Activity and Artifact: The symbiosis of truck drivers’ work and navigational systems

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Abstract: This paper outlines design ideas from a project dealing with different interaction concepts for the design of a computer based navigation system for truck drivers. The incentive for thinking about interaction concepts is that programming of navigation systems often occurs while driving, since that is when the support is needed. We have been working with ethnographical studies of truck drivers driving both over short and long distances. There has been quite a lot of work done in the field of cars and navigation, in this paper however the main theme is not navigation in cars as such, but the truck environment as an example of a high-demanding room for work activities. This lead to a design situation where the artifact and the activity has to go together, the artifact has to ‘melt-in’ to the work practice. We discuss how the design of computational power can melt-in to the work-practice without demanding too much of the attention needed for driving the truck safely.

Keywords: Interaction paradigms, Traffic information, Work Practice based design, Tangible interfaces, Paper interfaces.

1 Introduction
In this article we discuss design issues regarding navigation systems for in-car settings. The argumentation is based upon a field study of truck drivers’ work. We have studied how the truck drivers find the way to delivery or pick-up locations. In the navigation system designed for the truck-drivers in a mock-up we used the waybills to program the destinations. We found that the drivers that we studied are very good pathfinders, and in the end always find the destination—they have to. The aim with the field study was to inform the design of a navigation system.

This paper starts with a background to the project and to interaction concepts that relate to our work. The background is followed by an empirical part in which we focus on how one artifact, the waybill, is used by the truck drivers today. Since we have understood that the waybill is a central part in the truck-driver’s path finding we have chosen to include the waybill as an integrated part of the navigational system. Based on our field study we discuss how the waybill is used today and transform this into a design suggestion were the waybill gets added functionality. We conclude with a discussion about how to design a navigation system in a way that it melts into the work practice.

2 Background
2.1 The issue of programming destinations
The area of navigation systems is expanding and there are different ways of looking at the design. With navigation systems we address systems that are designed to make somebody, for example a driver or a pedestrian, able to find their way. Some of the systems let its users see their position in relation to other users, for example colleagues. In this paper we will focus on how drivers tells the system where they want to go, i.e. programs the destinations.

Navigation systems designed for use in cars and trucks are becoming more and more common, and there is a need to make the interaction more appropriate for the high-demanding in-vehicle setting. An observation we made when riding a
passenger car equipped with a navigation system was that the driver when programming the destination on-line seemed to be focusing more on the task of programming than the actual driving. The driver was very enthusiastic about what the system could do and how precise it was since we could all see where we were. We on the other hand were anxious about our safety, since our driver gave the programming of the navigational system so much attention at the same time as he was driving. The initial reason for us believing so was a near-miss when the driver, programming the system, realized that he should turn right instead of follow the road ahead. Afterwards we realized that the system when started, at its welcome screen did warn the driver for entering data into the navigation system while driving. This made us think about in which ways the navigational aid is designed to support the driver. Although our experience from the ride can be a product of the driver’s excitement of a newly bought car with a navigation system, we find that a basic feature of that navigation system is that it does not seem to be designed for programming destinations when driving.

The issue of people focusing more on the interaction with the computer system than the tasks it is designed for is addressed in several design concepts such as Calm Technology (Weiser and Brown 1996), Tacit Interaction (Nelson et al. 1999) and Tangible Bits (Ishii and Ullmer 1997). One common idea of the concepts are that information can be placed in the background or foreground (Tangible Bits) and center or periphery of our attention (Calm Technology) and the focus can shift between them from time to time. Due to our understanding the words have similar meanings, but uses different terminology in the different concepts. Weiser and Brown describe it as being attuned to information and they write that important properties of Calm Technology are the ability to move between the center and the periphery (Weiser and Brown 1996). There is also a vision about moving the points of interaction with the computational power out in the environment (Weiser 1991, Ishii and Ullmer 1997). In the Palette, by Nelson et al (Nelson et al. 1999), the paper cards are used as interaction points using the computational power to what it is good at and relating the paper cards to the information inside the computer. They write that Tacit Interaction “should engage a wider range of human perception” and enable “a larger degree of low-intentional interaction” than current interfaces. They argue that the Palette “explores ways to re-

physicalize the human computer interaction (HCI) and thereby allow the user to distribute tasks to less intentional, less intellectual modes of action”. (Nelson et al. 1999 p.360).

