Chapter 8
On the Concept of Intrinsic Coordination

As indicated above, one of the main research issues in CSCW is the understanding of how cooperative work is coordinated and integrated by using artifacts. This issue has often been cast as a question of exploring how articulation work is practiced and supported by way of coordinative artifacts. A series of focused, in-depth field studies have been undertaken with the specific purpose of investigating how the distributed activities of cooperative work arrangements are articulated and, in particular, how prescribed artifacts are devised, appropriated and used for these purposes (e.g. Carstensen and Sørensen 1996; Schmidt and Bannon 1992).

These studies have provided invaluable insights (and large sways of the previous chapter are obviously inspired by the approach taken in these studies). But perhaps it could be fruitful to complement the concept of articulation work with a supplementary means of describing how cooperative work is coordinated and integrated.

In the words of Strauss (1985, p.8), articulation work is a kind of supra-type work in any division of labour, done by the various actors concerning the meshing and integration of interdependencies inherent in cooperative work. The prefix 'supra' is of key importance here.[1] In the context of cooperative work this could entail that articulation work comes before or stands in a meta-relationship to a work task or a set of work tasks performed. We could suggest that the distinction between the articulation work and the cooperative work articulated is an inherent feature of the concept of articulation work. As we have seen, articulation work in the context of the building process often revolves around time schedules and meetings where the progress of work is discussed, dates are settled, responsibilities cleared up, and work tasks are distributed and redistributed (if need be). These observations concerning the second order nature of articulation work are hardly controversial.

[1] According to the Oxford dictionary 'supra' designates a prefix used in describing a phenomenon that is transcending, before or above something else. It originates in the Latin supra 'above, beyond, before in time.'

L.R. Christensen, *Coordinative Practices in the Building Process: An Ethnographic Perspective*, Computer Supported Cooperative Work,
DOI 10.1007/978-1-4471-4117-4_8, © Springer-Verlag London 2013

Recall the coordinative practices described above where actors coordinate their cooperative efforts by acting directly on the evidence of work previously accomplished by others. Where an actor for example changes the form of a geometrical representation of a building in a CAD model, not for the purpose of conveying a message, but as a part of designing a building; another actor notices this, and in turn acts upon this change of state.

How could we describe practices of this nature? As indicated above, probably not in terms of articulation work, bearing in mind that articulation work refers to an activity that is transcending, comes before in time or is 'above' the cooperative work articulated (Strauss 1985). In the above example of the integration of CAD models no such supra–type relationship is apparent. The actors are doing their job, going about their business without making any supra-type efforts to coordinate anything, and yet coordination of the design of the building is taking place.[2]

The Concept of Intrinsic Coordination

Perhaps we could use the concept of *intrinsic coordination* to complement our descriptions of the coordination of cooperative work. The concept of intrinsic coordination is not found in the CSCW literature. I have made it up. The concept of intrinsic coordination refers to the integration of interdependent work task by virtue of individuals acting on the physical traces of work previously accomplished by others.

Intrinsic Coordination and Acquired Skills

What we are implying, then, is that when actors coordinate their cooperative efforts by acting directly on the evidence of work previously accomplished by others we may describe them as engaged in practices of intrinsic coordination. However, it is important to note that before we are in a position to fully embrace this assertion, before we may be comfortable with it, we must first ask this: What makes the actors capable of performing intrinsic coordination?

In Chap. 6, in the discussion of practice and apprenticeship, we argued that the ability to participate in practice in the building process and work with for example representational artifacts is grounded in skills and techniques that may be conceived of as acquired by the individual actor not least through apprenticeship as a 'feel for the tasks'. The habitus, using Bourdieu's (1992) concept, of for example an accomplished building services engineer acts as a set of dispositions towards certain

[2] These observation and ideas draws on findings and analyses presented in articles published over the last couple of years (i.e. Christensen 2007, 2008, 2012).

ways of doing and being, acting and interacting that are in accord with or reflects the nature of the field of building design. These dispositions are in play in practices of intrinsic coordination as the actor acts directly on the evidence of design work previously accomplished by others.

Furthermore, we may note that practices of intrinsic coordination at least in a complex work domain such as the building process seem to be within the domain of the accomplished actor rather than the novice. It takes the habitus, the acquired skills and techniques of an accomplished actor to act directly on the evidence of work previously accomplished by others. In this manner the background for engagement in practices of intrinsic coordination is the acquired competences of an accomplished actor, a novice may simply not have the skills. Of course, the distinction between master and novice is not binary; rather we could describe it as a continuum where and actors slowly acquire the skills necessary to participate, slowly moves from being a novice to being a master of a practice. Bearing this in mind, intrinsic coordination as a way of integrating distributed tasks is obviously not fool proof since mistakes are made on a regular basis and the alignment of tasks may not always be successful, and this may partly be due to lack of skill on the part of inexperienced or semi-inexperienced actors.

In addition, recall also from our discussion in Chap. 6 that the habitus of several actors may have similarities to the extent that their individual history and experience with a particular practice such as building design coincide. Perhaps these similarities in regard to the nature of their individual habitus, the mastery of the similar techniques related to representational artifacts, is what makes actors in the building process capable of engaging in practices of intrinsic coordination in a reciprocal manner. That is, building services engineers may act on the evidence of work previously accomplished by the architects and if need be the situation may be reversed and the architects may act directly on the evidence of work previously accomplished by the building services engineers. In this manner intrinsic coordination within a community of practice may be facilitated by the similarity in acquired dispositions for action embodied in the actors within the same field of work.

