Creativity and Collaboration in Innovative Design

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Research in “Creativity and Collaboration in Design Engineering”

Creativity is a key asset to ensure economic success [survey about the “50 most innovative companies” in the world / BCG Perspectives, 2013]. In a context of global competition, our research goal is to understand and foster creativity in engineering activities. We aim at identifying the effects of external parameters, such as: physical environment, information stimuli, body position, culture and collaboration with others, on the creative performances of engineers. Our main focus is the “conceptual design” phase in the design process, when the problem space is explored and the first ideas generated. To study this specific human activity, we use methods of cognitive ergonomics and kansei engineering. The application of our research can be found in any field where innovative products/machines have to be designed by engineers and then used by people, for example assisting technologies (robots), communication devices, consumer packaging and so on.

The layout of our new laboratory is an experiment in itself. Based on the latest research in creativity and “FabLab” (Fabrication Laboratories) fields, the layout is aimed at supporting creativity and collaboration in design meetings / projects and at enhancing the user-friendliness and kansei value of designed artifacts. The equipment that can be found in the lab reflects the most innovative ways of designing, making, testing things with users and measuring kansei feedback. The equipment includes: 3D scanner, 3D printer, Arduino development toolkits, psycho-physical measurement tools (GSR…). Among several on-going research projects, we report below a selection of our research findings.

a) Study of ideation sessions in engineering universities in Japan and France

Creativity and innovation require collective efforts and collaboration between diverse people, with development of a “culture of collaboration”. This research aims to understand relations between collaboration and creativity in creative engineering design. This research follows a comparative approach on the dynamics of interactions in creative design projects across two similar engineering universities in France (Telecom ParisTech) and in Japan (Tokyo Tech). “Ideation sessions” were organized in Japan and in France. The experiments use videos of group work during a creative design task and interviews. Data are coded and analysed using combined methods for understanding creativity and collaboration, namely “Quality of Collaboration” method developed by ParisTech.

APPLICATION: The findings serve as “best practices” guideline for creative collaboration for students and engineers. The research will also be relevant for designing technologies (e.g. softwares) that facilitate collaboration in design.

b) Evaluation of the perception of robot and expectations across cultures

This study examines the perceptions, and attitudes towards robots in different cultures, especially across European and Japanese populations. Nomura (2006) reported a connection between assumptions and negative attitude towards robots for Japanese. The present study is the first to determine the influence of crucial factors like culture, prior exposure to robots through the media, and personal experiences using explicit and implicit measurements of the emotions towards robots. There seems to be evidence that the design of a robot shapes certain expectations in people. This is a clear indication, that the exterior appearance of social robots is an important factor which should not be underestimated for interaction purposes. We conducted a study with 101 participants and we found that robots which are designed after a biological model are associated with the models’ realistic behavior whilst the humanoid and service robots are perceived more autonomous and as support for humans by saving time and improving life. The appearance of the service and humanoid robots have gross features of a biological model but is not attempting to be an exact copy, so the participants did not associate them with human behavior.
APPLICATION: This study can be used in designing user-friendly robots and giving them an appearance which people like. The findings are especially useful in the case of robots with which people have close interactions, e.g. robots assisting elderly people.

c) Design and evaluation of emotional communication devices

We investigate whether people can communicate their emotions via a tangible object and how effectively the emotions can be conveyed from one person to another by haptic (tactile) feedback, including temperature, vibration and pressure feedback. We designed a system that detects a tactile input from a “sender” and transform it into a tactile output to a “receiver” device, using Arduino sensors and actuators. We conducted an experiment where two participants simultaneously use the system, one person using the “sender” device and the other one using the “receiver” device. Through tactile interactions with the “sender” device, the sender is asked to send to the receiver “patterns of emotions”. The receiver feels tactile outputs through the “receiver” device. The level of agreement between the “sender” and the “receiver” allowed to determine the most relevant gestures to be used for haptic communication.

The “Dancing Grass” prototype received the “Competition Award, 2nd place” (among 26 candidates) at the Innovative Design Contest, organized by the Design Society at 2014 Design Engineering Workshop (Taiwan).

APPLICATION: This study is used for designing communication devices that convey information about one’s emotions to relatives and friends. The design of such communication devices is likely to support richer at-a-distance human relationships and thus improve the wellbeing of people.

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In line with Tokyo Tech reform plan, our educational mission is to develop project-based learning and to support the internationalization of the university. As for project-based learning, a new course was created and taught to graduate students, consisting in “Creative Design for Innovation (1-2-0)” (~20 students). With this course, the students are expected to:
- develop an understanding of the design process of a new product
- improve their ability to identify a design problem
- learn creative-thinking techniques
- learn methods for collecting users’ needs and for conducting user tests
- be able to assess how design activities can impact people, society and environment

I also contributed to the teaching of user-centered approach through the transformation of two important existing courses in the Department of Mechanical Engineering: 「独創機械設計プロジェクト第一 (0-1-1)」 (~50 students) and 「独創機械設計プロジェクト第二 (0-1-1)」 (~50 students). I especially taught classes about functional and value analysis, user research/testing and design thinking approach.

In 2014, our lab hosted international exchange students from KAIST (South Korea), Tsinghua University (PR China), Arts et Metiers ParisTech (France), Telecom ParisTech (France) and KMUTT (Thailand).