Navigational support systems do have many areas of application and we decided to learn more about how truck drivers find their way today. Questions of importance for our project were if the truck-drivers wanted and/or needed a navigational system and secondly how it (the navigation system) could be designed to fit into the work practice of truck-drivers.

2.2 Our study
What made truck drivers work practice so interesting was the presumption that they are good at finding their way and often are put in situations that demand navigational skills. We also found it interesting to design computational power that would fit into the truck. To find out more about the profession we during the empirical study performed visits at a cargo contractor situated in the southeastern part of Sweden. The empirical study consisted of observing three different drivers during their workday, and observing a traffic controller at the main office. We took our place next to a truck driver, and used a video camera to capture the work activities that took place. We also spent some of the time observing and taking notes without the camera running. To learn more about the use of the waybill, we also made an observation of the traffic-leader at the cargo contractor.

In the work with our design suggestion of a navigation system, the cases where drivers drive in another area than the hometown-area, has been the most interesting. We soon found that there were situations where the drivers had difficulties finding the locations, both near home and far away.

The examples in the next section are chosen because we find they illustrate either of the following two themes: waybills in use and on-line and off-line route planning. We are in the presentation of our analysis of the empirical data not interested in if the drivers find their way, since they in the end always do, but in how they find it.

3 Waybills, experience and windows

3.1 About the setting and routes
One of the largest customers of the cargo contractor is a dairy making for example butter and ice cream.
The trucks that we followed consisted of a lorry and sometimes a trailer. The freezer is placed in the front of each superstructure, which means the frozen cargo has to be placed in the front part of the truck and trailer since it can not be mixed. The superstructures of the loads we followed had openable doors at one side and in the back of each vehicle.

The contractor is carrying on traffic in large parts of Sweden. At the cargo contractor the truck drivers load their load by themselves sometimes assisted by one or more colleague.

3.2 Examples of Waybills in use
In this section we give three examples of how we saw the waybill (see fig. 1) being used, first at the customer, then at the hub, and finally at the route.

Waybills at customers. When a truck has left home early in the morning, or late in the night, it is sometimes not clear where the returning cargo should be picked up several hours later. The traffic-planner make plans for the loads depending on what orders are coming in. Sometime during the day, when the driver is ready, he calls the controller and gets a list of pick-ups. The customers issues the waybill (see fig. 1), writes what the cargo consists of and were it will go. It is then handed over to the driver.

Waybills at the hub. The driver hands in the waybills and receipts (e.g. the last signed sheet of the waybill) to the traffic controller when returning to the cargo contractor’s garage from a route. The controllers take the waybills and types in the load in the computer system and then plan which truck to place it on. At the cargo contractor there are a big reloading area where the loads can dock at many gates. Drivers that finish their route before the working day has ended return back to the contractor to load the loads to the next day.

Joey told us that to spend some time at the hub and sort up the cargo was good since it in the longer run was time saving. He told us about a colleague of his that loaded the truck without sorting the goods before leaving the contractor. Joey said that this driver was on his way to the delivery places earlier than anyone else, but that he was home “many, many hours later than everyone else” (8.32). The point was that if time was spent sorting the cargo and the waybills at the cargo contractor before loading it “you’ll have it back several times”. When Joey returned to the hub, the day we followed him, he loaded the truck for his colleague who would drive to Jönköping (300 km away) about an hour later. He told us that he loaded the goods in a way that corresponded to the route, since he had driven it by himself. He also told us that he tried to “do it as easily as possible for the other drivers” (14.50).

After a while the driver that was going to drive the load came and they looked through the waybills and where the cargo was placed in the load. When riding with the truck driver Perry we saw that there were notes in top of the waybill, at the part of the waybill that fastens the sheets together. Perry explained that the notes described where in the load (i.e. the front, middle, back, left or right side of the truck or the trailer) the cargo was placed. He had not worked the day before, when the truck was loaded, so his colleagues were telling him by the notes. In both of these examples, especially the first, we find it interesting that the colleagues in fact help the driver to plan the route by loading the cargo in a good way for a smooth delivery.