The Logic of Intrinsic Coordination

At this point we could ask: Why do the various actors in cooperative work such as building design engage in practices of intrinsic coordination and in the process relate to or continue the work performed by other actors – what is the logic of this, why not e.g. begin from scratch?

Recall how the design of the working plans was carried out as direct elaborations of the previously created tendering plans, and how the tendering plans stem from the representations created in the conceptual design phase. One (obvious) answer is that from the point of view of the individual actor involved in design, it is more practical to continue the work on representations made by other actors, because it mostly requires less effort than the alternative, beginning from scratch.

However, we could argue that there is more to it than that. These practices also have an integrating effect as described above. Perhaps beginning from scratch is not a real option, because it risks breaking the continuity of the design process. That is, if the previous work was not taken into account, it would probably be entirely impossible to create the working plans, for example: the complexities of creating the highly detailed working plans would be overwhelming without less complex representations to build on. We could suggest that the gradual increase in the complexity of the representations makes the design process more manageable in the sense that it reduces the overall complexity of representing the building by allocating the process to a series of interrelated steps or stages.

In addition, in relation to design the affordances of a particular type of artifact mostly seem to meet the demands of a particular position in the taskscape. For example, the open and imaginative nature of sketches meets the demands internal to the task of making up the conceptual design of the building. To architects, their sketchy and informal representations capture the mixture of symbolic richness and abstraction, which allows them to express qualities of space, light, atmosphere, and materials (Schmidt and Wagner 2004, p.12). The sketches are highly theatrical; they use the language of 'artistic impurity, hybridity, and heterogeneity' for communicating certain ideas and qualities of an object. As mentioned, one feature of these informal representational artifacts is their openness to extensions, modifications, and novel interpretations (Schmidt and Wagner 2004).

Compared to sketches, the more accurate and generally less ambiguous CAD models are better suited to the task of creating the tendering material or the working plans. According to Harris (1995), architectural plans of a technical nature often rely on having the space divided in a predetermined way so as to make the significance of a graphical form depend partly on the absolute position it occupies within that space (Harris 1995, p.123). Architectural plans of scale such as CAD architectural plans are based on this principle. That is what makes it possible to calculate, for example, the exact size of a room measured in square feet or the distance from pavement to roof. CAD plans made for construction purposes are mapped to a coordination system referred to as 'module lines'. Moving a particular graphical element, for example the representation of a wall, in relation to these module lines will have an alternating effect – for example changing the size of a room. Perhaps we could suggest that the same commitment to scale and precision is not found in what is described above as informal imaginative and open sketches.

Following this discussion of the affordances of various types of representational artifacts we could suggest that different affordances are required of representations at different positions in the taskscape. For example, the requirements of conceptual design prompt the employment of sketchpads on the part of the architects creating the design concept; analogue to this, the requirements of the tendering project or the working plans induce the actors to rely on CAD applications rather than sketches, for example. The sketches and CAD models, described above, are not interchangeable at a given position in the taskscape due to their vastly different affordances. This may be part of the reason why certain types of representation are employed at certain positions in the taskscape and part of the reason why actors are compelled to permutate

the representational artifacts through practices of intrinsic coordination involving the characteristic inheritance of content from one type of artifact to another and the derived coordinative effects.

As progress is made, then, from one position in the taskscape to another, representational artifacts are created, elaborated and merged through practices of intrinsic coordination. These practices are partly prompted by the discrepancies between the affordances required of representations at different positions in the taskscape, and partly in order to reduce the complexity of the design process by allocating the process to a series of interrelated stages. This could be dubbed the 'logic of intrinsic coordination' in relation to architectural design.

With these propositions in mind, we may ask what kind of concept is intrinsic coordination?

Intrinsic Coordination as a Heed Concept

We will now, based on the work of Ryle (1955), describe intrinsic coordination as a 'heed concept'.

According to Ryle (1955, p.135), the category of 'heed concepts' includes: noticing, taking care, attending, minding, applying one's mind, concentrating, putting one's heart into something, thinking what one is doing, alertness, interest, intentness, studying, trying. Perhaps intrinsic coordination could also be considered a heed concept. Let us elaborate.

When a person hums as he walks, he is doing two things at once, either of which he might interrupt without interrupting the other. But when we speak of a person minding what he is doing e.g. when he is reading (or for example designing) we are not saying that he is doing two things at once. He could not stop his reading while continuing his attention to it (Ryle 1955, p.138). In a similar vein, we may add that he could not stop his designing while continuing to be engaged in intrinsic coordination (i.e. acting on physical traces of the design of others). He could of course continue to read but cease to attend (Ryle 1955, p.138), or continue to design but cease to engage in intrinsic coordination. The use of pairs of words such as 'read' and 'attend' or 'design' and 'intrinsic coordination' suggests that there are two synchronous or perhaps coupled processes going on whenever both words are properly used, but that is *not* the case. This is a feature in the use of heed concepts (Ryle 1955, p.138).

If we accept at least preliminarily the notion of intrinsic coordination as a heed concept, we may say that performing a task engaged in intrinsic coordination is one, rather than two coupled activities. The point is not least that intrinsic coordination cannot take place prior to the performance of a task or afterwards for that matter. It is part of the task, or more precisely, it is a characteristic way of performing the task. In this manner intrinsic coordination shares the quality of other heed concepts.

