Introducing the “Safety and Context” Workshop

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Abstract. The “Safety and Context” Workshop papers are about data, models and theories about safety in real life situations and the methodological problem of taking context into account. Introducing the workshop, is a tentative to define the needs in term of methodology and in terms of modelization, but first in terms of lists of variables that can describe the contextual components of context when how to improve Safety is the task at hand.

1. Introduction: the need of contextual models for safety

Since many years, an important interest was carried out to research finalized on safety, in the various fields where abnormal operations occur, involving more or less serious damages and an important mortality. This is the case with professional risky tasks, with domestic tasks which give place also to accidents and, obviously, with the tasks of driving vehicles in road traffic. Research on safety, namely how to avoid incidents and accidents, is more and more an approach which is interested in the response of the individual to her environment, as well as her dynamic adaptation, but also an ecological approach [1]

Predicting the response of an individual in order to improve her security and predicting how this person will be adapting to it, require behavioral models which are more and more data-processing models which allow simulation. To have an ecological approach supposes in addition models that are able to integrate the context, i.e. the particular conditions which make each execution of a task, an execution different from all the others.

The Context 05 workshop is the meeting of researchers interested in the topic of integrating the contextual variation of situations in research about safety. Although it is obviously difficult to predict what was unexpected, one can envisage the variations of values of variables that constitute the description of a situation and the effects on safety. And if too hard, we might have at least models which allow, a posteriori, but for the future, the integration of values and of variables of the context which prove to have effects.

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2. Systems and Models

If we name “human made system (S)” a whole made of parts acting on each-other in order to provide some kind of results, the user (U) the person that makes the system functioning, alone or in interaction with other users, then every systems, although rudimentary, have an internal model of the user (or of the users) that we name (u)S (the system’s model of the user). For instance a keyboard is related with fingers, one can see if a software is made for children or for adults, the sign “turn left” indicates that drivers can understand its meaning, and so on. On the other side, users do have an internal model about how the system functions in order to use it, that we name (s)U. It follows that a safe interaction between an user and a system requires that (u)S being safely compatible with U and (s)U being safely compatible with S. Finally with technical development, auto-regulative systems are smart assistant systems that comprehend ((s)u)S), integrating the model of the system the user has in order to modify it [2, 3, 4].

Auto-regulative situations of interaction between a system and its user are situations for which the system adapt s itself to the user and for which the user adapts itself to the system [5]. In that situation, the whole system integrates the user (or the users) as parts of the system in order to provide regulation as a one of the results.

Note that very simple systems can be auto-regulative systems. For instance, red lights can turn green with the presence of cars and red when detecting pedestrians. Drivers can adapt their behavior to form groups of car with the preceding cars (they will have the green light provided by the presence of the first car). The risky increase of speed can be avoided by making the light red for too rapid cars. The drivers can, in turn, find the speed that is both safe and providing the best probably of having the green light.

As a matter of fact, sophisticated auto-regulative systems are more and more context sensitive just because they are more and more context dependent. In the green light example, special cars for handicapped people might never find the green light if not detected as cars. This is the reason why internal model of the user has to be explicit, with specific formalism, and has to be adaptable to the changing context.

We shall first discuss inadequate matching between the functioning of the system and the user (work of Ghislaine Doniol-Shaw and Robin Foot), an explicit model of task realization integrating the context with contextual graphs formalism (Bazire et al), a research strategy that consists in comparisons between contextual variations (Sophie Midenet), an approach that integrate many systems when you deal with a complex system (Andry Rakotonirainy), an approach of different systems that has to be regulated, pedestrians and drivers, (Jacques Bergeron), an approach for many kinds of systems as those you can find at home (Pravin Shetty and Seng Wai Loke). As the research domain increases, becoming more and more complex, the challenging problem of taking the context into account become more and more difficult.

3. S-Functional Model, U-User Model

Electronic Systems are working for us. We use systems because it is more economic, more safe, or more rapid, or more something than not using them. Whatever the advantages are, there are some advantages of using a system, or more precisely a device. What the system is doing can be a part of our job or the whole of the job. Thus, it is important to know how much using a system satisfies the user. In other words if U agrees the work S is doing. Ghislaine Doniol-Shaw and Robin Foot report data about bus drivers that have to use a optical guidance system: vehicle direction is controlled by the route by a marked line on the pavement that is identified by an on-board camera mounted on the bus. When this optical guidance has been activated, the bus driving is like driving a tramway.

The bus drivers should find some advantages to such a system that guarantees, in addition of having less to do, a perfects stop for passengers at the platform station. However the system requires a lot of attention given that the guidance can stop at any times (due to a lack of optical data: when the marked lines are masked), when there is some obstruction on the road, so manual guidance is to be selected for detours, - detour that become very difficult to undertake if planed too late-. There is also a lack of confidence in the system about pedestrian passengers that could be standing between the platform and the bus position. Finally, facing the passengers, the drivers act as if they were driving. In summary, the system provides a "level of stress to the driving task" due to the necessity of switching from an automatic drive to a controlled drive at any time.