The two quotes above (8.32 and 14.50) and what the drivers did when loading Perry’s truck can be considered as examples of off-line route planning and navigation. Joey places the cargo in a way that corresponds to the actual delivery-order and how the cargo is to be unloaded. If there is a forklift at the first delivery place, for example, the cargo may be placed so it can be reached from the side. If the driver has to unload the cargo by hand at the first place it probably should be placed in the back of either the truck or the trailer. Another thing to consider is if there is a possibility to enter the delivery place with a trailer. The drivers told us that
some places were known to be hard to turn around at
with trailers.

When arriving to the traffic controller’s office
before leaving for a route Joey looks through the
waybills and asks questions if there is anything
unclear about where to find a place. When glancing
at one of the waybills he asks the traffic controller
where the delivery address, a construction site, for
the cargo the waybill is for, e.g. windows, is located.
A colleague, standing beside him, answers and tells
him to drive towards the church in Nättraby (about
ten km outside Karlskrona) and then to continue to
drive until he reaches the landing stage in Sjuhalla
(that is to be found some km from Nättraby). The
site, the colleague says, was to be found near the
landing stage. This points to another observation,
namely the stories about were to find a specific
place.

Waybills at the route. About four hours later
when Joey has delivered all the cargo, but
the windows, in Karlskrona, he drives on the motorway
towards Nättraby. He keeps the waybill, with the
address construction site in his hand. When leaving
the motorway in Nättraby he drives towards the
church. He mentions that he sees a road sign pointing
towards Sjuhalla and turns at the church, over a
bridge. After the bridge he follows the signpost,
again towards Sjuhalla. He says “you should be able
to see a constructing site” and continues:

(time 9.18.04) I believe that it can be a very nice
villa down by the sea that we will find over here,
because it was no small windows. I don’t think that
it was any cheep windows. Rather it was quite
exclusive stuff.

Joey continues to drive and slows down now and
then when looking at construction sites. When in
Sjuhalla he looks to his left, where a house is placed,
and says: “Here is the big ()” (9.18.23) Joey looks
towards the house and mumbles something about
the big windows would fit there. A car comes in
the opposite direction and Joey slows the truck down
and says:

(9.18.44) Let’s see here my little friend. Then you
have to drive in to your neighbor there, yes like that.
Beach road.

We find it interesting the way Joey comments a
house and then just a moment after comments what
the driver of the car should do. The observer riding
with Joey sees a construction site and proposes that
to be the one. Joey says that it should surprise him if
it was, he looks towards the construction site and
then says that it is not the right windows. Joey
continues to drive and after about one and a half
minute approaches a crissroad where there are signs
indicating a road construction work. Joey says:

(9.22.07) Road construction work! Aah, but look
here this looks very good, look Sjuhalla, Sjuhalla
landing stage.

As we told above a colleague mentioned this
landing stage in the morning. When he arrives to the
Sjuhalla landing stage there is a crossroad with one
way to the left and one to right. He looks at the
signpost. It reads Havsvagen (the Sea road):

(9.22.19) And there [at the sign] it reads... Not our...
Here [at the waybill] it reads Huvsvagen.

Huvsvagen corresponds in English to something
like the hood/shield road. The observer says:
‘Havsvagen (Sea road)’ and Joey says:
That can be the case. Havsvagen (Sea road) let’s
go for that. It sounds good, it sounds more realistic.

Joey then turns left and enters the Havsvagen
road. After a few meters he says: “There is the
construction site (...) (9.22.38)” He says that it
seems to be of no use to try to unload the windows
and also matches the windows in the cargo with
empty holes in the house: “And here we can just
forget. There the big window, that I have, will be.
Here we can just forget to be able to unload it. We
have to go out and talk with...” (9.22.50).

He then jumps out of the truck cabin and walks
around at the construction site searching for
someone to ask about a truck.

3.3 Waybills: Central pieces of paper

Joey keeps the waybill in his hand during the whole
ride and looks at it from time to time. The address is
slightly wrong at the waybill and although it is not a
big miss spelling the driver seems to wonder if it is
the right road. So in the window example Havsvagen
(Sea road) makes sense because it is located next to
the sea. The road Huvsvagen (hood/shield road) may
as well be found a few km away. Often there is logic
in the naming of roads in a way that all names
follow some kind of common denominator that
connects to the area. A finding we made during our
empirical study was that the truck drivers seldom
ook anything for granted—a name, of a road or a
firm, that was miss-spelled at the waybill was often
checked with the traffic controller back at the office.

