

# SOCIALLY AWARE COMPUTING

M. Cecilia C. Baranauskas<sup>1</sup>,

**Abstract** — Initiatives towards the definition of grand research challenges have been undertaken for several scientific domains in countries with long scientific tradition, such as the USA and Great Britain. The Brazilian Computer Society organized a first workshop on Grand Challenges in Computer Science Research in Brazil, for the years 2006-2016. One of the five resulted Challenges is Participative and Universal Access to Knowledge for the Brazilian Citizen. This challenge brings to attention Ed Lee's statement from the 34th IEEE Computer Society International Conference: "Neither a computer nor the teaching of computer science has any value or meaning outside of its impact on people". The goal of this Challenge is to break barriers that hamper access to technology and interaction possibilities, especially in developing countries. This paper sheds light to the various dimensions of this Challenge, illustrated by underway Projects and discusses implications for the Computer Science and Engineering curricula.

**Index Terms** — computer science research challenges, design for all, socio-technical systems.

## INTRODUCTION

The main resource of the society in the near future will be knowledge mediated by technology. The amount of information digitally available grows everyday, and the means to spread it are also available through Information and Communication Technology (ICT). Nevertheless it is not everyone who is able to access it. Some authors say the barriers to access knowledge do not have a technological nature, but rather social and economical ones [1],[2]. Barriers to access knowledge pass through both types of illiteracy, the literal and the digital illiteracy, a reality of many developing countries, especially ours.

The Brazilian Computer Society's (SBC) challenge #4 dares us to think of and research about "Participative and universal access to knowledge for the Brazilian citizen". This is one of the five Grand Challenges in Computer Science Research for the years 2006 - 2016 that resulted from an event in 2006 sponsored by SBC. We think that the Engineering and Computing communities in Brazil have a role to play and a responsibility to face: designing systems that can be accessed by everyone, to the greatest possible extension, without discriminating. This has been a particular endeavor in the Human-Computer Interaction (HCI) field.

Today there are public and private initiatives in the country to provide universal computer access, but most people still do not make sense of the possibilities brought by computers and internet. At the same time, we have noticed in recent years the amazing success that applications like Orkut are having in Brazil especially with the young people. What kind of system could be developed that would work as a source of knowledge and would be appealing to the Brazilian's less favored population?

We have learned preliminary lessons suggesting that usability and accessibility concepts must be extended to include the affective and emotional relations of these people with the new situations mediated by technology. This understanding demands the designer's immersion on inclusive scenarios for which traditional HCI methods do not seem appropriate anymore. New dimensions for the context should be addressed to include culture and aesthetics, the emotional and socio-pragmatics of this user daily experience in a world populated by artifacts of technology.

This paper brings to attention Ed Lee's statement from the 34th IEEE Computer Society International Conference: "Neither a computer nor the teaching of computer science has any value or meaning outside of its impact on people". We will present some research efforts being conducted towards a socially responsible design, discussing also implications for the Computer and Engineering curricula.

The paper is organized as follows: the next section presents our understanding for the socially aware computing concept; it is followed by the presentation of two Projects illustrating some dimensions of socially aware practices concerning systems design. Then, a general discussion with implications for computing and engineering curricula is offered.

## SOCIAL CONTEXT AND TECHNOLOGY DESIGN

The Unesco's World Report [3] states that ICT should create conditions for the emergence of knowledge societies and these societies are a source of development for all. But for this society to arise, it is necessary to bridge the gap and diminish the digital divide. In order to achieve that we need to develop systems that can be accessed by everyone. Universal access initiatives should address at least three main issues [4]: user diversity (user with different skills, knowledge, age, gender, disabilities, literacy, etc), technology variety (support to a broad range of hardware, software and network access) and gaps in user knowledge

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<sup>1</sup> M. Cecilia C. Baranauskas, Instituto de Computação, Universidade Estadual de Campinas, UNICAMP, Av. Albert Einstein N 1251, CEP 13084-722, Campinas, SP, Brasil, [cecilia@ic.unicamp.br](mailto:cecilia@ic.unicamp.br)

(the difference between what users know and what they should know).

In a country that has continental dimension and 187 millions of inhabitants, the variety of its population could be huge. Only 28% are actually completely literate [5], 14% have some kind of physical disability and 79% (of the population with 10 years old or more) have never accessed the internet [6].

