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Autonomous driving: an exploratory investigation on public perception

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Abstract

The automotive sector is constantly evolving, self driving cars are the result of a complex design that adopts a good variety of devices and sensors that capture information from the external environment which is then transmitted to an internal computer, in order to guarantee the vehicle efficiency, safety, stability. This text aims to present itself as an overview of the world of self-driving cars, glancing at my research project and focusing attention on the quantitative research conducted by me to test the level of knowledge of concepts such as robotaxis, automation, autonomous driving.

Keywords: Autonomous driving - Automotive sector - Research project - Public perception - Exploratory investigation - Automation - Robotaxis - Research design.

1. The automotive sector.

The automotive sector is constantly evolving. Self-driving cars are the result of a complex design that adopts a good variety of devices and sensors[1] that collect information from the external environment and then transmitted to an internal computer, in order to guarantee the vehicle efficiency, safety, stability[2]. In accordance with the meaning that we find in the most common dictionaries (eg Treccani), the term autonomous refers to the ability and the faculty to govern or stand up for oneself. The National Highway Traffic Safety Administration (NHTSA), or the US government agency for road safety, outlines a rather precise definition of autonomous car, noting that it is "a vehicle whose operation occurs without direct intervention by the driver to control steering, acceleration and braking and that it is designed in such a way that he does not expect to constantly check the road when the automatic mode is running[3]. In accordance with the above, it would be the vehicle's ability to detect external information with techniques such as Radar, Lidar, Gps etc., in a hybridization between these components and the advanced control systems on board the car, to allow the achievement of a certain degree of autonomy regarding the paths to follow and any obstacles and signals to be monitored.

[1] AI Cesarano, 'Empirical methodologies for the design of innovative autonomous driving solutions' (2020) EJPLT European Journal of Privacy Law & Technologies Giappichelli editore Issue 2020/1- 2020. http://www.ejplt.tatodpr.eu/Article/Archive/index_html?ida=190&idn=6&idi=-1&idu=-1

[2] AI Cesarano, *Autonomous driving: un'indagine esplorativa sulla percezione pubblica* Between science & Society Italian Institute for the future 2020.

[3] BC Zanchin, R Adamshuk, MM.Santos, KS Collazos, 'On the instrumentation and classification of autonomous cars', IEEE International Conference on Systems, Man, and Cybernetics, novembre 2017.

2. Autonomous driving as a beneficial application of AI.

Autonomous driving is a fruitful application of Artificial Intelligence (AI) in the automotive sector, which represents the future of smart mobility and whose applications will affect, as well as the automotive sphere, various aspects, not secondary, of the society in which we live. Today, AI can be found in the most diverse fields, from manufacturing to finance, from the healthcare sector to digital marketing, becoming the protagonist in what concerns the design, development, production and marketing of vehicles. AI is today at the center of a heated intellectual debate that sees scholars of different scientific vocations divided between statements and categorisations.

An univocal categorization of AI is somewhat difficult to propose precisely because it is a discipline straddling two scientific sectors, placing itself on two sides: that of a clear engineering matrix, which aims to build auxiliary machines for human activities and in some cases able to compete with Man in mainly intellectual tasks, e that of a psychological nature, oriented to build machines whose goal is the reproduction of the essential characteristics of human cognitive activity, arousing attention to some traditional philosophy diatribes and puzzles of the mind, for example the much debated mind-body problem[4]. In June 1956 four American scholars - John McCarthy, Nathaniel Rochester, Marvin Minsky and Claude Shannon - in an organized seminar in the United States (Dartmouth New Hampshire) it has remained historic for the definition of this discipline, laid the foundations of what would have been defined the programmatic basis of AI, defining the related research areas and the first programs for so-called "intelligent" computers. In the presentation the conference that marked the birth of AI reads:

In principle [by AI means] every aspect of learning and intelligence which can be described with such precision that it can be simulated with specially built machines. We will try to build machines capable of using language, to form abstractions and concepts, to improve themselves and solve problems which are still the exclusive domain of human beings[5].