Everything the driver does includes one or more
waybills, the planning for the day, the loading of the
truck and it is also a part of the way finding. We
therefore consider the waybill as a central artifact in
the work of the truck drivers we have observed.
Another reason to consider waybills as central
artifacts is that they are used by many different roles
within the cargo contractor. Different people use it in different ways; still the same information is present at it. The waybill is issued by the customer, handed over to the truck-driver, then to the traffic controller and to the final customer when the cargo is delivered. It then ends up at the table of the accountant at the cargo for accounting reasons. The waybill is an important document because the information about the cargo is printed on it and that it during the transport is annotated with notes. It is mediating both asynchronous and synchronous communication between for example customer and customer (what is delivered), customer and cargo contractor (billing), driver and customer (what is loaded and where will it be delivered) and driver and driver (what is loaded, and where is it loaded). The traffic controller uses it when planning for transports and when discussing orders with the driver.

4 The design—Melting-in and Waybill Interaction

4.1 Interact by using waybills

We have chosen to call the system that we have designed NaviMap, since it is a digital map with the purpose to support navigation. The design is based on what we have seen during the field studies, and the focus has been work. To have work as perspective is a bit different from making things smart or embedding computational power into existing things. The NaviMap is designed to be a part of the work activity, and to melt into the practice as well as it should stay obvious both in function and use.

Some observations at the field were directly converted to restrictions that we constructed for our design. For example was it obvious that the design should consider usage while driving, this with the safety aspects that follows. The driver seemed to be very aware about the surrounding traffic and the environment at the same time as they for example looked for an unknown delivery place (e.g. the Window example). We were also able to identify a difference in on-line and off-line usage of navigational aid, this lead to the possibility to bring the NaviMap outside the cabin. What perhaps was most important in our continued design work was to get an understanding of how the truck drivers work, and the things that are important for them. Examples of what we found out to be important for them is their high ambitions with road safety, the big role time plays in the daily work (opening and closing hours at delivery and pick-up places), and how the freshness of food change their route (they has to deliver everyday commodities before the local store opens in the morning), collaboration and planning.

The NaviMap navigation system that was the result of the design process within the project now consist of mock-up used for demonstrational purposes. The mock-up consists of a screen illustrating a digital map, and a barcode reader in which the waybill can be put in. We image the system to function in the following way: Grouped with the address at the waybill is a barcode containing the map coordinates (see fig. 2). One of the ways the NaviMap is programmed is by putting the waybill with the address barcode in front of the barcode reader. When the driver holds a waybill in front of the barcode reader (see fig. 3) the navigation system look the coordinates up and displays it as a dot.

Figure 2: An example of a barcode tagged waybill. The barcode (A) is grouped with the delivery address (B).

Figure 3: The waybill (A) is kept under the barcode reader (B). The destination is then programmed into the navigation system, that is then programmed. The destination shows at the digital map (C) as a dot.
green dot at the digital map. The idea for this way of interacting is borrowed from the Palette (Nelson et al. 1999), where paper cards are used to control an MS PowerPoint presentation, one card for each slide.

The Navimap is programmable all the time and is designed to support both the planning of the workday in the morning or during the day (off-line) and finding the next location when started driving towards it (on-line). This is an important point of the design of the system, and addresses directly the problem mentioned earlier in this paper. Based on our empirical findings we find it to be an important feature of the system that the driver can program it whenever he or she finds it helpful. A need to be guided to a location may not arise in the morning or when the truck is parked, but just as likely at the motorway, or at the narrow ‘no-where-to-stop-the-truck’ road. Another point is that finding the way from example the city of Karlskrona to Nättraby does not seem to be the problem. This is perhaps a well-known way for the driver. The challenge is to find the construction site, and an indication at the Navimap may be helpful to show that the delivery or pick-up place is not very far away, for example to the left in the next crossroad.

4.2 Paper interfaces

Paper interfaces have proven useful in other settings, for example story boarding (MacKay and Pagani 1994) and giving presentations using a paper interface connected to PowerPoint (Nelson et al.1999). Paper interfaces allows the interface to be spread out, paper can easily be carried around, manually sorted and put in folders. It supports that the interaction points are kept to the objects or, as in our case, kept to strong references to the object.