However, there are a few features that set intrinsic coordination apart from other more general heed concepts. For example, intrinsic coordination is always part of

cooperative work in the sense that intrinsic coordination by definition is the integration of interdependent work task by virtue of individuals acting on the physical traces of work previously accomplished by others. In comparison, doing something *attentively* or doing it *carefully* (both general heed concepts) is obviously not necessarily part of cooperative work and its integration. In this manner intrinsic coordination is a specialised heed concept to be used only in the context of describing the coordination of cooperative work.

These considerations aside, the central question is this: does the concept of intrinsic coordination add anything to our ability to account for the coordination of cooperative work? We will explore this issue by explicitly comparing the concept of intrinsic coordination to well-established concepts within CSCW, namely articulation work (e.g. Gerson and Star 1986; Schmidt 1994; Schmidt and Bannon 1992; Strauss 1985, 1988; Strauss et al. 1985) awareness (e.g. Heath and Luff 1992; Heath et al. 2002) and feedthrough (e.g. Dix 1996; Dix and Beale 1996).

Intrinsic Coordination Compared to Articulation Work

In this section we shall compare the concept of intrinsic coordination to the concept of articulation work in order to determine if they are interchangeable concepts or not.

Recall that according to Strauss (1985, p.8) articulation work is a kind of supra-type work in any division of labour, done by the various actors concerning the meshing and integration of the interdependent activities inherent to cooperative work . In a similar vein Schmidt describes articulation work as reflexive second order activities (Schmidt 2002, p.464). Perhaps it is safe to say, and this is meant to reiterate a point made above, that the distinction between the articulation work and the cooperative work articulated is an inherent feature of the concept of articulation work.

In comparison, using the concept of intrinsic coordination does *not* entail making a distinction between the work and extra activities aimed solely at coordinating the work. That would be a contradiction in terms considering that intrinsic coordination as we described it above is a heed concept. Recall that when we speak of someone performing a cooperative work task engaged in intrinsic coordination we are not saying that he or she is doing two things at once. He or she could not stop the performance of the task and continue to be engaged in intrinsic coordination. The usage of a heed concept such as intrinsic coordination and especially a heed adverb such as intrinsically has the merits of suggesting that what is described is one activity with a special character, rather than two activities that are somehow interrelated in their execution (see Ryle 1955). In comparison, we may say that actors engaged in articulation work in relation to a set of cooperative work tasks, may stop performing the tasks and continue any articulation work in relation to their coordination. For example, two carpenters engaged in distributed cooperative work tasks on a rooftop may stop working on the roof and continue their conversation concerning how to coordinate their interdependent efforts – in fact this may often be the case. In this manner articulation work may be said to stand in a supra type relationship to the

work tasks articulated, whereas intrinsic coordination may not. That is, articulation work may be an activity separate from the performance of the cooperative work articulated, and in comparison intrinsic coordination may not.

The point we are trying to make is that if intrinsic coordination is a heed concept i.e. a characteristic way of performing a cooperative work task (to a coordinative effect) then it does *not* qualify to be described as an effort that may be said to stand in a supra-type relationship to the tasks performed. In this manner the concept of intrinsic coordination is *not* interchangeable with the concept of articulation work.

Furthermore, we could suggest that intrinsic coordination is *not* based on the use of specialised coordinative artifacts or coordination mechanisms. As mentioned above a coordination mechanism is a construct consisting of, one the one hand, a coordinative protocol (an integrated set of procedures and conventions stipulating the articulation of interdependent distributed activities) and on the other hand an artefact in which the protocol is objectified (Schmidt and Simone 1996, p.166). In contrast to articulation work, intrinsic coordination does not rely on the use of coordination mechanisms – claiming so would be a contradiction in terms in the sense that there is no place for a discrete coordinative protocol when coordination is achieved by acting directly on the evidence of work previously accomplished. We could suggest that the use of a coordination mechanism is evidence of a supra-type effort to coordinate cooperative work, an effort unlike intrinsic coordination.

Perhaps, then, we could rest the distinction between the concepts of articulation work and intrinsic coordination on a distinction between coordination done through supra-type activities or second order activities (articulation work) and integration achieved by virtue of individuals acting on the material evidence of work previously accomplished by others (intrinsic coordination). This seems to be a tenable position to take, since it makes it possible to distinguish with relative clarity between two forms of coordination of cooperative work. It speaks in favour of the distinction between articulation work and intrinsic coordination that, without it, we would be compelled to place two different modes of coordination in the same category (as far as I can see). Seemingly, this could be avoided by upholding the distinction between articulation work and intrinsic coordination.

In sum, we have argued that the concept of intrinsic coordination is *not* interchangeable with the concept of articulation work (although it may complement it).

Intrinsic Coordination Compared to Awareness

In this section we will compare the concept of intrinsic coordination to the concept of awareness in order to determine if they are interchangeable concepts or not.

As mentioned above, the idea of awareness, at least in CSCW, originally emerged in a number of work place studies by not least Heath and Luff (1992, 1996) of Line Control Rooms on the London Underground as well as the studies of air traffic control work by the Lancaster group (Harper and Hughes 1993; Harper et al. 1989a, b). In these studies it was noted how collaborative activity in complex organizational environments

rests on the individuals' abilities to create awareness through bodily conduct whilst engaged in their respective activities. That is, it was described how actors produce awareness by rendering a feature of their conduct or a feature in the environment *selectively* available to others. We shall elaborate.

According to Heath and associates (2002, p.318), the ways in which actors produce awareness is inextricably embedded in the activities in which they are engaged, and the ways in which those activities unfold. Simply put, what individuals are aware of depends upon the activities they and others are engaged in. Awareness, then, is a practical accomplishment that arises in and through action and activity. This feature of awareness is shared by intrinsic coordination in the sense that both awareness and intrinsic coordination are inextricably part of performing the work. However, there are also important differences between awareness and intrinsic coordination, as we shall see.

