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▶ **To cite this version:**

Sylvain Mondon, Anne Marchais-Roubelat. Decision processes in action at sea, a methodological challenge for real world research. Bi-annual International Conference on Naturalistic Decision Making NDM13, Jun 2017, Bath, United Kingdom. hal-02334576

HAL Id: hal-02334576
https://cnam.hal.science/hal-02334576

Submitted on 26 Oct 2019

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Decision processes in action at sea, a methodological challenge for real world research

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ABSTRACT
Relationships between decision process and action in real world conditions emerge as a key issue in elite sport as well as in organization studies. When pressure is high and environment is evolving rapidly, acting despite a limited situation awareness is common. In such stressed situations, the observation of phenomenon raises methodological difficulties such as the access to information and its validation with regard both to the decision-making process of the decision-maker and concurrently to the course of action. Studying in real time decision processes of a professional skipper at work during an ocean yacht race from the viewpoint of the router embedded in the skipper's team provides an opportunity to go forward in understanding relationships between decision processes and action in real world when phase shifts occur. The methodological choices are discussed and research directions for further real world researches are proposed.

KEYWORDS
Decision Making, Earth and Atmospheric Sciences, Uncertainty Management, Team and Organizational Factors in Complex Cognitive Work, Elite Sport.

INTRODUCTION
Relationship between decision processes and action in real world conditions emerge as a key issue in elite sport (Macquet & Kragba, 2015) as well as in organization studies (Marchais-Roubelat, 2012; McAndrew & Gore, 2015). During past decades laboratory approaches showed a variety of human behaviours and preferences in controlled experiments (Kahneman, 2003). Even if laboratory experiments can be very sophisticated as the one described by Brandt, Lachter, Battiste and Johnson for pilots (2015), some dimensions can't be replicated accurately enough to stand for real world. The full complexity of real world action involving multiple goals, time stress, uncertainty management, complex task is still not fully achievable in laboratory (Kahneman & Klein, 2009). In order to better understand relationships between decision processes and action, it is essential from our viewpoint, not to postulate anything about the relationship itself. Thus, we should be careful to incorporate no tacit premise in our approach. Especially, the framing of the research should not influence the way either decision processes or action are considered. A promising way to gain significant insights about relationships between decision processes and action is to work on real world by means of real time observation. Our guess is that stressed situations are likely to emphasise the relationships between decision processes and action because high time stress prevents from delaying acts. In such a stressed situation, it is common to act with limited situation awareness as shown by Klein, Orasanu, Calderwood and Zsambok (1993). The focus on real world practitioners adopted here meets the one promoted by naturalistic decision making (NDM) community for nearly 30 years (Gore, Flin, Stanton & Wong, 2015). We have chosen a field relevant for both elite sport and organizational science: the action of skipper during ocean yacht race. It has been chosen because it consists of an organisation (skipper and his or her team) involved in an action where decisions must be made and implemented to handle the boat and manage its trajectory. So we can assume that during the race few decisions should be made in a given period of time. Our intention is to develop a fitted methodology to perform an inquiry in the field of yacht race in real time in order to better understand relationship between decision processes and action at sea with a view to improve training to get better performance. Gore *et al.* (2015) recalled that the area of elite sport is being investigated only for few years. So, our approach represents also an opportunity to explore a new field, highly compatible with NDM requirements, which could provide new "concrete examples from a specific profession" as recommended by Klein (2015). Even if "methodological advances in accessing expertise have gained respect and validity", NDM practitioners "recognize that the frameworks, models, and methods" used "have their limitations" (Gore *et al.*, 2015). So, as we faced similar limitations, the developments proposed hereafter may be relevant for NDM practitioners. The methodological difficulties enhanced by NDM researchers are first highlighted when exploring the field in the context of action. Then, we discuss the design of a collaborative partnership for such a research during an ocean race, in terms of research embedment and of research methodological issues. First results and preliminary analysis are exposed. Finally, expected further outcomes are discussed and leads for further real world researches are proposed.