The machines described by AI pioneers as "intelligent" are calculators digital, which by virtue of their particular characteristics and properties fundamental can be considered instruments with extraordinary symbolic processing skills, never seen before in a machine, and for this reason combined with some specific traits intrinsic to human intelligence. One of the most anticipated challenges of AI for the future, therefore, is represented by a "driverless" vehicle, as Elon Musk[6] said in 2016, founder of Tesla, one of the leading international giants in development of autonomous driving, in an interview with the BBC: "In the long term, nobody will buy a car unless it's autonomous. Owning a car that is not self-driving in the long term will be like owning a horse - you would own it and use it for sentimental reasons but not for daily use. The proliferation of research, studies and projects in the transport and logistics sector in the recent years is an indicator of the importance assumed by this particular strand of studies; in front of the numbers, there is no denying the great advantage that autonomous driving could offer to a technologically advanced society like ours. Every year in the worldwide there are about 1,400,000 people who die in accidents

[4] R Cordeschi, G Tamburini, 'L'Intelligenza Artificiale: la storia e le idee', in E Burattini, R Cordeschi, *Intelligenza artificiale. Manuale per le scienze umane*, Carocci, Roma, 2001.
[5] J McCarthy, M L Minsky, N Rochester, C Shannon, 'A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence', August 31, 1955, AI Magazine, vol. 27 n. 4, 2006.
[6] C J Rory, 'Tesla chief Elon Musk says Apple is making an electric car', BBC News**,** 11 gennaio 2016

road, an authentic massacre. But the most accredited statistics speak clearly in relation the causes of these accidents, which in 90% of cases [7] (European Parliament, 2019) are attributable to inappropriate behavior or distraction of the driver; is only in one, to say the least, a small percentage, equal to about 2% of cases, liability it is attributed to technological defects in the vehicle (which, for the most part, depend on it from inadequate maintenance). As Butti[8] writes:

With the widespread diffusion of the driverless, the decrease in the number and the accident severity will be drastic: this is indicated by all forecasts independent scientific studies currently available […]. The benefits summarized above illustrated in terms of security are however sufficient by themselves to promote driverless driving technology.

3. Research project.

My research project is part of the "Research strategy and innovation for the intelligent specialization RIS3 Campania "and the areas of development in it: aerospace, cultural heritage, tourism, sustainable construction, biotechnology, human health, agri-food, energy and the environment, advanced materials and nanotechnology, transport and logistics[9]. The research involves the development of innovative systems to support autonomous driving (partially autonomous driving), combining one of the transversal sectors (Information & Communication Technologies) with a vertical sector (Transport and Logistics) of particular relevance for the Campania Region. In particular, the research theme involves the development of a new paradigm of safer and smarter mobility, with increasing automation quotas which must be harmonized with the characteristics of the human being to allow him to maintain an active role in the new socio-technical system. The research theme intends to investigate the methodologies necessary for the conceptualization, prototyping and verification of more suitable user interfaces to ensure effective interaction with the driver (in the context of partially or totally autonomous driving), taking into account technological aspects such as those relating to the individual and his cognitive, behavioral, etc. The application of innovative design methodologies (based on UCD and UX) will guide the design in the conceptualization phase, to allow a preliminary prototyping of the technological construct and its interface before it becomes a definitive product and allow to verify in advance how the people interact with the technological system. If this cooperation, studied through empirical methodologies, gives promising signals or highlights some critical elements, the user interface may be modified accordingly. Therefore, in addition to the conceptualization and prototyping methodologies, the development of technology verification methods are also an essential part of the innovative research system. Simulation environments are available within the Scienza Nuova[10] research center, both aimed at the automotive domain, and reconfigurable thanks to the presence of a driving simulator and a virtual environment in which different interaction experiences can be reproduced. Several technologically advanced tools can be used such as eye-tracking, biometric sensors, systems for detecting the emotional state through videocameras etc.

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[7] https://www.europarl.europa.eu/news/it/headlines/society/20190410STO36615/le-statistiche-sugli-incidenti-stradali-mortali-nell-ue-infografica; Parlamento europeo, 'Le statistiche sugli incidenti stradali mortali nell'UE', 16 aprile 2019.

