you reduce speed, then you of course become more susceptible to...]
A	Ja [yes]
C	Både vind og strøm [Both wind and current]
A	Det er klart [That's clear]

Text 4.1. Partially predictable forces.

We want to maintain the course, but the wind will change it if we do not intervene. We can use the rudder to counteract the force of the wind, but, at this time, we are slowing down to kill time, so the low speed will decrease the force of the rudder. In such cases, we can use the engine to speed up a bit to counteract the effects of low speed.
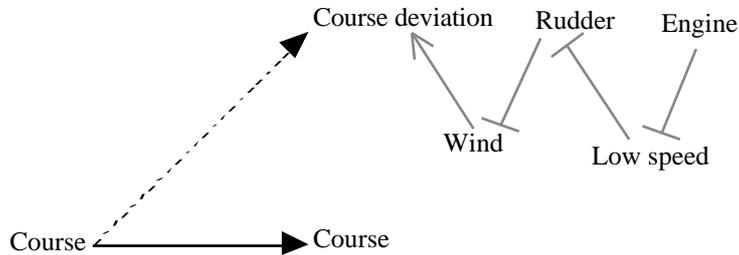
Fig. 4.3. Maintaining course. Speeding up to increase the effect of the rudder to counteract the force of the wind.

Although physically Fig. 4.4 and Fig. 4.5, using the engine to counteract low speed or to increase speed, amount to the same (cf. that Produce ¬P = Destroy P, Maintain ¬P = Suppress P), the control behavior is quite different.

Fig. 4.4. Counteracting low speed.

Fig. 4.5. Increasing speed.

If, as in the present case, we are only interested in counteracting low speed because low speed hinders the proper use of the rudder, then we will decrease speed as soon as we have performed the maneuver, which we will not do if Fig. 4.5 is in effect. Furthermore, we are not really interested in speed in Fig. 4.4, but in increasing the flow of water along the rudder. Increased speed is only a side-effect.
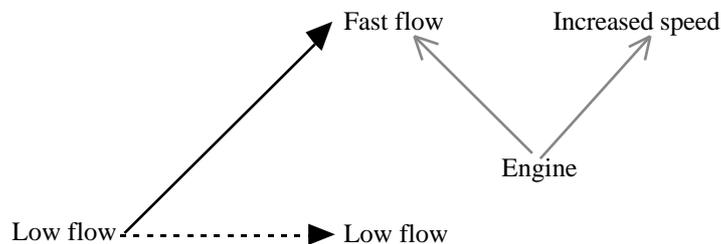
Fig. 4.6. Producing more flow along the rudder by increasing RPM.

Fig. 4.6 shows a more detailed analysis of Fig. 4.3 that describes how it is possible for the engine to counteract low speed by presenting a full control

action of the *produce* kind. In many, but not all, cases, the *enhance* and *counteract* relations are just short-hand for more complicated full control actions.

4.3   Complex action structures

Real maneuvering and navigation consist in handling a large set of concurrent control actions where the same objects and states participate in several actions simultaneously. For example, the trip from Felixstowe to Rotterdam involves at least three major control actions: maintaining safety, maintaining course (or preventing course changes), plus heading for Rotterdam.
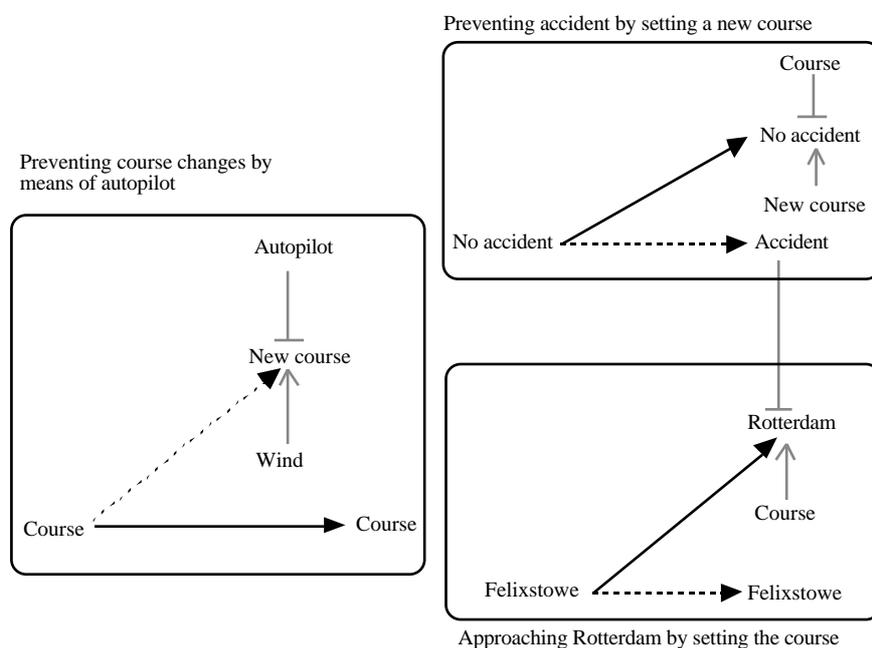

Fig. 4.7. Maintaining safety and course and heading for the destination.