METHODOLOGICAL CHALLENGE OF ACCESS TO INFORMATION: ISSUES FOR OCEAN YACHT RACE DECISION AND ACTION PROCESSES

Developing a method aiming at performing a kind of "cognitive task analysis" (Crandall, Klein & Hoffman, 2006) to elicit knowledge and analyse data in order to represent "real world" relationships between decision processes and action in the field of ocean yacht race raises several methodological difficulties. Those methodological difficulties form the challenge of accessing relevant information on a convenient way. This challenge is composed of several difficulties of different levels: duration, distance, acceptability, stakes and diversity of sources. Most of them have been dealt for other fields by NDM community in earliest studies for outdoors operations (Klein *et al.*, 1993; Zsambok & Klein, 1997), for elite sport (Macquet, 2010, Macquet, Ferrand & Stanton, 2015) and for mountain expeditions (Allard-Poesi & Giordano, 2015).

Duration and phases of the action

Ocean yacht races usually last several days. Even if we expect some decision to be made in this period of time, the exact time of occurring can't be presumed. So the study must cover at least the entire period of the race not to miss any important phenomenon. Except in the case of mountaineering (Allard-Poesi & Giordano, 2015), most of the elite sports already studied by NDM practitioners were focused only on a short period of time. Furthermore, the sailors are 24h a day at work. Time is a key issue in organization (Orlikowski & Yates, 2002) as well as for elite athletes in managing competing activities (Macquet & Skalej, 2015). Sailors must dedicate their time to competing tasks like tuning, steering, computing route, analysing situation, observing environment, communication to media, checking the boat, repairing broken pieces or sleeping. The researchers must be ready to capture phenomenon which can occur at any time during any activity (Klein *et al.*, 1993). Because of its duration, ocean race as an action process includes many decisions, which can be connected with different phases of the race. As a result, the connection between these decisions and phase shifts in the action appear key issues for research in the field.

Distance to the action

In the case of sailing across an ocean, the size of natural field is only limited by continents and islands. Keeping a continuous access to action wherever the boat is, is a difficulty as soon as the boat leaves the dock. The idea to shorten distance between action and researcher is a leading idea in the earliest studies developed by NDM community about fireground commanders (Klein *et al.*, 1993). The issue is to be as close as possible to the action where decision are supposed to be made in order to get relevant information for subsequent analysis and interviews by performing direct observation in real time if possible. When the distance becomes a problem, means of communication may compensate it as exposed by Orasanu and Fisher (1997) in the field of spaceship crew and by Allard-Poesi and Giordano (2015) in the field of mountaineering. Those studies both show that means of communication (emails and phone calls) are essential to keep researchers in touch with practitioners when they can't be at the same place. During an ocean race, although information technology shortens the distance between the sailor and his or her team, the skipper has a full autonomy of decision to influence the course of the action.

Awareness of what is at stake

The professional skippers of the biggest modern yachts crossing ocean and rounding the world are very experienced sailors. They are considered as experts by others in the sense given by Klein (Klein, 1998). In such a technical complex field, being aware of what is at stake for the expert is a difficulty for the researcher. This is all the more critical when action is going on because direct interview can't be dedicated to long explanation. The researcher faces also the difficulty of knowing what are the meaningful cues to be noticed and how to seize them. The issue of understanding what is at stake is an essential point to get and validate information and to avoid later misinterpretation (Klein *et al.*, 1993). For ocean race, four main domains of interest can be identified to define what is at stake: boat handling, weather conditions, information and telecommunication systems, competition evolution.

Distributed situation awareness

During yacht race, information can be collected from a lot of different sources. Each source provides data from specific viewpoint useful to document at least one side of the action. Describing the side of the environment can be done by quantitative data as well as by qualitative data. Quantitative raw data can be provided by measurements (onboard sensors, remote sensing, buoy, weather stations) or by model analysis (national weather services). Qualitative data can be provided by weather bulletin, comprehension of the router, perception of skippers. Describing what is happening in term of action at race level can be informed by general trajectories of the whole fleet provided by race organizer, by detailed trajectory of a given boat provided by one team and by high frequency onboard monitoring of the route. These quantitative data sets can be completed by qualitative statements and comments from individuals or organizations (ex. press release). Taking into consideration "both human and technical agents as well as the way they interact" is the basis of distributed situation awareness (DSA) described by Stanton (Stanton, 2016). DSA is a critical issue for the athletes and coaches (Macquet & Stanton, 2014) and also for researcher analysis (Macquet, 2013; Macquet *et al.*, 2015). In ocean race, data

provide a double perspective. On the one hand, data serve as a decision support system to help the sailor to make decisions to create new phases in the action processes. On the other hand, data are benchmarks for researchers to assess the decision process and action.