[8] L Butti, 'Auto a guida autonoma: sviluppo tecnologico, aspetti legali ed etici, impatto ambientale', Rivista giuridica dell'ambiente, n. 3/4, 2016

[9] http://burc.regione.campania.it

[10] The Scienza Nuova research center of the Suor Orsola Benincasa University of Naples is directed by professor Roberto Montanari, my tutor, who covers the teachings of cognitive ergonomics, interaction design, technologies for cultural heritage. Co-founder and R&D director of RE: Lab www.re-lab.it

4. The public's perception of autonomous driving.

However, the line of studies attributable to autonomous driving remains a niche sector confined to a limited audience and for the most specialist who really knows its functions and applications. For such reason, the goal of the research was to investigate and study perception and representation of autonomous driving in all its aspects, testing the level of knowledge of concepts such as automation, self-driving cars, robotaxis, to understand how much citizens really know about autonomous driving, touching topics like the security, trust[11], innovation, reliability, stability. The tab. 1 summarizes the research design, while in tab. 2 the conceptual map reports the indicators and dimensions explored by the study. The sample is formed by adults (18-65 years old) residing in Campania stratified by age, while the questionnaire is structured with closed questions, including some at the end relevant questions the "Other" option, where the interviewed can freely choose to write their answer on the question submitted. The territorial area is limited to the Campania provinces as Campania is the region where the doctoral project with an industrial character resides and is a particular topic relevant for this territory as already stated above[12], therefore the target of the research includes adults from Campania. The method used is the Web Survey through structured questionnaire, as it is impossible to conduct a study today without the aid of digital technologies that facilitate dissemination, collection, analysis and the identification of the target, which in this case also widely includes the so-called "digital natives"[13].

Research design

Tab. 1 Research design "Autonomous driving"

Research Questions:	Study the perception and representation of autonomous driving
Metodo:	Web survey
analysis unit:	Adults aged 18-65 years
Territorial area:	Campania provinces
Sampling:	Sampling reasoned choice
Population:	The set of adults aged between 18-65 residing in Campania
Data collection:	through a structured questionnaire

The dimensions explored by the study are socio-graphic, cognitive of the phenomenon and finally that relating to values, attitudes, opinions, representations of the concept. For each dimension it was considered useful to study some indicators: in particular for that socio-graphic age, gender, residence, educational qualification and employment status; in the cognitive dimension one is chosen to operate towards some indicators such as the level of knowledge of the sector, acquisition of the concept of autonomous driving, automation, robotaxis; the value sphere is widely investigated by numerous indicators such as perception

[11] The issue of trust in people is crucial for the introduction of self-driving cars, and the fear associated with a lack of security and stability cf. European Journal of Privacy Law & Technologies.

[12] Cf. http://burc.regione.campania.it

[13] M Prensky, 'Digital Natives, Digital Immigrants', On the Horizon, vol. 9 n. 5, ottobre 2001 (MCB University Press); A I Cesarano, *I nativi digitali tra rischi e opportunità. Le ricerche di EU Kids online,* Youcanprint, 2018.

topics related to autonomous driving through mass media and new media, mental (internal) representation of the subject, evaluation of opinions on autonomous driving (safety, utility, progress), perception and representation of the automation concept etc. The questionnaire is structured with 21 questions that they start from a generic theme, inherent to the research question about the means used for ordinary journeys, the time taken for such journeys, the system of public transport and the use of the car, to then go into the heart of the research by exploring with targeted questions the knowledge and perception of the

self-driving, of the robotaxi, and investigating in two specific questions legal and ethical issues related to civil liability in the event of a road accident.

Study the perception and representation of autonompus driving

Socio-graphic dimension	***Cognitive dimension of the phenomenon***	***Values,attitudes, opinions, representations, concept images***
Age	*Degree of knowledge of the sector*	*Perception of topics related to autonomous driving through mass media and new media*
Gender	*Acquisition of the concept of autonomous driving*	*Representation of the internal concept (mental image of the subject)*
Residence	*Personal knowledge of autonomous driving concept vs. actual concept*	*Representation of the external concept (image that external subjects give)*
Educational qualification	*Knowledge of the concept of automation*	*Evaluation of opinions on the autonomous driving (safety, utility, progress etc.)*
Employment status	*Knowledge of the concept of robotaxis*	*Degree of differentiation between opinions and the autonomous driving sector*
		Opinions about the autonomous driving
		Perception and representation of the concept of automation
		Perception and representation of the concept autonomous driving
		Perception and representation of the concept by robotaxi

Tab. 2 - Conceptual map of indicators and research dimensions

The fifth question of the survey was intended to analyze both the cognitive dimension of the phenomenon that the value[14]: the user is asked through a frequency scale that goes from "never" to "very often" if in the last six months, through the mass media and new media, had had knowledge of the self-driving. What clearly emerges from the data is that the "never" dominates the others answer options, such as questions "read a newspaper article" or "seen an online video of a car driving alone" (fig. 1).