Heading for Rotterdam is a *production* action, since we would have stayed in Felixstowe, had we not done something. This something is starting the engine and setting the course for Rotterdam. Therefore, as appears from Fig. 4.7, the course is a means for getting to Rotterdam, but it is simultaneously the goal for the *maintenance* action performed by the autopilot. If nothing is done, wind and current will change the course, and it is the job of the autopilot to counteract these forces and keep the course constant. Finally, the course is an obstacle for maintaining safety if another ship is approaching in the opposite direction. If we do nothing here, the course of events will terminate in an accident, which will surely prevent us from achieving our destination. This turns a course change into a countermeasure for *preventing* the collision.

If we disregard time, the situation contains a contradiction well known from robot planning theory: the course we maintain in order to get to Rotterdam will cause an accident that will prevent us from getting there. As in all such cases, contradictions are resolved in time: we first change course to prevent the accident and then go back on the original course to get to Rotterdam.

4.4   The logic of backgrounding

The distinction between the active and passive projection is not absolute but depends upon the backgrounding process: the "passive projection" signifies the course of events we expect if we do not do anything, and these expectations are based on knowledge of backgrounded physical laws and human habits and plans. The passage plan can be seen as a means for *producing* a new course, if we only consider the physical forces, so the control action of the officer of the watch is a production action: *setting* a new course. However, if we backgkround the passage plan—e.g. by using the VMS system that takes care of changing course automatically—then the course change simply becomes a let-action: we *let* the VMS system do its work (Fig. 4.8).
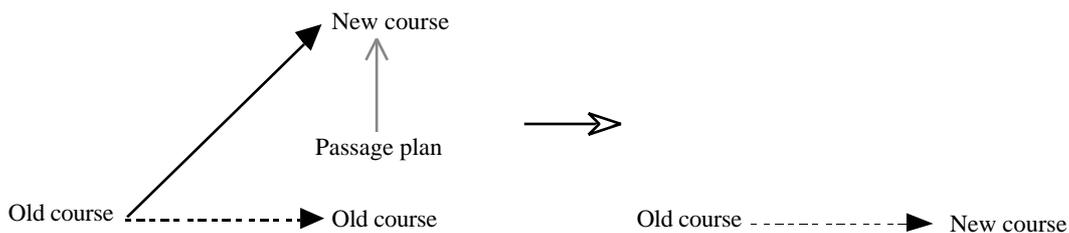
Fig. 4.8. Backgrounding the passage plan turns a produce-action into a let-action.

Possibly we can begin to construct an algebra of control actions. The process in Fig. 4.8 seems to be fairly general, and can be generalized as shown in Fig. 4.9: backgrounding the means turns the active projection in a passive one.
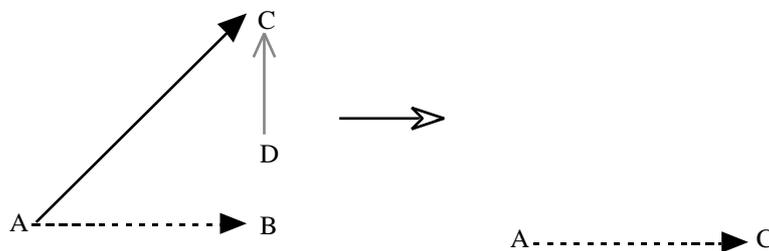
Fig. 4.9. Backgrounding the means of a production action turns it into a let-action.

This rule can be used to resolve the disagreement between Talmy's and this account: the force keeping the object immobile is backgrounded in normal language (Fig. 4.10).
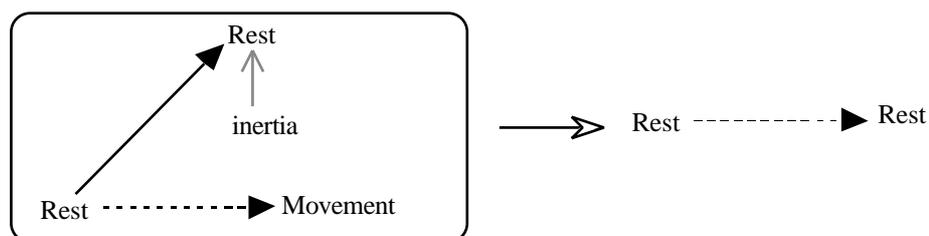
Fig. 4.10. Backgrounding the forces that strive to keep the object immobile

5   Reciprocity

The reader may have felt that Posner's analysis of speech acts is unnecessarily longwinded: when A utters a directive to B, A intends B to know that A intends B to execute the order when he hears it, and, furthermore, A firmly believes that if B knows this, B will in fact execute the command when he hears it, which however he cannot be sure of. I personally find it difficult to understand such descriptions, so how can it be true that they can govern my communicative habits?