Acceptability of the research

Another crucial point for researcher interested in "real world" is to make the research acceptable for the field he or she would like to study. To that respect, the first point to deal with is to get an agreement in principle from a skipper to be studied at work in the course of action during a yacht race. As previously recalled time management is a critical point for skipper, the researcher position can't be too much intrusive. The difficulty for the researcher is to propose a research design light enough to be agreeable to the skipper and deep enough to enable fruitful inquiry: a balanced position must be negotiated. The purpose of the researcher is to have an access to relevant information in a transparent manner without significantly disturbing the way action is taking place.

DESIGNING A COLLABORATIVE PARTNERSHIP: PROCESS AND DISCUSSION

The research project intends to better understand the relationship between decision processes and action during ocean yacht race run by experienced sailors skipping multihull boats. Thanks to an 11 years experience in advising skippers between 2000 and 2011 in weather forecasting and routing, one of the two researchers involved in the project has a privileged access to the field. An agreement in principle has been given by one racing team to open the doors to a research project over several years. Since this point of departure in 2012, we have been progressively working out a convenient methodology to keep cautiously mutual trust and information exchange. We are presenting important issues encountered between 2012 and 2016 when the approach has been developed along with preparation, training and races ("Route du Rhum 2014" and "Transat Jacques Vabre 2015"). Then the focus is put on the next race "Transat Jacques Vabre 2017" for which we intend to implement an intensive observing period to highlight specific settings.

Embedded research

Even necessary, agreement in principle is not sufficient to perform an in depth inquiry. To our comprehension from preliminary discussions, the key issue is that the research has to be not only acceptable, but also promising enough for the skipper to sound useful in one way or another for short and long term. The time spent for the research from the viewpoint of the skipper is seen as a long term investment with regard to the expected outcome of the research. The second step is then to assess different possible positions for the researchers to do proper in depth research in a transparent manner and a convenient way for the team. Considering short term, the researchers and skipper acknowledged that the main challenge is to compensate in one way or another the fact that the sailors or team could spend time by discussing with researchers instead of paying attention only to they work in the course of action. Thus the deal concluded to that respect is that the researcher who is skilled in weather forecasting and routing can have a full access of the work of the team in real time in the condition that his or her skills can benefit to the team if he or she detects an occasion to do so. It is a kind of short term investment. The skipper expects that the skills of this researcher can save time to handle situation and complement distributed situation awareness. By doing this, the researcher is accepted as a special team member. Let's notice these short term as well as long term investments have no guaranty of success, they both are risky gambles for the skipper and for the researcher. Thanks to such a unique opportunity to be part of team, the research project is designed with one embedded researcher only whereas the second one keeps a distant outside viewpoint of the field and focuses on methodology and analysis, from common theoretical bases. The insider position is then balanced with the outsider one to reduce as much as possible biases in data collection as well as in subsequent analysis.

Time and ethics

Being inside a team is likely to have an influence on the action management. So there is a significant risk of disturbance and change in the focus of the sailors that has to be taken into account by the researcher. To that respect, our intention is to cover different stages of the preparation of the race by a compatible research activity so as to benefit each opportunity to learn more about the field and the skipper as well as to build trust all along the research project. It seems to us that the skipper should start the race (and we should start our intensive observation as well) with a mind free to focus entirely and deeply to his work (and we should do it as well). Furthermore, we would not accept a situation where our research is responsible for even the smallest trouble in the mind of the skipper. All discussions prior to the race must avoid to induce discomfort neither for the skipper nor for his or her team. This point is essential to our approach in order to neither influence the way of thinking nor the way of doing things of practitioners. This revealed to be crucial to create condition of acceptability of the research. To avoid any trouble four commitments have been made. The first commitment is to assure that the researchers behaviour will be as low profile as possible. The second commitment is to share the results with the sailors, as soon as they are robust enough. The third commitment is not to communicate personal information publicly and not to convey any information to other teams. The forth commitment is to mention any information in case it could be relevant for the race to the skipper, the router or the technical team.