In spite of the supremacy of some computer hardware and software, it is necessary to think of solutions that can be accessed through any platform, i.e., that can be reachable by anyone. But much more than that is the challenge of designing interface and interaction solutions to reach the diversity of the population.

The accessibility recommendations are not enough to handle all the complexity that the Design for All demands in the scenario we have [7]. To start facing the challenge, we decided to work directly with the user, in a Semio-Participatory Framework. The expression “semio-participatory” is used as a generic term for participatory practices that carry messages; i.e. the study of communication between agents effected by means of its participation in design (in analogy to semio-chemical processes in which chemical substances carry messages establishing communication among organisms). Including the user in the design process is vital to make sure we are creating systems that make sense and that are part of the users’ context of life.

Thus, the target of our design model investigation is the diversity in competencies and needs we find in the Brazilian population, including people with impairments as well as the functionally illiterate, the majority of our population. This initiative can be situated in the research topic internationally being called “Societal Interfaces”: advanced interaction approaches that are explicitly designed to improve or solve a specific societal aspect using HCI [8]. I prefer the expression “Socially Aware Computing” to mean the theory, artifacts and methods we need to articulate to actually make the design socially responsible, participatory and universal as process and product.

Figure 1 illustrates the conceptual model [9] for the Semio-participatory framework to support the research challenges.

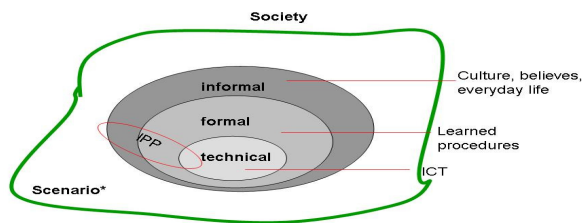


FIGURE 1  
THE SEMIO-PARTICIPATORY FRAME

In this Figure we situate our understanding of systems and technology design in a "semiotic onion" where the technical level (design of technology) presupposes knowledge of the informal and formal levels of the domain. Signs of the informal and formal layers of the social group are necessary to actually address a subset of the society (Scenario\*) regarding technical devices. Inclusive Participatory Practices (IPP) are methodological instruments proposed to clarify the signs of the informal, formal and technical levels of the knowledge crossing the three layers of the semiotic onion. These practices are conducted throughout Semio-Participatory Workshops, which join representatives of the community and researchers to share experiences and get a common ground understanding regarding the prospective system to be built.

The next section illustrates different aspects of the framework in two projects: *TodosNós*, and *E-Cidadania*.

## DESIGN OPENED TO THE DIFFERENCES AND FLEXIBILITY AT THE USER INTERFACE

### Case 1: TodosNós

The post-modern world demands an independent position, face to the deep transformations of the society. We are forced to recognize that our world resists the great narratives of a direction alone; our world is plural. The fragmentation of great narratives under the pressure of multiple local forces led to the concern for the Other. Much of the post-modern thought is related to the recognition of the Other - other individuals, other groups, other species, other cultures, the other of the conscientious mind, the other of the rational mind. The *TodosNós – Unicamp acessível* Project has been an inspiration and has illustrated the way we deal with the problem of identities and differences in the design context.

*TodosNós* is a Project that studies and proposes inclusive environments – physical and virtual, in the University. It concerns the whole environment of the student with impairments in the University, proposing ways to make possible the permanence and the continuation of their studies in the University. Accessibility is understood in its widest sense, considering aspects accessing the physical world, the virtual world, the knowledge and the formal and informal attitudes of everyone in the University space.

*TodosNós* is a research environment multi and interdisciplinary. Different units (faculties and institutes) of the University take part in it, including people with impairments. The group is hosted by the LAB (Laboratory of Accessibility), located in the Central Library Cesare Lattes.

In this Project we could exercise the Design for the challenge of the differences, especially considering the Web as communication channel for all. Design for All is considered not in the sense of the “average” citizen, but

considering the differences of each one.

The Semio-participatory framework was applied since the beginning of the Project, involving the university community in activities with material adapted for the participation of everyone, including blind people, for example, in the participatory practices for the problem articulation and proposition of design ideas. Figure 2 illustrates products and moments of inclusive participatory activities.



FIGURE 2  
THE *TodosNós* INCLUSIVE ENVIRONMENT ILLUSTRATED

Besides the academic results of studies in several domains, some practical results of this Project have been materialized into inclusive systems in the Web, such as: the redesign of the Academic Portal [11], and WARAU [12], an environment to support the adequacy of websites to the accessibility and usability standards and requirements. This last system resulted from a process developed with a small team of webdesigners working in the university [13].