P	That is the dredger, and there is a small ship (...) coming in or .. I'm not quite sure what course he is gonna take, but we will se in a minute
(P)	
C	Yeah, it looks like he is most on on the western side of the fairways
P	Yeah
C	Yeah
(P)	
C	But some times, when when the draft allow them to (...)
P	(...) cuts straight over and all sorts of things, yeah
C	Yes I have seen that happened
P	Yeah
(P)	
C	Is he coming in without a pilot....
P	He is coming without a pilot yeah, he is gonna pick up a Pilot ... in here, to go to Ipswich, which is sometimes a bit of a problem cause they don't always ...
C	Yeah I can imagine
P	...realise exactly where they should be in the channel
C	Mmm mmm
(P)	
P	Nah, well as long as he keeps heading like that, will be all right

Text. 5.1. Guessing the intention of a small ship. Departure from Felixstowe.

The fact is, however, that even in dull everyday navigation, structures of this type is operational.

  Consider Text 5.1 and Fig. 5.1.
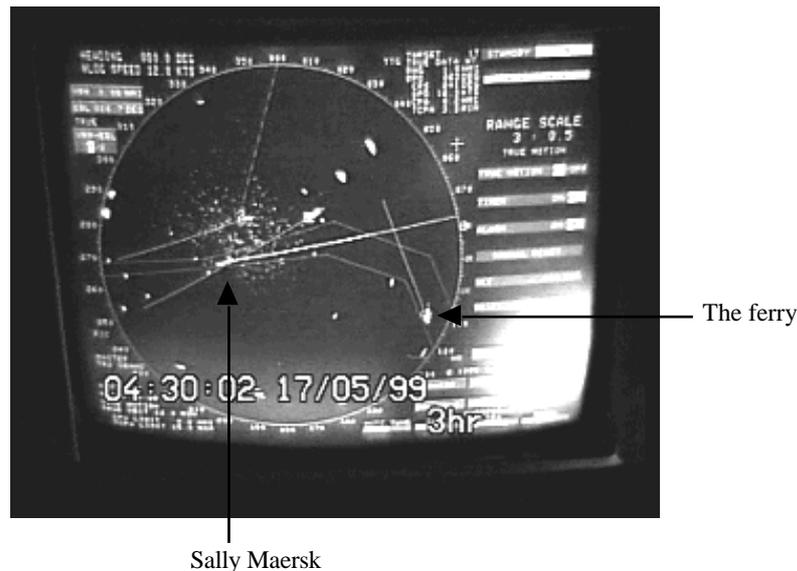
The ferry

Sally Maersk

Fig. 5.1. Radar image corresponding to text 5.1.

As the text shows, observations of other ships' movements are often formulated as guesses at the intention of the foreign captain, and as forecasting future scenarios. The captain and pilot identify a ferry and begin guessing at his course *(what course he is gonna take, he is most on, on the western side of the fairways).* Predictability seems to be highly valued, since they complain about ships that cut straight over, and the captain asks whether she will have a pilot aboard, implying that a pilot will ensure normal and predictable behavior.

The reason for this preference is that the captain and pilot keep imagining scenarios for their own near future, and in order to do that, they have to make guesses about the intentions of other ships.

As they talk they are looking at the radar-image in Fig. 5.1. The parallel lines are the fairway, Sally is eastbound, the ferry northbound, and they have to decide how to pass each other. According to Nielsen (draft) the normal thing is to keep to the right in the fairway, but they cannot be sure the other will do this. The pilot has to make up his mind whether to keep to the right or moving to the opposite side in the channel. Since Sally is a large ship, such moves must be started long time in advance. Sally does not know the ferry and therefore cannot contact it to ask about its plans, but must guess its intentions by observing its course change. Thus, the Pilot must entertain beliefs about the intentions of the ferry and conversely for the ferry.

In addition party A must have beliefs about party B's beliefs about A's intentions: has he correctly guessed what I am about to do? This faculty is used when ships change course: a course change should be so sharp that the other party can see it as a course change. The *Manner* of a course change is thus

used as a sign of one's intention: I change course in such a manner that the other can guess my intention.