In the course of their work performance actors may find that the activity in which they are engaged becomes potentially relevant for others within the domain and yet their colleagues are seemingly involved in something else. In such circumstances, an actor may modulate an activity (e.g. speak louder, stare in an obvious manner, or overtly move an object about), to enable others to gain awareness of some matter at hand, without demanding that anybody should respond. Heath and Luff (1992) gives a fine example of this as they describe how the operators in a control room coordinate train traffic and movement of passengers on a particular line. The control room can house several staff, including the Line Controller who coordinates the day-to-day running of the railway and the Divisional Information Assistant (DIA) who, amongst other things, provides information to passengers and to Station Managers (Heath and Luff 1992). In this setting awareness is produced through very delicate bodily practices:

> On occasions, it may be necessary for the Controller to draw the DIA's attention to particular events or activities, even as they emerge within the management of a certain task or problem. For example, as he is speaking to an operator or signalman, the Controller may laugh or produce an exclamation and thereby encourage the DIA to monitor the call more carefully. Or, as he turns to his timetable or glances at the fixed line diagram, the Controller will swear, feign momentary illness or even sing a couple of bars of a song to draw the DIA's attention to an emergent problem within the operation of the service. The various objects used by the Controller and DIA to gain a more explicit orientation from the other(s) towards a particular event or activity, are carefully designed to encourage a particular form of co-participation from a colleague, but rarely demand the other's attention. They allow the individual to continue with an activity in which they might be engaged, whilst simultaneously inviting them to carefully monitor a concurrent event. (Heath and Luff 1992, p.81).

In this manner actors in the underground control room create awareness of their activities through modulation of their activities with bodily conduct directed at co-located colleagues in an unobtrusive way. That is, as Heath and associates (2002, p.321) express it 'actors may render activities selectively available' to their colleagues. How does this feature of awareness compare to intrinsic coordination? We could suggest that intrinsic coordination does not involve individuals rendering activities *deliberately* or *selectively* available to

others through bodily conduct (e.g. modulations in voice, gesture, pose, stance, gaze, glance, etc.). Intrinsic coordination does not rely on this sort of selective rendering of activities in the sense that intrinsic coordination merely refers to actors in cooperative work acting on the physical evidence of work previously accomplished by others to a coordinative effect.

Furthermore, unlike much production of awareness through bodily conduct, intrinsic coordination does not rely on co-location, as we shall see now. Within CSCW, awareness is commonly associated with a particular type of workplace. In part, this association derives from the fieldwork settings of the studies that contributed to the recognition and understanding of the phenomenon in the first place. These settings have certain characteristics that make awareness pertinent and have been described by Suchman (1997) as 'centres of coordination'. These include such settings as subway control rooms, air traffic control rooms, newsrooms, trading rooms, and the like. According to Heath and associates (2002, p.320), one of the important characteristics of such work places is that personnel is co-located in the 'same' physical domain (through continually interact with others outside that domain). As indicated, co-location enables not least the production of awareness through bodily conduct such as modulations in voice, gesture, pose, stance, gaze and glance whereby actors render a feature in their actions or in the environment selectively available to others (Heath et al. 2002). How does the notion of co-location relate to intrinsic coordination? We could suggest that in contrast to awareness, co-location is irrelevant for intrinsic coordination in the sense that for an individual acting of the physical evidence of work previously accomplished by others the co-presence of these 'others' is irrelevant or unnecessary. That is, in respect to the notion of co-location awareness and intrinsic coordination seem to differ.

Compared to awareness, then, intrinsic coordination does not involve rendering activities selectively available to co-located colleagues through bodily conduct or otherwise. That is, co-location is irrelevant in intrinsic coordination just as there is no place or need in intrinsic coordination for bodily gestures. Furthermore, intrinsic coordination is in no way confined to specific domains such as centres of coordination in the sense that intrinsic coordination may transgress several settings – think of how intrinsic coordination with CAD models transgress several physical settings (i.e. architectural office, static engineers office, building services office, etc.).

We could suggest that the difference between intrinsic coordination and awareness is (partly) the difference between heeding the material evidence of work previously accomplished by others (intrinsic coordination) and rendering activities selectively available to co-located others through bodily conduct that these others in turn may take heed of (awareness). Note that one of the differences is related to the object that is paid heed to. Acting intrinsically involves paying heed to the physical traces of work previously accomplished by others, whereas producing awareness involves bodily conduct that co-present others may take heed of subsequently. That is, in intrinsic coordination it is the state of the material field of work that is heeded, and in awareness the heeded object is mainly bodily conduct.

In sum, we have argued that the concept of intrinsic coordination is *not* interchangeable with the concept of awareness (although it may complement it).

Intrinsic Coordination Compared to Feedthrough

Leaving the distinctions between the concepts of articulation work, awareness and intrinsic coordination for now, another concern appears. Perhaps other, more established concepts within CSCW and related research fields are already doing what intrinsic coordination does. Are *intrinsic coordination* and *feedthrough*, for example, interchangeable concepts? In addition to contrasting intrinsic coordination with articulation work and awareness, perhaps it could also be helpful to contrast the concept of intrinsic coordination with Dix's concept of feedthrough (Dix 1997; Dix and Beale 1996). We shall do so in this section.