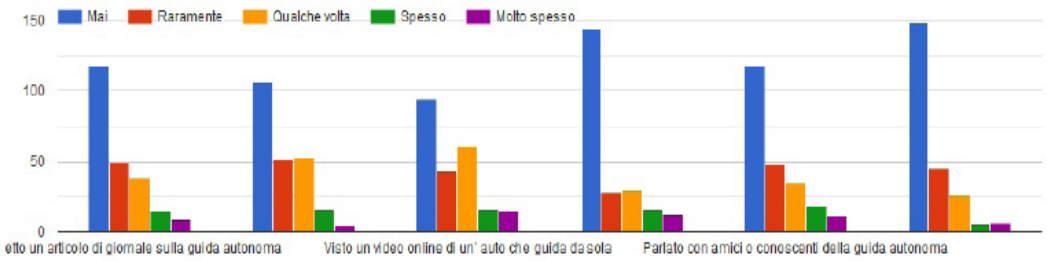

Fig. 1 Frequency with which in the past six months respondents have come into contact with the concept of autonomous driving.

So there is very little knowledge of the concept of autonomous driving, even if the sample was made up of a percentage of very young people who it stands at around 40% (equal to about 112 people out of 235 in total) of the sample with an age ranging from 18 to 35 years, with a strong familiarity with the new technologies. The "no" (64.8% of cases) is also the answer with the highest percentage to the question "Have you ever driven a car equipped with assistance systems to guide?" (Fig.2)

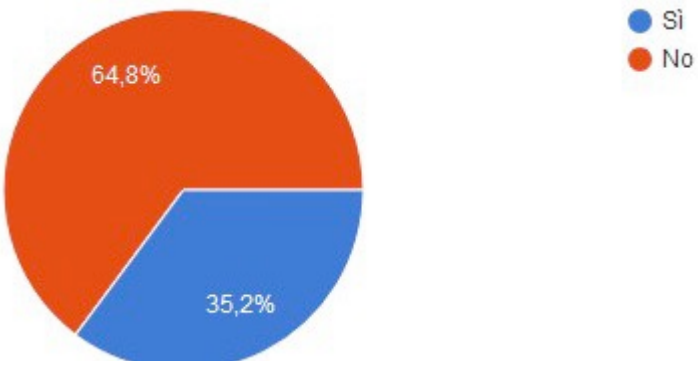

Fig. 2 Answers to the question: "Have you ever driven a car equipped with driver assistance systems?"

However, factors emerge in subsequent responses to the questionnaire important worthy of consideration. Despite little or no knowledge autonomous driving (predictably) by a considerable share of the sample, which by the way was composed mostly of women (about

[14] In table 2 it is possible to consult all the dimensions, including also the cognitive of the phenomenon and values.

64.8%) which could be considered as a "gender gap" in that less interested in this sector and less informed on this, it does not emerge from the data a complete mistrust in the safety of autonomous driving, as we might expect. This is clear from the answers to the question of whether with the introduction of the robotaxi could increase road accidents: only one person replied "10" (very likely) on a scale of 1 to 10 (235 replies total) while the highest frequency was 1, as can be seen in figs. 3-4, but a certain condition of uncertainty about the real possibilities offered by autonomous driving dictated by a poor knowledge of the sector. Consequently, it is logical think that if people had a greater perception and knowledge of autonomous driving, they would have greater confidence and less fear at the introduction driverless cars.