The same pattern is repeated in the next text:

Guess intention		
($11.41.08)	(D)	Han **vil gå syd om dredgeren** og nord om os [He **will go south of the dredger** and north of us]
		....
Suggest own maneuver		
	(C)	Aha .. jamen vi vi turner.. **vi laver en tre tresseren**, vi vi kører rundt her så ... han han skal jo sikkert .. jeg ved ikke skal han vesterud eller nordpå det ved jeg ikke [Aha...yes, but we turn...**we make the tree sixty,** we we go around here so....he he must surely...I don't know whether will go west or north, I don't know]

Text 5.2. Guess intention + Predict future + Own maneuver.

The last example shows that it is in fact a useful faculty to be able to imagine what the other believes I intend. In this case it enables the captain to realize the background paradigms are wrong, and to refocus the backgrounded information.

We are sailing in circles outside Rotterdam, waiting for a free berth, when Sealand Atlantic exits the harbor.

S.Atlantic	Sally Mærsk, the Sealand Atlantic [VHF]
Pilot	Sally Mærsk [VHF]
S.Atlantic	Yeah, good afternoon Captain, are you turning to port now, are you, over ? [VHF]
Pilot	Yes, I'm turning **slowly to port**, yes [VHF]
S.Atlantic	Okay, we, we are, we will be steering our course of about two nine zero, and we will stay to the north of you, if that is agreeable with you [VHF]
Pilot	yeah fine, I will be following the deep draft route outside [VHF]
S.Atlantic	Yeah, and can you give us **a red to red** passing, please, **port to port** [VHF]
Pilot	**port to port**, yeah fine okay [VHF, talking to the Sealand Atlantic]

Text 5.3. Focus on parameters: *red to red* versus *red to green*.

The assumed background action is "passing head-on" and the focus paradigm contains two members, *red to red* and *red to green* (red = port, green = starboard), from which they have to choose (See Figs. 5.2-5.3).

Fig. 5.2. What Sealand Atlantic believes Sally intends: passing head-on
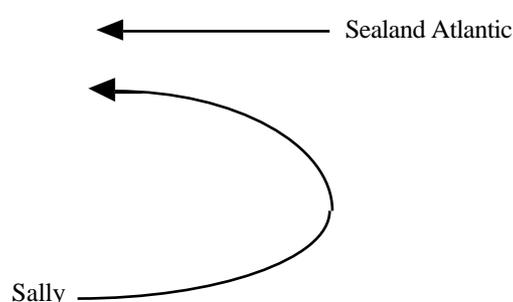
Fig. 5.3. What Sally really intends: sailing in circles, and passing port to

port to port.   starboard.

Sealand Atlantic makes the wrong choice *red to red* (port to port*)* possibly because she does not know that Sally is turning port and that the action will therefore be "overtaking". In Text 6.4, the captain begins to focus the modality paradigm (how *can* we) and the correct action (he will *overtake* us probably) and the Pilot quickly realizes his error *(not possible)* — although he does not admit to it!

S.Atlantic	Standing by zero two one six[VHF]
Pilot	Okay [VHF]
Master	Who was that?
Pilot	The outgoing ship, Sealand Atlantic, she want to pass **port to port**
Master	How, **how can** we do that? [pass the Sealand Atlantic port to port]
C. officer	(...)
1. officer	Yes
Pilot	We are steering around slowly, slowly
Pause	
1. officer	I presume he means that he will …
Master	Yeah, but **how can** he ... (...), he will **overtake** us probably ....
Pilot	Yeah, I don't know
Master	...yeah, no, so um, **port to port**
Pilot	Sealand Atlantic, the Sally Mærsk [VHF]
S.Atlantic	Sally Mærsk, Sealand Atlantic [VHF]
Pilot	Um, you want to pass us on our **starboard** side, on the **north** side? [VHF]
S.Atlantic	Roger, Ill like to ...I, I heard you were **turning** to your **port** to go back in, I (...) in with the drencher, otherwise we are going **red to red**, over [VHF]
Pilot	I think **red to green** with us [VHF]
PilotSt	Sealand Atlantic ,Pilot Maas [VHF]
S.Atlantic	Pilot Maas [VHF]
PilotSt	The, the Sally Mærsk is **turning** to **port**, so you can proceed her north of her, over [VHF]
S.Atlantic	She is gonna **turn to port**, okay thank you, thank you, Sally Mærsk [VHF] [notice that the Sealand Atlantic thinks they are talking to the Sally Mærsk—when they are in fact talking to the Pilot Station Maas Approach].
Pilot	Yeah (...) **port to port, red to red not possible**
Master	That is **not possible**
Pilot	His **red** side to our **green** side

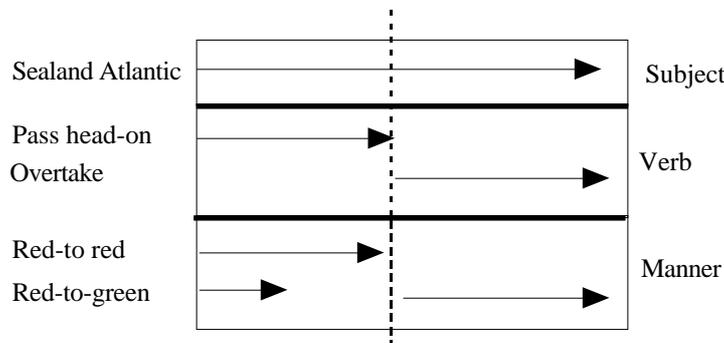Text 5.4. Shift of focus from manner to modality and verb.