According to Dix in some cases cooperative work is coordinated through the artifact rather than by direct face-to-face interaction or by other forms of verbal interaction. Dix states that:

> In a cooperative setting not only is it important to see one's own updates, but also to see the effects of other people's actions. This is feedthrough. The presence of feedthrough effectively creates an additional channel of communication through the artefacts themselves (Dix 1997, p.38).

According to Dix, this form of coordination is often more important than direct verbal communication. It is effective, partly because it is tied so closely to the work itself, and partly because it is implicit, unconsciously noted and acted upon. So far Dix is describing a coordinative practice akin to intrinsic coordination. Consider, however, Ramduny and Dix (2002) in a discussion of awareness of user activity in a collaborative environment:

> Delivering feedthrough at the wrong pace can be problematic. If it is too slow, users may have to act without up to-date knowledge of one another's actions. If it is too fast, users may be distracted by irrelevant changes. Some feedthrough is very goal-directed – information directly used by users in their tasks (Ramduny-Ellis and Dix 2002, p.122).

The notion that feedthrough can be delivered at the 'wrong pace' seems to indicate that in some instances the 'information' that feed through the artifacts is distinct from the efforts that are being coordinated. How else could it be delivered at the 'wrong pace'? It seems that, at least in some instances, the concept of feedthrough is concerned with 'meta-information' used to coordinate collaborative work.

Furthermore, the concept of feedthrough seems to rely on the notion that 'people's actions' feed through the artifacts from actor A to actor B in the form of 'information'. Dix and Beale:

> The sharing of information comes because of feedthrough, when people are aware of and respond to the effects of one another's actions. In the sales situation the information from the factory floor must be timely, that is feedthrough of the factory staff's actions to the sales force. (Dix and Beale 1996, p.6).

Perhaps a closer look at the concept of information is warranted. The scientific formulation of the concept of 'information' can be traced back to the 'mathematical theory of communication' developed shortly after WWII by Claude E. Shannon for the purpose of measuring the transportation capacities of communication networks

(Shannon 1948, p.379). Of course, the word 'information' was in common usage for many years before its scientific conceptualisation. It was recorded in print in 1390 to mean 'communication' or 'knowledge' or 'news' of some fact or occurrence (Oxford English Dictionary). However, as a part of his mathematical theory of communication, Shannon coined a definition of information that transformed it into a physical parameter capable of quantification. He accomplished this by separating information and meaning. He applied 'meaning' to the semantic part of a message and used 'information' to refer to the quantity of different possible messages that could be carried along a channel of communication at any one time depending on the length of the message and on the number of choices of symbols for transmission at each point in time (Aspray 1986). For his purpose, this was quite appropriate, because semantic aspects of communication are irrelevant to the engineering problem (Shannon 1948). Shannon had coined a quantitative concept to be used for measuring and emphasized that 'information' should not be confused with 'meaning' (Shannon and Weaver 1949, p.8).

In relation to the concept of feedthrough, does the term 'information' refer to a quantitative measure, to meaning or both? Perhaps the very idea that information or some other fixed correlation between ideas and symbols migrate through the artifact is untenable. Recall our discussion of *telementation* in Chap. 6. Is the concept of feedthrough associated with the notion of telementation? Perhaps, to the extent that it suggests that information is fed from actor A to actor B through the conduit of artifacts. Harris (1981) holds that it is not tenable to maintain that meaning can take a fixed form (of for example information) and migrate from head to head via artifacts or other means. That is to say, there is no stable entity of for example information that may be propelled back and forth between actors like a tennis ball in a game of tennis. Consequently, in practice there is no semiological tennis ball that may be feed through form actor A to actor B. It seems that we have no other recourse but to suggest that the concept of feedthrough is associated with the notion of telementation. In addition, we could suggest that there is a kinship of sorts between Harris' (1981) notion of *telementation* and what Reddy (1979) has dubbed *the conduit metaphor*. Perhaps the concept of feedthrough is a form of the conduit metaphor.

According to Reddy, the English language alone hosts more than a hundred expressions based on what he calls 'the conduit metaphor' (Reddy 1979). Reddy calls it 'the conduit metaphor', because it implies that thoughts are transferred from actor A to actor B through some conduit or other. Reddy argues that it is almost impossible for an English speaker to discuss communication without committing to some form or other of that metaphor. Is the concept of feedthrough a commitment to a form of conduit metaphor? Perhaps, to the extent that it suggests that information is fed from actor A to actor B through the conduit of artifacts (e.g. Dix and Beale 1996, p.6; Ramduny-Ellis and Dix 2002, p.122). If we accept this, the analytical use of the concept of feedthrough is, in some instances, a commitment to a form of the conduit metaphor as well as the notion of telementation.

In contrast to the concept of feedthrough, the concept of intrinsic coordination, as we are attempting to cast it, does not rely on the notion of information, does not commit to the idea of telementation and is not a form of the conduit metaphor

(as far as I can see). That is, actors engaged in practices of intrinsic coordination may have as a basis for their actions something quite different from e.g. telementation, namely, acquired dispositions to perceive, comprehend and act that could be interpreted as oriented towards one task or another and performed most often in the natural attitude of the actor (as mentioned above). In sum, the concept of intrinsic coordination and the concept of feedthrough are not interchangeable concepts.

Gothic Cathedrals and Steel Rolling Mills

It seems that we have been unable to point to concepts that are interchangeable to intrinsic coordination. That is, the concepts of articulation work, awareness, and feedthrough all differ from our notion of intrinsic coordination. However, we may be able to point to (empirical) descriptions of practice that may, in our perspective, be described as intrinsic coordination. We will now turn to investigate this matter. In this section we shall investigate how on the one hand James (1981, 1985) and on the other hand Popitz and associates (1957) have described practices that may, in our perspective, be described as intrinsic coordination.