The use of waybills to program the navigational system reduces the complexity of the in-truck programming so that it is possible to program the system while driving (without hazard the safety on the road). This makes it possible for the driver to choose intentionally when he wants to use the system. This in relation to a system that would require to be programmed before the driver left in the morning. As Suchman points out, the analytic planning perspective does not work as the only model for how to interact with systems (Suchman 1987).

In our design the driver has to actively activate the system. This intentionally in the system is something that we think is very important. It would probably be possible to automate this with a smart tracking system, distinguish which waybill that currently was in use and let the system display the position it represents, but the benefit of this is small. The advantage of intentionally is control, and there is no reason to bother the driver with information that s/he does not need.

The design suggestion that we propose is an add-on to an existing system, something that makes the investment cost low. But designing an add-on has other advantages as well, all functionality that exists in traditional navigational system can be used as they are used today. It would be possible to have paper interface objects for this as well as for destinations, but we believe that it is a point in not having function cards. When there only is one paper way of interaction, the result should be obvious and easy to predict. The function (display the closest way between where I am and the place I want to go to) and the object (the delivery place) becomes one and the same in terms of interacting.

4.3 Work practice and the design

During the window example, the driver held the waybill on the steering wheel for about fifteen minutes until he arrived at the right address. He read out the road name aloud twice and he even spelled it out, all while driving. What we find interesting in the quotes of Joey that the driver references to the windows in his cargo when he is to decide whether it is the right construction site or not (see the quote 9.18.04, 9.20.33 and 9.22.50). When driving the truck Joey looks at the surroundings, the waybill, at the road and the traffic (see 9.18.44). We see that Joey tries to match the surroundings with the properties of the cargo, i.e. the windows, and then manages to turn down some alternative places as unlikely to be right. The surrounding comprises points of references, some of them mentioned by the colleague in the morning (e.g. the Sjuhalla landing stage and the bridge in Nättraby). When discussing the location in the morning he asks about the address at the waybill. The waybill in its current form is an important document is easy to bring to share with others.

The waybill never seemed to be in the way of anything the driver did, on the contrary, the waybill melted into the activity of driving and navigating on the up-and downhill narrow roads leading towards Sjuhalla. Worth mentioning is also that the driver did not pick up a map, when he looked for Sjuhalla. On other occasions we could observe drivers looking at maps (at information boards at breaking areas or at paper maps inside the cabin), often
carefully, but exclusively when the truck was parked. We look at this kind of planning as an off-line activity, compared to the use of landmarks and waybills during the drive as an on-line activity. The requirements of systems designed to support on-line navigation are different from the ones for off-line navigation. If something is done while driving it can not distract or occupy too much of the drivers attention.

4.4 Melt-in – an interaction design quality

In our study the waybill stood out as a very central artifact. This made us think about what the qualities of the waybill was, and as mentioned above there are several good things about this piece of paper. It does not interfere with the practice nor does it hinder it, it is simply very well suited for its purpose.

In a study of Air Traffic Control (ATC) work (MacKay et al.1998) researchers concluded that the flight-strip had good properties for that context, at the same time as they could see the benefits that computers could have in the ATC work. The profound solution presented was the augmentation of the flight-strips, the strips function in the same way as they did before, but now with the added quality of computational power.

In the NaviMap system we do not try to invent something that will replace the waybill, partly because we can’t come up with something that is better, partly because we have no reason to do so. The waybill plays the same role in the practice as before, but we have augmented it, in a way that it contains the address (in a way that computers can understand). This makes the programming, the input, to a navigation system easy to do while driving. The driver organizes the work in the same way as before, by sorting the waybills, and he is in control of his work, using the navigation system whenever he finds it suitable. The work practice stays the same, but gets added possibilities. This is what we think is a good way of new technology to Melt-into the work practice.

5 Navigation in Theory and Practice

In the pages that follow, however, I will argue that all activity, even the most analytic is fundamentally concrete and embodied (Suchman 1987 p. viii).