Fig. 5.4. Refocusing the verb.

The process of refocusing backgrounded paradigms can be depicted as shown in Fig. 5.4.

To the left of the dashed line the verb is assumed to be "pass head-on" and focus is on the manner of overtaking (*red-to-green* or *red-to-red*). To the right of the line, the verb is refocused, "pass head-on" is replaced by "overtaking", and the manner slot is adjusted accordingly.

If we formulate these processes in terms of virtual worlds (Fig. 5.5), it turns out that our captain, A, must be able to believe that B (the captain on Sealand Atlantic) believes that A intends to sail head-on. A must be able to create a mental picture of how his own mind looks inside the other's mind. We have to stipulate at mental structure like Fig. 5.5 in order to account for the refocusing actually taking place.
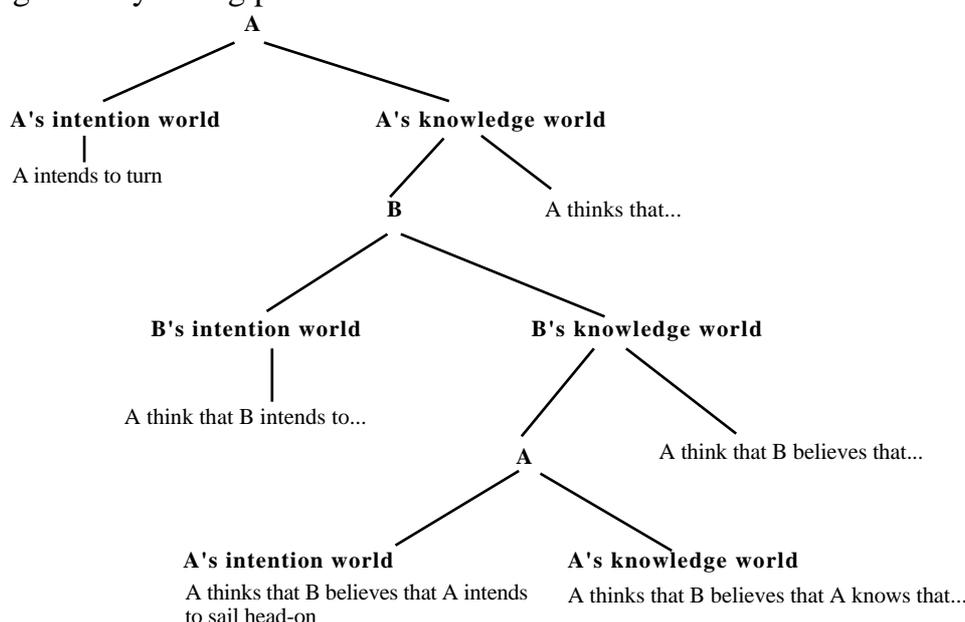

Fig. 5.5. Embedded possible worlds of the captain

These examples suggests that the minds of the individual actor must have a recursive morphology as suggested by the rules (Cf. Ryan 1991):

Actor   Intention + Knowledge + Obligations + Values
Intention   {Own intentions}*
Knowledge   {Own knowledge}* {Actor}*

6   Semiotic control

In Section 3 we gave examples of how maritime tasks and communication influence one another, Section 4 showed how maritime tasks were structured, and Section 5 finally emphasized the phenomenon of reciprocity, the ability of people to form pictures of other peoples' mind.

In this section we shall sketch a theoretical framework in which these observations can find a place. There are two kinds of observations that needs an explanation: (6.1) how do communication, virtual worlds, and task execution influence one another and (6.2) how does communication shape the tasks it coordinates?