Our first case is a historical study concerned with the creation of the cathedral of Chartres, a study conducted by James (1981, 1985). We will suggest that over 40 distinct building campaigns leading to the construction of one of the most renowned pieces of Gothic architecture was integrated through what we describe as intrinsic coordination.

After a disastrous fire Notre Dame de Chartres was rebuild between the year 1194 and the year 1230. According to James (1981, 1985), the appearance of the cathedral today cannot be explained as the result of a coherent master plan or even the presence of a master designer (what we today would call an architect). Altogether it took between 25 and 30 years for nine different master masons to build the cathedral in 30 distinct campaigns. Masons built Chartres; there was no overall designer or architect, just a succession of builders (James 1981, 1985; Turnbull 1993). That is, large mobile teams of masons build the cathedral. Such teams were highly mobile (out of necessity) and moved around the countryside from job to job working for as long as a particular building campaign lasted. That is, when the funds for a particular building campaign ran out they would leave the site in a body, the crews still intact under their master, to find another project, in a sense they were like the circuses of today which roam the country settling for their allotted time and then, complete with their tents and tools, departing for other places' (James 1981, p.9). Until funds and a new master mason and crew were found the building site of the cathedral of Chartres was inactive for months even years at a time. This entails that the cathedral seems to have been build in distinct campaigns by discrete crews of actors.

James describes that one of the most important social rules governing the relationship between successive crews and their distinct building campaigns seems to have been that when a the master of a crew took over and started a new campaign, he did not move or alter what had already been built: 'He might change the shape of

the next stone, but what had already been put down was sacrosanct (…) the stones of Chartres show that, once placed, they were not touched again' (James 1985, p.125). Furthermore, James (1985, p.146) states that 'for most of the time the master's freedom was heavily constrained by what had already been built, so his major training lay in learning how to adapt himself to circumstances.' In this manner James seems to indicate that the master masons were committed to the state of the cathedral in-the-making as they found it at any given point in the process, and from this basis they had to elaborate on the building.

The absence of a master planner or plan coupled with the distributed nature of the work organization and the discontinuous building process begs an explanation as to how the interdependencies between campaigns were managed or coordinated. James describes the building of Chartres as 'the *ad hoc* accumulation of the work of many men' (James 1985, p.122), and in a way it seems to underscore the absence of formal architectural design and planning as we know it today. Perhaps we could suggest that, in our perspective, it sounds as if the distributed building campaigns were integrated partly through practices of intrinsic coordination. If we accept this suggestion, it seems that over 40 distinct building campaigns leading to the construction of one of the most renowned pieces of Gothic architecture[3] was integrated partly through what we describe as intrinsic coordination.

Of course the activities of a particular building campaign was coordinated though articulation work as well. According to Turnbull (1993) actors resorted to the use of string for measuring, templates for the prolific production of stone, and talk for coordination. In addition to intrinsic coordination, then, other modes of coordination have played a part here as well.

We now turn to our second example of distributed cooperative work activities that, in our perspective, can be described as integrated through intrinsic coordination. The case study was conducted by Popitz and associates (1957) and is concerned with cooperative work in the German steel industry where manually controlled steel rolling mills shaped hot steel ingots into strips of varying forms and dimensions. We will suggest that the distributed task involved in operating the steel rolling mills were mainly integrated through practices of intrinsic coordination.

Popitz and associates (1957) describe how the cooperative work ensemble running the mill is – for all practical purposes – unable to coordinate their individual activities by talking to each other. The noise level of the mill prevents them from talking and some of them cannot even see each other. It is not uncommon that operators do not talk to each other during the operation of the rolling mill for the length of an 8 h day.[4] Furthermore, Popitz and associates (1957) informs us that operators are so intensely occupied with controlling the rolling mill, a process with a strict temporal order, that they do not have time to talk and cannot be attentive to for example the hand gestures of each other. Each operator is on his own in doing his work, albeit in a manner

[3] We could note that today the cathedral is considered one of the most beautiful examples of gothic architecture (Turnbull 1993).

[4] Not considering socialising in the for example the lunchroom or outside work.

where activity at any time fits closely into and continues the steel transformation process in the mill where every variation in the work of another actor that is of importance to the process must be immediately adhered to often by performing a variation in his own work. The steel rolling mill crew nevertheless manages to act in a concerted way without verbal communication and without gestures. They are able to integrate their distributed cooperative effort by appreciating the state of their common material field of work, by paying attention to the vibrations of the mill and the glowing strip of metal rolling through (Popitz et al. 1957, p.187). In this manner the distributed activities associated with operating the rolling mill are integrated by acting directly on the state of the material field of work.

Furthermore, in discussing this case, Schmidt (1994, p.23) puts forward the apt proposition that cooperative work may be 'solely mediated by changes to the common field of work'. Schmidt holds that cooperative work involves interaction through the changing state of the field of work – what one actor is doing is of importance to another actor and perhaps in turn another actor as changes propagate through the common material field of work (Schmidt 1994, p.23).

Perhaps we could suggest that, in our perspective, it sounds as if the distributed tasks involved in operating the steel rolling mills were integrated through practices of intrinsic coordination. We could also remark that the concept of intrinsic coordination seems to be akin to the notion that cooperative work may be 'solely mediated by changes to the common field of work' as argued by Schmidt (1994b).