Note that being ready to switch at any time comes from contextual uncertainty and from drivers knowledge and confidence about how much the system can have by itself the right response in a risky situation, (s)U. Note also what could be (u)S, the model the system implicitly comprehends: something like " I can drive and park the bus for you. Doing so, you might be performing other tasks such as taking care the passengers, and so on". The system does not integrate the fact that the driver is lacking confidence and has an additional amount of attention to give when he or her is surveying the controlled drive. Having a better (s)U should improve the use of the guidance system by bus drivers. As the authors say: "*driver preference as regards conduct in the bus depends mostly on the need to ensure ongoing control of the vehicle, but could also reflect the discomfort felt from the lack of utility their hands provide and from the image of shirking work duties that this conjures, as the movement of their feet on the acceleration and brake pedals goes unperceived by transit patrons and even more invisible to those outside the moving bus*". This is a User's feeling (U) of that has to be integrated in (u)S.

4. How to get adequate models of the user?

How to proceed in the design of a device in order to make it adequate for users? A first step is to have a model of the user or to measure how the device is used. These are two approaches, tackled respectively in the two following presentations, are both related to automobile infringements of conductors to indication, a behavior that causes many road accidents: M.Bazire and her colleagues analyze the interpretation of iconic indication and propose a user modeling in the form of a contextual graphs in order to describe how people understand road signs and S. Midenet measures and compares two modes of red lights regulation according to their incidence on safety.

Regarding the high rate of driver transgressions of the Highway Code, M. Bazire consider that there is a gap between the prescribed task (the way the system is supposed to be used by the user, very often (u)S) and the effective task realization (the way people actually use the system, which is U) which comprehends non-respect of the road safety laws. Data show for instance that the more people drive, the less people are able to recall the meaning of road signs. Then, she hypothesizes that acquiring expertise in driving means taking the whole driving situation into account. As a consequence, the context of the task at hand then becomes more important than the formal meaning of a road sign. She proposes the use of contextual graphs to represent the different possible actions regarding the different contexts in which the driver is involved. It appears then that the driving task can be assimilated to a contextualization of the Highway Code prescribed procedures.

The methodology adopted by S. Midenet is somewhat different. By taking directly into account the contextual data collected from a multi-camera system that automatically detects red-light running occurrences, she proceeds to comparisons of situations, putting in evidence the strategy of red lights control which is the most favorable to the traffic flow safety given the environmental context. In section 1 of this introduction, we focused on the necessity to have the knowledge of variables that prove to have effects. This is precisely the goal of S. Midenet work that is to find out new parameters that impact on red-running phenomena and the interrelations between contextual factors and red-running occurrences. As she says, her work is done "*to discover new knowledge and rules that could be used for the design of innovative control strategies like real-time adaptive strategies, in order to improve the impact on traffic signal compliance*."

We think that this kind of work could be facilitated if we could have some theories of what the context of a situation is made of? For instance S. Midenet find that "*if the driver could anticipate some benefits for the next steps, the driver would probably be more likely to clear the red line*". This is related to planning further issues. Results from anticipation and planning are the kind of contextual data that could be of importance for safety, although not being in the current situation. We need a list of such contextual variables both for analyzing human-system interaction and to be implemented in our models of U.

5. Safety and context between systems

Although, having variables and models for a single system is a hard job, research deals very often, with many systems that enter in interaction. Think, for example, to the situation in which your bathtub fills of water while being likely to overflow while your chicken cooked with the furnace is likely to burn! This is however a simple case because a same user is facing two systems. Harder is the case in which different users interact within a same system, or with different systems that interact.

For instance, we have seen that the vehicle guidance is one system, the set of road signs is another system, a third system could be the vehicle itself. All of them is another complex system. A. Rakotonirainy considers the driver, vehicle and environment as a whole and focus on the principles that underlie the system in order to model it with the view of understanding, predicting and improving driver behavior. He lists a wide range of factors in space and time. Factors include goals, distraction, errors, expectancies, workload, attention, traffic, vehicle safety features, automaticity, fatigue, memory, capabilities, training and experience. There exists theories of complex systems and the work of Rakotonirainy is about the driving system as such a complex system that needs to be modeled using Bayesian networks as a context-aware system from which emerges the driving behavior.

Rakotonirainy defines a complex system "*as a system in which the number of states that can be anticipated or understood can not be accurately identified or enumerated. A complex system consists of dependent components or sub-systems. Components exhibit inter-relationships and interdependence. Some behaviors or patterns emerge from a complex system as a result of the patterns of relationship between its components. The emerging behavior cannot be identified or deduced by observing individual components of the system. Complex systems research seek to understand (i) how a large number of factors of different types are combined and (ii) how components influence each other to collectively produce an aggregated phenomenon (emergence)*". Bayesian networks are used to evaluate the probability of a certain behavior to occur. As a result, the study of a set of individual driving behaviors as a complex system could reveal common characteristics among different drivers and will allow a greater understanding of this complexity. Here again, we get an approach that has the goal of collecting by discovery, not only the set of adequate variables, but the set of variables interactions that can affect safety. Note that the mathematical modeling with probability is a way of avoiding the collection of a number of data. On the other side, one needs to know what kind of contextual variables is to be considered.