6.1   Communication, virtual worlds, and tasks

In the examples we have seen the following types of influences:

1 Utterances influence actions which influence the state of the ship (Figs. 3.1, 3.2). Rudder commands makes the helmsman turn the wheel which makes the ship turn.
2 Utterances influence action obligations (maintenance goal) which motivate appropriate actions (Figs. 3.3). Course commands make the helmsman perform course-corrections that maintain the ordered course.
3 Utterances influence communicative state (Figs 3.4, 3.6, 3.7, 3.10), Utterances create a new value for a sentence part, maintain or delete a word reference, or delete members of a focused slot.
4 Utterances influence other utterances which influence communicative state (Fig. 3.8). Questions generate answers which select one option out of several.
5 Utterances influence communicative obligations (Fig. 3.9). Reminding maintains a communicative obligation.
6 Utterances influence knowledge (3.11) or obligations (3.13). Verbalization maintains situation awareness, and the norm of verbalization is maintained by reprimands.
7 Knowledge influence utterances (3.12). Relevant knowledge (should) make the crew member speak up.
8 Actions influence the state of the ship (4.2) or the effectiveness of other actions (4.3). Actions are performed to attain a goal or to prevent obstacles to goal.
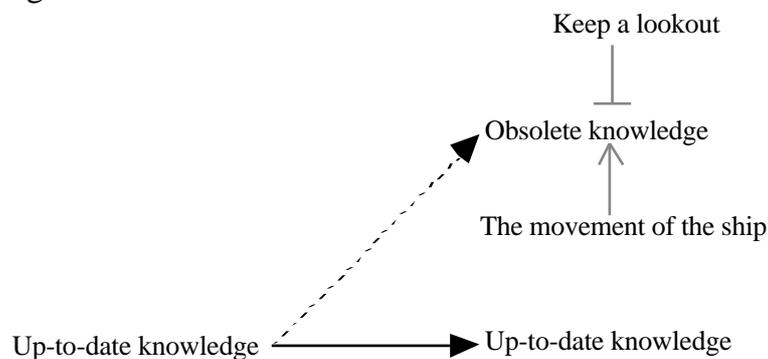
Fig. 6.1. Maintaining situation awareness by keeping a lookout.

If we add perceptual actions—observing the environment—that serves the same purpose as the verbalization in Text. 3.3, namely to maintain situation awareness (Fig. 6.1), we can set up a full circle as shown in Fig. 6.2.

Utterance

Virtual worlds   Virtual worlds

Perceptual Actions   Motor Actions
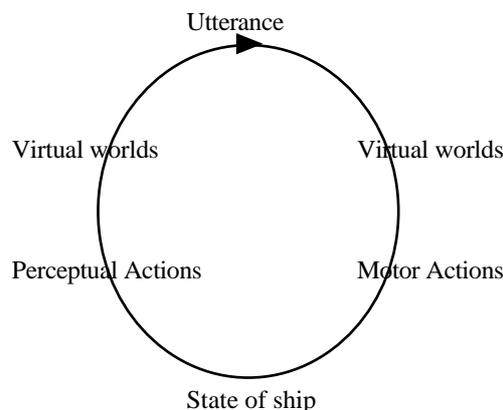
State of ship

Fig. 6.2. The circle of actions and perceptions.

As indicated in (1), we are sometimes tempted to assume short-cuts, e.g. influences directly from utterances to motor actions, or from perceptions to motor actions, cf. the skills/rules/knowledge hierarchy in Rasmussen 1986: the *virtual-world* postulate is less motivated in simple rudder commands than in planning conversations such as Text 3.4 or in refocusing processes as in Text 5.4.

However, besides these circular influences between the systems there are also recursive processes within each system. They are processes that keep transforming the internal state of the system, producing an output that is used as input in the next time-step.
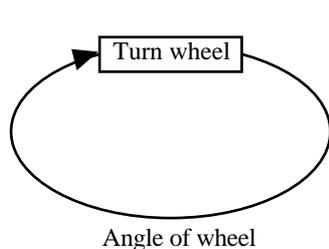
Turn wheel

Angle of wheel

Fig. 6.3. Recursion of actions.

Say something

State of commnication:
Subject, Modality, Verb,
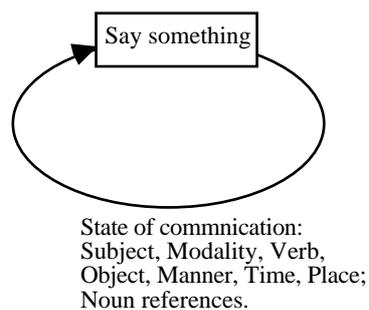Object, Manner, Time, Place;
Noun references.

Fig. 6.4. Recursion of communication.

This is clearly observable in the action system and the communication system: turning the rudder leaves it in a certain position which is the point of departure for the next turning operation, and changing the course of the ship leaves it on a course that is the input to the next course-change (Fig. 6.3). The same is true of conversation: an utterance affects the consensus of the interlocutors and leaves it in a certain state; if a participant is not satisfied, he must

explicitly change the current state to the one he desires (Fig. 6.4). The autonomy of the communicative system explains why one can loose an argument: A person looses an argument if the conversation ends in a state with which he personally disagrees, because his contributions were not able to change the state in the desired direction.