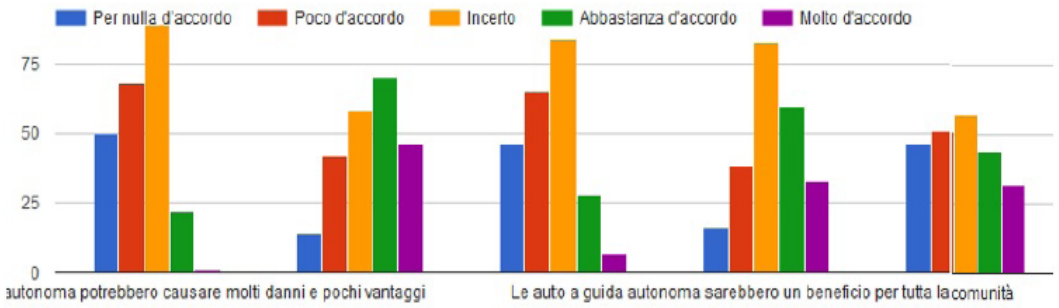

Fig. 3 Perception of the risks and benefits associated with autonomous driving

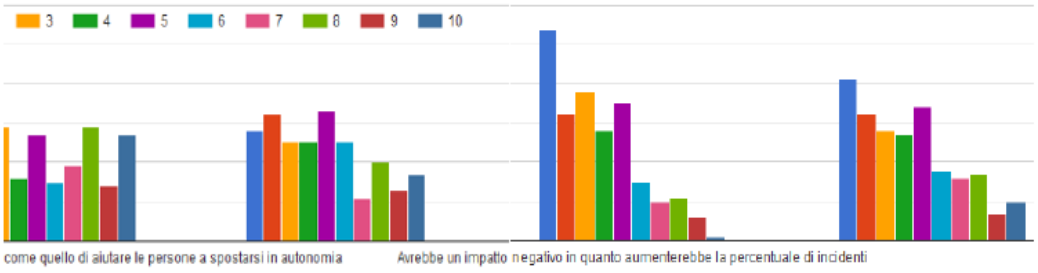

Fig. 4 Perception of the risks and benefits associated with autonomous driving, in particular the introduction of Robotaxis.

The condition of uncertainty is clearly visible from the data: in fig. 3 the frequency higher is almost always around "uncertain", even when it is exceeded by little to "agree enough" to the statement whether self-driving cars represent a desirable progress. This confirms the above, or that people have no mistrust of autonomous driving, but they do not have a correct knowledge, a correct perception and above all they do not feel informed on this matter, but still show that they have an interest in this sector and consider it a technological advance, so they have an internal mental image of progress. In the diagram in fig. 5 it is possible to note that 48.7% of users responded with an image of progress and technological advancement to the question “What representation comes to your mind of reading the definition of autonomous driving? ".

Fig. 5 Answers to the question "What representation comes to your mind when reading the definition of autonomous driving?"

The ethical-legal issue seems to be one of the most critical, if not the most critical thorny, for the introduction of self-driving cars. The principle of responsibility civil and criminal in road accidents turns out to be a theme of heated debates and able to channel the attention of several scholars[15]. Within the research, this thorny problem is addressed in two questions, asking users directly for their opinion in case of road accident both with a fully autonomous car and with a partially autonomous car. From the two pie charts in fig. 6-7 a tangible difference immediately emerges in the responses of users to vary (albeit slightly in drafting and reading, but which however has a great meaning) of the question asked. In a car a fully autonomous driving, according to the sample subjects the responsibility civil and criminal would be in 27.8% of the cases of the company that manufactures the car (manufacturer), while in 24.8% of cases it would fall on the company that produces the car components[16] (manufacturer of the product components), and in 22.6% of the cases is the company that produces the self-driving car components that the owner of the car; the remaining percentages are divided between the owner of the car (17.4%) and very low shares that stand at around 0.4% (equal to 1 person), for different answers given freely through the option "Other" contemplated at the end. In a partially self-driving car it stands out instead a rather high percentage, equal to 39.1% of the answers, which he attributes responsibility to the owner of the car, while a 34.8% is to the owner of the car that to the company that produces the product components; the remaining percentages are divided into 11.7% for the company that produces the components of the car, 7.8% for the company that produces the car and shares equal to 0.4% for every person who has given free answer to this question.

[15] For a complete and somewhat exhaustive discussion on the subject, see M C Gaeta, *Liability rules and self-driving cars: The evolution of tort law in the light of new technologies* (ESI 2019)
[16] Sensors, videocameras, etc.

Fig. 6 Answers to the question "In a hypothetical accident committed by a fully driven car autonomous, whose civil and criminal liability would it be?"

Fig. 7 Answers to the question: "In a hypothetical accident committed by a partially driven car autonomous, whose civil and criminal liability would it be?