The quote above is from the book Plans and situated actions by Lucy Suchman, a book that starts out with a discussion about navigation (see Suchman 1987). According to Suchman a Trukese and a European navigator navigate in the same way, but describe their methods as very different. The European culture emphasizes an analytic approach to problems, an approach that makes us use plans to get where we want. One example from Suchman, which relates to the quote above, is the Canoe example. Suchman explains how a plan can be good for the activity of getting a canoe through a series of rapids:

The purpose of the plan in this case is not to get your canoe through the rapids, but rather to orient you in such a way that you can obtain the best possible position from which to use those embodied skills on which, in the final analysis, your success depend. (Suchman 1987 p. 52)

The truck drivers that we have studied have plans and they sometimes refine them on the way. A plan is a resource for handling the truck on the road. The drivers plan in advance which order to visit delivery places and thereby the way to drive. This planning, for example sorting up the waybills, looking at the cargo and at maps at the route and before leaving the cargo contractor, makes the driver aware of where to go. Trucks are not allowed (nor can they) drive everywhere. Some roads are too narrow, others are not dimensioned for the weight or, the height. That the drivers have to choose their route carefully can also be said to be a part of the navigation. Consider for a moment the navigation system we mentioned in the beginning of this paper. In the situation we described the driver of the passenger car tried to put in a destination when driving although it warned him not to. What we find interesting is that there in the design of that system seems to be an assumption that the driver always stops and looks where to go, and/or has a plan for exactly where to go ahead and then follows that plan. Suchman points out that plans are not controlling our actions, but serve as resources for it (Suchman 1987 p.49). Often the need of a navigation system can arise when you are arriving to a city and are looking for a special address and find that it was not where you supposed it would be. Or it can arise when the truck driver sees the delivery place at the map at the breaking area but can not figure out how to get there. The waybill represents the cargo, and if the driver knows where the cargo will go, then it also represents the delivery location. One of our points is that it would not be a good design of a navigation system for truck drivers to exclude any place and any time to program the destinations, because the need of the support is not always there but it can arise anytime. In the window example Joey needed no help in
getting to the church in the nearby village, but he might find it useful to have navigational aid for the few km thereafter. In other cases the opposite might be true. You recognize the place when you see it, but you need help to get that close.

6 Conclusion

What we have done is to design a system concept that might make our roads more secure and the work practice enhanced rather than changed. We have chosen to work with truck drivers in a shipping setting, but it does not seem undoable to design a similar system for passenger cars. Technically it is a small thing, but the big difference is in the interaction objects. Other objects that can be used for interaction with the navigation systems both in trucks and in other setting can be for example business cards, road maps with commercials for e.g. restaurants, hotels and petrol stations. We find that there is a need to investigate what can replace waybills in different settings.

As many times when introducing new artifacts in a work practice there are considerations to be made about how the work is carried out today. One of our concerns about a navigational aid is that the drivers today are aware about for example whom to ask about route advice and often have local knowledge about the area to visit. Finding for the driver an unknown delivery place can be said to be a social activity where experiences are exchanged, e.g. by telling stories. New technology may also add a pressure at the driver to find the way right away which may affect the local awareness. We have seen that the drivers often call their colleagues and ask for road descriptions. This informal communication can today be legitimate and other information can be added by the way.

The more general benefit of this paper is on an another level thus. We believe that there all too often is a gap between the work practice and interaction design, what is presented here is one attempt to exemplify the close relation between artifact and activity. It also aims to show that the qualities of work can be kept if you put your mind to it, in this paper we have used the term melt-in to describe this. This is only one way of many to bridge this gap, but we think that it is a good way. Earlier we have seen in the work done by Nelson et al. (Nelson et al. 1999) and work in the field of augmented reality (see for example (MacKay et al.1998) that add-ons often can create good conditions to work within, conditions that make the meeting between work and technology less obtrusive. Waybills have been around for a long time, while navigational systems are newly born. The waybills have grown in to the work that the truck drivers have and it has become a central part of it. To give the navigation system a fare chance to take a place beside the waybill as an artifact, you have to give it a little help. We are convinced that a navigation system that is designed in a good way can be of great benefit for the truck drivers, and when we ask them they agree. But the fact remains, they can do their work without it, they do it today. Complex programming and/or programming that inflicts the security or occupies their attention and valuable time are things that might make the drivers not use a navigation system that otherwise has good qualities. With this we want to show that it is possible that with simple means make the difference between a bad and a good system. The concept of artifacts melting in to work activities, is one approach that we find useful, and are convinced would be applicable in other domains.

References