A good example is the discussion about the reference of the word "dredger" in Text 3.3: if the captain had not objected, the consensus would stay as the pilot had left it in line 5. Other examples are course commands that produce the initial state for the subsequent course corrections.

We therefore have to combine Figs. 6.1-6.2 and 6.3-6.4 in order to cover the facts. How should we do this? We first note that a different kind of material is used to influence a system than is recursively produced inside the system. The state of the wheel can be described as a angle, but the turning of the wheel is influenced by rudder commands. Rudder commands are linguistic entities and not angles. Similarly, what is reproduced in conversations is communications, but conversations are influenced e.g. by observations of ships and buoys. But (observations of) ships or buoys are not the same as utterances. The word "dredger" can appear as the subject of a sentence, not the dredger itself. For this reason, the item that influences a system must be processed differently than the items the system reproduces, it must have a different function.

One possibility is to postulate that each system is driven by a set of parameterized rules of the form $State_t = Function(State_{t-1}, Param_{t-1})$. The external influence is formalized as a set of parameters that modify the rules but cannot directly process the internal state of the system. Elsewhere (Andersen 1999 and forthcoming) I have called such systems for *perturbed recursion systems.* They have become popular for describing self-organizing/autopoietic systems. Cellular automata (von Neumann 1966), Lindenmayer grammars (Lindenmayer 1968), genetic algorithms (Davis 1996), and many formulas for generating fractal images (Peitgen, Jürgens & Saupe 1992) are of this type. Fig. 6.5 and 6.6 illustrates the concept.

Rudder commands   Dredger, ferry, etc.

Turn wheel   Say something

Angle of wheel

State of commnication:
Subject, Modality, Verb,
Object, Manner, Time, Place;
Noun references.
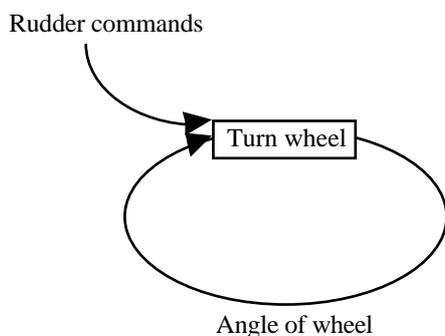
Fig. 6.5. Perturbation of actions: An-   Fig. 6.6. Perturbation of communica-
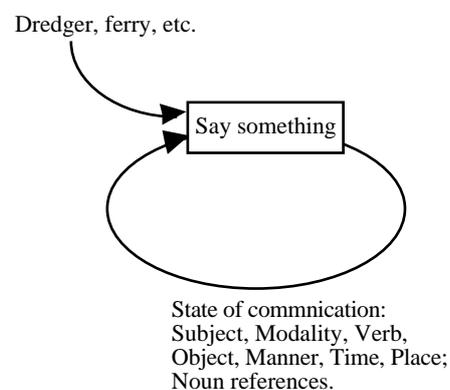
gle = TurnWheel(Angle, Command).   tion. SentententialSchema = Talk-
                                          ing(SentententialSchema, Perception)

6.2   The shaping of tasks by semiotic control.

In this section we can be a bit more precise about the way semiosis shapes a physical process, called *semiotic control* in Pattee 1996b. Let us start with a representation of the physical process of turning the rudder. The rudder-movements generated in Text 6.1 could look at little like Fig. 6.7 (for realistic values of course corrections, see Løvborg 1998).

	(L)	Hard to starboard
	(K)	Hard-a-starboard
		(P)
	(L)	Starboard twenty
	(K)	Starboard twenty
		(P)
($13.52.39)	(L)	Starboard ten
	(K)	Starboard ten
		(P)
	(L)	Okay ... starboard twenty
	(K)	Starboard twenty
		(P)
($13.54.38)	(L)	Hard to starboard
	(K)	Hard-a-starboard
		(P)
	(L)	Starboard twenty
	(K)	Starboard twenty

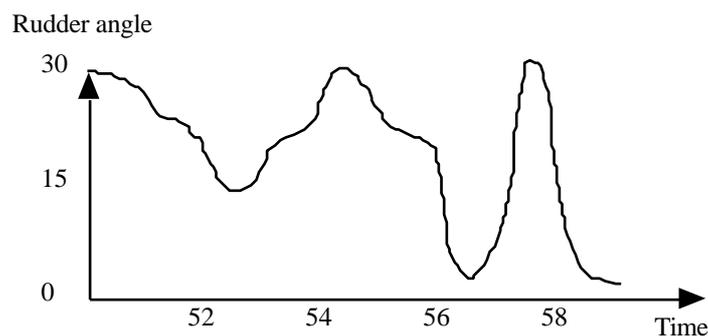Text 6.1. Rudder commands during harbor entrance

Fig. 6.7. Fictive log of rudder positions.