Another kind of complex interactive system is the one that share Pedestrians and car drivers. Note for instance that a driver should have a (s(up))U, which means that the driver U should have the model (s) that the pedestrian (up) has of the system. For instance, if a child is going to cross the street, the driver could infer that the child is likely to not be paying too much attention to the red light.

The paper of J. Bergeron and J-P Thouez is about conflicts between pedestrians and drivers. What is of importance, is that the authors collected some 14 000 observations on ten selected intersections in each of the two larger Canadian cities, Montreal and Toronto, Canada. Maybe this is the kind of number of observations we need, if we want to take into account the variety of contextual elements. For instance, accidents could be rare, although too numerous, because the co-occurrence of contextual elements that could produce these accidents are themselves rare. Note also that adding variables and values of variables multiplies the number of observations that is required. The variables the authors were using are for the driver: head movement of drivers, direction they look in, visual contact, hand gestures (as a signal toward a pedestrian who is within one's visual range), vehicle speed modifications (acceleration, braking, stopping), steering wheel movements in the presence of a pedestrian, etc. Pedestrians' behavior included movements of the head, direction one looks in, visual contact with a driver, hand gestures (as a sign to a driver), modifications of movement (stopping, walking faster, turning back) as related to the presence of a car, a small truck or any kind of heavy vehicle, time needed to cross the intersection, etc. Weather conditions, the times of day and the traffic density have also been kept in consideration.

Here again, some variables are contextual variables such as traffic density, both for pedestrians and drivers. Although, we model individual user, social interaction could be a provider of decision-making. For instance, pedestrians following other pedestrians could fit their behavior to the pedestrians they follow: "*if they cross the street, thus the light is red, or the crossing is safe*". The authors also report that "*Most important of all is the cognitive comprehension by drivers and pedestrians of norms, standards and penalty application prevailing in each geographical context*". This is again the kind of contextual variable that could be listed for improving research on context effects on safety.

Finally, note that a same system interacting with different users should comprehend the model of each: (up, ud)S, which means that the system has the model of pedestrian (up) and the model of drivers (ud). This is insufficient since the system must coordinate the two models. Thus, the right model has to integrate Up/Ud coordination: (up ⇔ud)S.

6. Safety and context between multi-systems

Finally, the most complex situation is the situation in which many users interact with many systems. This is the kind of problems encountered with domotics: at home each member of the family interacts more or less with each of the systems, and the members of the family can form groups that interact between them as well as with group of systems: for instance, "children that operate the stove in the company of adults". This example given by P. Shetty and S. W. Loke is the kind of complex interactions one can find at home. It is also an example that indicates the kind of context-aware system we need since for instance that "children may not operate the stove *unless* in the company of adults". Another important topic addressed by Pravin Shetty and Seng Wai Loke is about security (for machines) and safety (for humans). Security could be one of dimensional dimension of context for safety. For instance, it may be that people's safety in the road traffic, avoiding damages for people, is better solved when taking into account cars security. This is not to say that drivers might have cars in good shape, but to say that avoiding damages for cars is perhaps a good way of avoiding damages for people.

A multi devices and users complex system needs some sort of supervision that will take care of both people and devices. The supervisor in turn needs some kind of internal representations of its components and a structure that facilitates safe decision-making. As did M. Bazire and her colleagues, P. Shetty and S. W. Loke propose a formalism based on contextual graphs and a hierarchical structure : "*an enclosed ambient environment would typically contain numerous subambients as well as active processes, agents and information resources. … . Ambients and processes which are at the higher level of the nested structure are responsible for managing resources which are more vital and important than those which are at lower level*". Although about authentication, the shetty and loke approach is appealing for safety in general since safety can be hierarchically managed with priorities. This is of importance. Suppose that we finally get a list of all of the contextual variables. So, we could use them to anticipate their effects, and if associated with safety deficiency, we could try to correct or attenuate the damages. Unfortunately, it could be that the hierarchy of contextual variables is also a contextual variable. If so, then we need to understand the causes of hierarchical changes. It could be that the causes are themselves determined by the context. The consequence would be that the hierarchical changes of contextual variables have to be modeled for each study.

7. Conclusion about the necessity to build explicit context-based models for Safety

The "Safety and Context" Workshop papers are about data, models and theories about safety in real life situations and the methodological problem of taking context into account. We have successively seen the relation between the functional model and the User model and their compatibility, the question of how to get adequate models of the user, Safety and context between systems, and finally, the relation Safety and context between multi-systems.

In the framework of Context 05, the International Congress, these topics could find further development if we pay attention to solutions other researchers find when attempting to simulate contextual effects in their domain. But from now, we already get some insights for making progress for safety, taking seriously context into account.

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