In sum, the case of Chartres (James 1981, 1985) as well as the case of the steel rolling mill (Popitz et al. 1957), suggest that others describe phenomenon that in our perspective may be described as practices of intrinsic coordination. Consequently, the concept of intrinsic coordination amounts to a notion, a shorthand, or more precisely, a conceptualization of the phenomenon or insight that cooperative work can be integrated by acting on the state of the common material field of work. As such the concept of intrinsic coordination does not point to a 'newly discovered' empirical phenomenon. Rather, the preoccupation with the concept of intrinsic coordination in this book amounts to an attempt to conceptualize the phenomenon and in turn explore how this concept (i.e. intrinsic coordination) relates and compares to other established concepts within CSCW such as articulation work, awareness, and feedthrough.

Intrinsic Coordination, Awareness and Articulation Work

For the sake of clarity, perhaps it would be prudent to pause at this juncture and briefly take stock. We shall do so not least in regard to the relationship between intrinsic coordination, awareness and articulation work.

Above, the notion that cooperative work may be coordinated by virtue of individuals acting on the material evidence of work previously accomplished by others was conceptualised as intrinsic coordination. We traced the origins of the concept of intrinsic coordination to the field of entomology. In relation to this we noted that a stimuli-response model of action was associated with the use of the concept of intrinsic coordination in this research field.

In relation to transposing the concept of intrinsic coordination to the field of CSCW, i.e. to the analysis of the coordination of cooperative work, we found a need to supplant this stimuli-response model of action. We argued that intrinsic coordination in a human context may be conceived of as practice based on acquired skills and techniques that may be described as embodied in the habitus of the individual actors, rather than in terms of stimuli-response.

Subsequently, we suggested that intrinsic coordination could be described as a heed concept and that it may be used as a heed adverb. The notion that intrinsic coordination is a heed concept has the merit of suggesting that intrinsic coordination is a characteristic manner in which cooperative work may be performed, rather than a separate activity. Following this, we asked if the concept of intrinsic coordination would add anything to our ability to account for the coordination of cooperative work? In order to address this question we compared the concept of intrinsic coordination to not least the concepts of articulation work and awareness. We found that none of these concept where interchangeable to the concept of intrinsic coordination, although it was suggested in passing that they may complement it.

We indicated that articulation work, intrinsic coordination and awareness may act in concert as distinct yet interconnected modes of coordination in cooperative work. The constitution and articulation of the taskscapes in advance of their performance may be handled through articulation work with coordinative artifacts. Recall for example how actors such as planners partly constitute the taskscapes of the building process through articulation work with for example Gantt charts or by colour coding architectural plans. When the distributed tasks in turn are to be actually performed and integrated on a concrete level, intrinsic coordination may complement articulation work. Recall for example how cooperative work tasks in the building process are integrated intrinsically i.e. on the level of the concrete material performance of the tasks by virtue of actors acting on the material evidence of work previously accomplished by others. On par with intrinsic coordination, awareness practices may also play their part in regard to the integration of cooperative work tasks in the concrete i.e. as they are performed. Recall the awareness practices described by Heath and Luff (1992) and Heath and associates (2002) in relation to centres of coordination such as control rooms where coordination is partly achieved by virtue of actors rendering activities selectively available to co-located others through bodily conduct that these others in turn may take heed of. Finally, articulation work may take on the character of an evaluation or ordering process after the tasks have been performed. For example, recall the meetings where the representations of the taskscapes on the Gantt charts are calibrated to reflect the progress of the tasks on the building site.

It seems that articulation work may be performed prior, in parallel to, and after the performance of the tasks articulated (articulation work may be described as a 'supra-type' or 'second order' activity precisely because it may be performed separately from the tasks – even in instances where articulation work is performed in parallel to the tasks, articulation work may as mentioned be considered a supra-type activity). Note also how intrinsic coordination may *not* be performed prior, in parallel to, and after the performance of the tasks articulated in that intrinsic coordination is a characteristic manner in which cooperative work may be performed to a coordinative effect,

rather than a separate activity. As mentioned above, intrinsic coordination (and possibly awareness) are heed concepts.

Perhaps the three concepts of articulation work, awareness, and intrinsic coordination could amount to a trinity in the CSCW toolbox for the description and analysis of the coordination of cooperative work. Of course more analytical and empirical work needs to be done in order to establish this firmly, and an interesting question for further empirical research is how exactly does articulation work, awareness, and intrinsic coordination practices complement each other as distinct yet interconnected modes of coordination in cooperative work?

References

Aspray, W. 1986. The Scientific Conceptualization of Information: A Survey. *Annals of the History of Computing* 7(2) 117–140.

Bourdieu, P. 1992. *The Logic of Practice*. Polity Press, Cambridge

Carstensen, P., C. Sørensen. 1996. From the Social to the Systematic: Mechanisms supporting coordination in design. *Computer Supported Cooperative Work. The Journal of Collaborative Computing* 5(4) 1996.

Christensen, L.R. 2007. Practices of Stigmergy in Architectural Work. *Proceedings of the 2007 international ACM conference on Supporting group work.* ACM, Sanibel Island, Florida, USA, 11–20.

Christensen, L.R. 2008. The logic of practices of stigmergy: representational artifacts in architectural design *Proceedings of the ACM 2008 conference on Computer supported cooperative work*. ACM, San Diego, CA, USA, 559–568.

Christensen, L.R. 2012. Stigmergy in Human Practice: Coordination in Construction Work. *Cognitive Systems Research*, 20–21.