Capacity and awareness

We have been implementing different tools and methods since 2013, bearing in mind the advice of Crandall *et al*. (2006, p. 143) by "understanding the way people think and reason in natural contexts, cognitive task analysis practitioners are more likely to recognise important aspects of cognition when they encounter them". Our method provided us a training of about four years in the field by observing action, interviewing practitioners, data collecting and analysis of events. We progressively developed a deeper understanding of stakes, multiple goals by discussion and interview, direct observation on board and in the shipyard. By doing this we validated the usefulness of the method and tools for the field and built continuously a trustworthy climate for collaboration. We now significantly better understand what's happening, what is at stake and the research is accepted by the skipper, the team and the sponsor. The researcher in reflexive position inside a team shares shemata and common knowledge of the team (Lipshitz & Ben Shaul, 1997) and is sensitized to collective mind (Weick & Roberts, 1993).

Intensive observing period

We intend to implement an intensive observing period for the next east to west double handed transatlantic involving "Classe Ultime" yachts (Trimarans longer than 60 feet) due to start from Le Havre (Normandie, France) in October 2017 to Salvador de Bahia (Brazil). As routing is allowed in race rules, co-skippers are going to work with a router to define and adjust race strategy. To be as close as possible to the practitioners without interfering in the race process, one researcher is shadowing the router. In this position the researcher will have real time access to all technical information. Furthermore, he or she will be able to hear and record discussions between skipper and router during the race and days before start. He or she also will be able to interview router as often as needed in the course of action and at times he may have an access to direct discussion with skipper to clarify point as well as with sponsor, technical team and communication agency. As the route of the race crosses Atlantic Ocean starting at mid latitudes and finishing in the tropics of southern hemisphere (Brazil) the sailors are facing typical navigation problems. Indeed, they must sail at first in the westerly flow of mid latitudes then find a way to catch the northeasterly trade winds of northern hemisphere. Then they must cross the doldrums and catch the trade the southeasterly trade winds of southeast hemisphere, which creates phase changes. As several weather systems are encountered, a proper management of the transition from the influence area of one to the influence area of the next one is a crucial issue. So not only decision are to be made, but important decisions are to be made at least at those major transitions.

Dynamic and complex field

Modern multihull yachts of "Classe Ultime" are the fastest sailing boats (speed are faster than 40 knots) having a race across ocean. In that case, those boats can move faster than most of usual weather systems on the one hand and can sail twice faster as the wind speed in particular conditions. Taking this into account, the sailing area is very large because an extra distance can be more than compensated by a small increase in wind speed or a better angle in wind direction. As biggest and fastest boat, "Classe Ultime" yachts are the one which are concentrating interest of media and investment of sponsors. The teams are composed of highly skilled workers, the crew are composed of experienced professional skippers and sailors. Skippers have to manage budget, boat, team, crew, innovation and are used to make decisions in stressed and uncertain situation at sea. Situation is dynamic because of three reasons: natural conditions (both atmosphere and ocean) are evolving in a continuous way, the boat is moving along its trajectory on its own pace, and rivals are sailing their way too. These yachts require high skill to be skipped properly. All the skippers of "Classe Ultime" trimaran have been sailing multihul for at least 10 years and up to 20 years for most of them. As an example, in particular conditions, the difference between high performance and danger for life (capsize) is less than 20 centimetres along a rope or less than 5 degrees of the true wind angle. The racing team is managed by one of the most experienced skipper (Lionel Lemonchois). He has been sailing for more than 35 years. During the last 15 years the sailor broke more than 10 world records in trans-oceanic route or round the world non-stop on big catamarans and trimarans. He is considered as one of the most experienced multihull skippers by others.