Fig. 6.7 could be the result of measurements of the rudder stem. There is a purely physical explanation for the relation between wheel position and the position of the rudder, so semiotic control is only active in the helmsman's

input to the wheel. Since rudder orders are of the produce-variety, the beginning of Text 6.1 can be depicted as shown in Fig. 6.8.
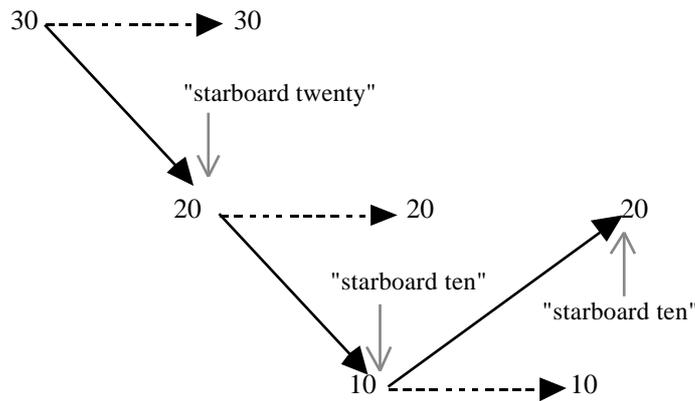

Fig. 6.8. Sequence of rudder orders

Whereas Fig. 6.7 describes the rudder movements as a physical process, Fig. 6.8 describes it as semiotic control, the wheel-movements being controlled by language. Two differences are obvious: although the same physical reality is represented, Fig. 6.8 adds two non-physical features: (1) the continuous movement of the rudder is segmented into a set of discontinuous pieces, and (2) each piece is cleaved into an actual world and a virtual, counterfactual world—what would have happen if the order was not given. Since the two representations denote the same phenomenon, it makes sense to superimpose them on each other, as shown in Fig. 6.9.
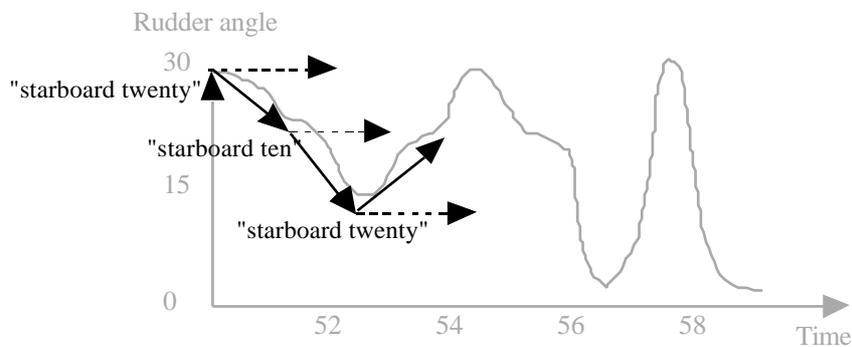

Fig. 6.9. Semiotic control of physical matter

I suggest that this kind of superimposition could be a paradigm for representing semiotic control of physical matter. Similar diagramming techniques is in fact well known in semantic analysis under the name of _semantic fields,_ that essentially consist in projecting a section of the vocabulary onto the piece of the world it articulates.

Normally this is done by representing the piece of the world by means of two dimensions, and let lines show the boundaries of the word meanings.

Fig. 6.9 is similar, but with one important difference: the dimensions are not chosen to match the distinctive features of the vocabulary, as one normally does, but are selected because of their utility for a physical description. The result of superimposition is therefore a comparison of two different languages, the language of linguistics and the language of physics. The claim is that this is in fact the correct way of solving the problem: the physical and linguistic aspects of the same process are best combined by producing a systematic comparison between two descriptions in two difference languages, the language of physics and linguistics. *Semiotic phenomena are causally active decorations of the physical process.*

We can now see the reason why semiotic processes and the processes they control ought to share properties: semiotic control segments its controllee and adorns it with virtual, counterfactual versions. But since semiotic processes can control other semiotic processes, as in Text 3.9 where the captain uses language to maintain a language habit, it follows that it must shape itself in the same manner. Communication is planned, monitored and corrected like any other task onboard, and communication about communication about communication... is not rare: an authentic example is *I heard on the walkie that You talked about your having talked to the pilot!*

From this we should expect that segmentation and virtualization will also take place in semiotic processes, and this is in fact one of the basic ideas in structural linguistics. The continuous acoustic waveform is segmented into phonemes—a fact that underlies any alphabetic writing system—and linguistic elements, such as e.g. words, assemble into substitution classes, such as word classes, where the meaning of choosing one member of the class is colored by the unrealized other possible choices. The homological structure of the content (controllee) and expression (controller) was a basic assumptions in glossematics (Hjelmslev 1963).

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