Dix, A. 1996. Challenges and Perspectives for Cooperative Work on the Web *Proceedings of the ERCIM workshop on CSCW and the Web*, Sankt Augustin, Germany.

Dix, A. 1997. Challenges for Cooperative Work on the Web: An analytical approach. *The Journal of Collaborative Computing: Computer-Supported Cooperative Work* 6 135–156.

Dix, A.J., R. Beale. 1996. Introduction. A.J. Dix, R. Beale, eds. *Remote cooperation: CSCW issues for mobile and tele-workers*. Springer Verlag, 1–10.

Gerson, E.M., S.L. Star. 1986. Analyzing due process in the workplace. *ACM Transactions on Office Information Systems* 4(3) 257–270.

Harper, R.H.R., J.A. Hughes. 1993. What a f-ing system! send 'em all to the same place and then expect us to stop them hitting: Making technology work in air traffic control. G. Button, ed. *Technology in Working Order: Studies of work, interaction, and technology*. Routledge, 127–144.

Harper, R.H.R., J.A. Hughes, D.Z. Shapiro. 1989a. Working in harmony: An examination of computer technology in air traffic control. *Proceedings of the First European Conference on Computer Supported Cooperative Work, Gatwick, London, 13–15 September, 1989*, Gatwick, 73–86.

Harper, R.R., J.A. Hughes, D.Z. Shapiro. 1989b. The Functionality of Flight Strips in ATC Work. The report for the Civil Aviation Authority. Lancaster Sociotechnics Group, Department of Sociology, Lancaster University.

Harris, R. 1981. *The Language Myth*. Duckworth, London.

Harris, R. 1995. *Signs of Writing*. Routledge, London and New York.

Heath, C., P. Luff. 1992. Collaboration and control: Crisis management and multimedia technology in London Underground control rooms. *Computer Supported Cooperative Work (CSCW) An International Journal* 1(1–2) 69–94.

Heath, C., M.S. Svensson, J. Hindmarsh, P. Luff, D. Lehn. 2002. Configuring Awareness. *Computer Supported Cooperative Work* 11 317–347.

Heath, C.C., P. Luff. 1996. Convergent activities: Line control and passenger information on the London Underground. Y. Engeström, D. Middleton, eds. *Cognition and Communication at Work.* Cambridge University Press, Cambridge, 96–129.

James, J. 1981. *The contractors of Chartres*. Lakes Printers, Wyong.

James, J. 1985. *Chartres: The masons who built a legend.* . Routledge & Kegan Paul, London.

Popitz, H., Hans Paul Bahrdt, Ernst A. Jüres, H. Kesting:. 1957. *Technik und Industriearbeit. Soziologische Untersuchungen in der Hüttenindustrie.* J. C. B. Mohr, Tübingen.

Ramduny-Ellis, Dix. 2002. Impedance Matching: When you need to know What. F. X., F. J., D. F., eds. *Proceedings of HCI2002* Springer, London, 121–137.

Reddy, M.J. 1979. The Conduit Metaphor: A case of frame conflict in our language about language. A. Ortony, ed. *Metaphor and Thought*. Cambridge University Press, Cambridge.

Ryle, G. 1955. *The Concept of Mind*. Hutchinson & Co., London.

Schmidt, K. 1994. *Modes and Mechanisms of Interaction in Cooperative Work.* Risø National Laboratory, Roskilde, Denmark.

Schmidt, K. 2002. Remarks on the complexity of cooperative work. P. Salembier, T.H. Benchekroun, eds. *Cooperation and Complexity in Sociotechnical Systems, [special issue of] Revue des sciences et technologies de l'information, [série] Revue d'intelligence artificielle (RSTI-RAI),, vol. 16, no. 4–5.*, Paris, 443–483.

Schmidt, K., L. Bannon. 1992. Taking CSCW Seriously: Supporting Articulation Work. *Computer Supported Cooperative Work (CSCW). An International Journal.* 1(1–2) 7–40.

Schmidt, K., C. Simone. 1996. Coordination mechanisms: Towards a conceptual foundation of CSCW systems design. *Computer Supported Cooperative Work: The Journal of Collaborative Computing* 5(2–3) 155–200.

Schmidt, K., I. Wagner. 2004. Ordering systems: Coordinative practices and artifacts in architectural design and planning. *Computer Supported Cooperative Work (CSCW): The Journal of Collaborative Computing* 13(5–6) 349–408.

Shannon, C.E. 1948. A mathematical theory of communication. *The Bell System Technical Journal* 27 379–423.

Shannon, C.E., W. Weaver. 1949. *The Mathematical Theory of Communication*. University of Illinois Press, Urbana.

Strauss, A. 1985. Work and the division of labor. *The Sociological Quarterly* 26(1) 1–19.

Strauss, A. 1988. The Articulation of Project Work: An Organizational Process. *The Sociological Quarterly* 29(2) 163–178.

Strauss, A., Shizuko Fagerhaugh, Barbara Suczek, C. Wiener. 1985. *Social Organization of Medical Work*. University of Chicago Press, Chicago and London.

Suchman, L. 1997. Centers of Communication: A case and some themes. L.B. Resnick, R. Säljö, C. Pontecorvo, B. Burge, eds. *Discourse, Tools, and Reasoning: Essays on Situated Cognition.* Springer-Verlag, Berlin, 41–62.

Turnbull, D. 1993. The ad hoc collective work of building Gothic cathedrals with templates, string, and geometry. *Science, Technology, & Human Values* 18(3) 315–340.