RESULTS AND PRELIMINARY ANALYSIS

Along the development of methodological framework, different embedded observations have been performed during last 4 years. Action based observation and preliminary analysis showed that phase shifts are important issues in the relationship between decision processes and action. Preliminary analysis is based on 3 cases involving the same skipper: crew training (2 days onboard and workplace observations), single handed transatlantic race (10 days observation inside the shoreteam in a routerlike position), double handed transatlantic race (10 days observation inside the shoreteam shadowing the router). Decision processes in those cases are performed in stressed situations especially high for the two race cases. From the analysis at the level of the action focused on the boat considered as an organization, we can assume that the way action is going on is governed by rules. Those rules depend either on the environment only (ex. weather, overarching action, side action), or on the organization only (ex. boat capacity, crew skills, team behaviour, expected goal), or on an interaction between environment and the organization (ex. the way low pressure is pulling a sail to create

aerodynamic power, interaction between skipper and race organizer). A shift in phase occur when at least one rule is modified for a significant period of time according to length of action. If it seems quite easy to identify and describe one phase or another, the shift between them is much more complicated than it could be inferred at first guess. Embedded observations showed that a phase shift can spend quite a long time. Influence of a given rule can decrease gradually whereas another one is increasing. The influence of a given rule can fluctuate in a general trend of decrease or increase. It has been noticed that all along a transition period between two well settled phases, there is a gap in analysis of relation between action and decision if the influence of changing rules (emerging or disappearing) is not taken into account. Our guess is that such an approach focused on transition periods may benefit, not only to NDM practitioners, but also to organizations for performance improvement.

CONCLUSION AND RESEARCH DIRECTIONS

As skippers are convinced that human factor can make a difference in yacht race there is an opportunity to design a research project to study this field to better understand relationship between decision processes and action in "real world" to improve performance. Thanks to a specific skill held by one researcher in an important domain for the performance of the action, it has been possible to enter the field with mutual trust and respect. Considering longer term than a single race, skippers rely on researchers also to help them to improve their performance for next stages of their career. In terms of acceptability of the research as well as in terms of capacity building of the researcher, it appears to be all the more important for the researcher to be involved in the team as early as possible. Discussion showed that to be accepted by the team the researcher activity must not interfere the course of action and not modify the way of thinking of skippers during the race. The researchers are expected not to disturb the organisation even if the only fact that a research is performed can have an impact on the team behaviour at work. The design of intensive observing period lasted four years because of cautious step by step working out to find the deepest acceptable way to do research in embedded but not intrusive position.

The first outcome we were expecting was to show that the original position of the researcher can provide valuable information unreachable otherwise. Second, we expect to identify pieces of information that can lead to better understand relationships between decision processes and the changes occurring in the action process. We are also expecting to show how rich a qualitative empirical analysis of real world action can be when conducted in such dynamic context documented by very different sources of information.

Finally, we are expecting to identify tracks to follow to better understand how expert sailors are thinking at sea and how they can improve their ability to make a difference in real time. As our approach is relevant to macrocognition (Klein, Hoffman & Militello, 2016) expected outcomes may lead to refine NDM frameworks and applications in a multidisciplinary effort according to the views expressed by Mosier and Militello (2016). Complementary research involving embedded position in other fields could be developed. The proposal is to do more researches as an insider to identify small scale processes in real time as close as possible of the action in the real world. The way we conduct our research project could be implemented in other organizational contexts in order to look for similarities or differences in the relationship between decision processes and action. A comparison of knowledge elicitation in real world studies by the method proposed here and by other methods like ethnomethodology, action research or process studies could identify methodological advantages of each for a better understanding of the relationship between decision processes and action in different uncertain contexts where phase shifts occur. Finally, for each step forward it would be interesting to confront the fields results to existing decision making models.

ACKNOWLEDGMENTS

We gracefully thank sailors, teams and sponsors for their collaboration and the time they dedicated to our work.

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