Conclusions.

From a comparison between the answers to these last two questions one could affirm that in the case of totally autonomous driving, people attribute the responsibility of the road accident to subjects who do not identify themselves in car owner, but who seem rather divided between various subjectivities external, e.g. the company that manufactures the car, or the components of the car, or in concomitance with the owner. Otherwise it happens when the car is driving partially autonomous: in this case the responsibility is recognized both in the subjectivity of the car owner (39,1%) both when the latter is in concomitance with the company which produces the autonomous driving components(34,8%). Finally, as far as the concept of automation is concerned (fig. 8), it seems re-propose that condition of uncertainty and neutrality that occurred in some questions on the effects of autonomous driving. In fact, most responses on a frequency scale of 0 to 10 stand at around 5, featuring a condition of indecision, perhaps due to lack of elements to express oneself,

but the aforementioned people's consensus on technology and progress is proposed again: to statements such as "the automation of everyday life I it perplexes "or" I find it aberrant to replace machines with beings humans ", the highest frequency is 0.

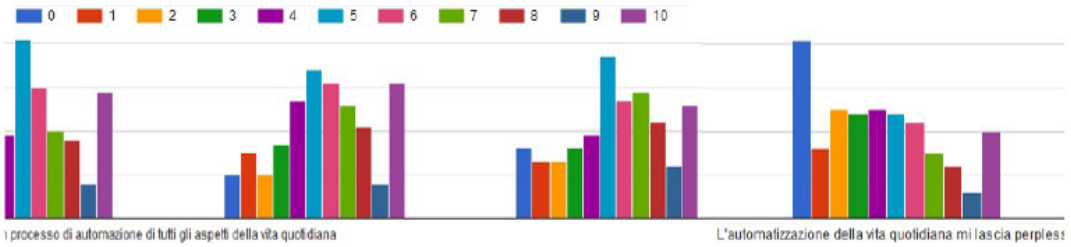

Fig. 8 Perception of risks and benefits to the automation of daily life

5. ADAS: the project of a new investigation

The project of the new survey will focus on advanced driver-assistence systems (ADAS), the goal is to investigate and study the perception of accidents and near misses through the systems called ADAS, structured into two sections, one concerning the knowledge of the

functioning of the system, the other focused on accidents and near accidents. The tab. 1 summarizes the hypothesis of the research design developed, not yet implemented but in the testing phase, in fact at the present time the questionnaire structured through Google modules has been sent to a first panel of experts both in ADAS and in methodologies, i.e. those who have ADAS domain competence or technical competence on the construction of the questionnaire and on the analyzes, to collect the first comments and suggestions in view of the final version to be disseminated both in Italy and in Sweden. The pilot study within the RE: Lab of Reggio Emilia[17] is conducted on a small selected sample of people to analyze some categories of the research that will eventually undergo changes, after the conclusion of this survey to refine some questions. Given the experimental nature of the study, it is not possible to define in this phase the unit of analysis and the population to which the survey is addressed, i.e. the subjects and the set of target subjects of the research, as it will be decided in one phase implementation of the users to be involved in the study. The questionnaire is

structured with 28 closed questions, and is divided into several sections. In the first part, the research objective is to investigate the knowledge of the functioning of the system by focusing attention on the various ADAS, and in some questions to test people's real knowledge of Adaptive Cruise Control and of the difference in operation with another ADAS the Cruise control. In the second part, the research objective is aimed at investigating the perception of accidents and "near accidents" near accidents in relation to use and interaction with ADAS, the responsibility of ADAS in road accidents and near road accidents. The method used is the Web Survey as it is impossible today to conduct a study without the aid of digital technologies, that facilitate the dissemination, collection, analysis and identification of the survey target.

Table 1 Hypothesis of research design ADAS advanced driver-assistence systems

Research Questions:	Study the perception of accidents and near misses through ADAS
Metodo:	Web survey
analysis unit:	
Territorial area:	Italy
Sampling:	Sampling reasoned choice
Population:	
Data collection:	through a structured questionnaire

[17] Roberto Montanari, my tutor, who covers the teachings of cognitive ergonomics, interaction design, technologies for cultural heritage. Co-founder and R&D director of RE: Lab www.re-lab.it