### Case 2: e-Cidadania

Social networks play a dominant role in influencing the adoption and the use of information and communication technology [10]. That gives us a hint that online social networks may be the means we were looking for to promote the constitution of a digital culture in our population. We are naming “inclusive social network system” the type of web application, with design solutions necessary to leverage their relation to knowledge and social condition in their everyday life.

*e-Cidadania* is a research Project inspired by the SBC 4<sup>th</sup> Challenge: the Participative and Universal Access to Knowledge for the Brazilian Citizen. It is not an e-Gov Project in the strict sense of the term, as *e-Cidadania* emphasizes the relationship people establish in their informal communities organized around some special interest, the use of artifacts of the society, including technology. Nevertheless, results of this type of

investigation may be of interest to e-Gov systems development too.

*e-Cidadania* is about designing computational systems for ordinary people, especially those unfamiliar with the ICT, the vast majority of the Brazilian population. Unfamiliarity with ICT would not be that hard, if we were not working with a real scenario of functional illiteracy and few years of school these people were exposed to. This Project is about empowering those people to perceive themselves as citizens, through the use of systems that are operable and make sense to them.

Differently from solutions we find in research projects of other developing countries for the access of illiterate people to digitalized information, we seek for solutions under the principles of Design for All:

*The design of products and environments to be usable by all people, to the greatest extension possible, without the need for adaptation or specialized design.*

This means the solutions should not discriminate the less capable; moreover, the design solutions should promote their learning and potentially enable a general improvement in their condition regarding technology in their lives.

We count on a partnership with a Program of the Citizenship Secretary of Campinas City Hall to work with communities of Vila União, a suburb area in Campinas considered class D and E in terms of socio-economical indicators. A kind of “TeleCenter” hosts the activities; it is a physical space where several community initiatives for digital inclusion associated to the federal and local governments take place; Casa Brasil, Centro de Referência da Juventude (CRJ) and Jovem.com are some of those programs.

From the theoretical and methodological perspectives, the goal implies the search for new process models of software design and development to support inclusive interface design driven by a socio-technical vision. From a practical perspective, the goal involves the design and development of a system for the community designed with the community itself, where the challenges of interface and interaction design will manifest themselves in the form of the diversity of the users' competencies and capacities, whereas the user spectrum includes people with impairments (sensory, cognitive and physical) as well as functionally illiterate people.

The development of the research proposed in this Project presupposes the joint participation of the research team with the partner community, in the search of solutions for supporting inclusive social relations, construction and sharing of knowledge.

The Design for All, with the user was experienced in *e-Cidadania*, with three Semio-Participatory Workshops, as illustrated by Figure 3. The First Workshop addressed problem clarification and semantic analysis, setting out the first requirements for the system. Two artifacts were used: The Stakeholders Frame and The Evaluation Frame. We started by identifying the different parties interested in a

prospective inclusive social network, the problems they face and ideas for solving them. The Second Workshop investigated the natural flow of communication and sharing in people's social networks: how people interact in their daily social networks, what their needs are, how they organize themselves, how they communicate, and mainly how their social norms are established and maintained. We adapted CARD techniques for raising and organizing the narratives. The Third Workshop raised ideas for the representation of visual and aesthetics elements for the prototype that is now in development. Braindrawing was one of the techniques used.

### The Semio-Participatory Workshops



FIGURE 3

THE THREE SEMIO-PARTICIPATORY WORKSHOPS ILLUSTRATED

The main achievements of the project so far include:

- A broad understanding for what characterizes social network systems, especially in the context of our Project;
- A proposal of software development model aligning social aspects and user interface demands to technological solutions;
- The articulation of process and product relations through diving into semio-participatory workshops within the community;
- Design and development activities regarding the inclusive social network system.

In the e-Cidadania model, software development and participatory practices have a symbiotic relation. The main idea behind the technical solution we are proposing involves the concept of flexibility at the user interface. Flexibility is understood under the Design for All principles: we mean solutions opened to the differences among users without segregating them. This flexibility is driven by norms – some entered by the designer, some captured from the context of use. The treatment for tailoring counts on a framework which includes management and interpretation of norms reflecting in the UI tailored to the different users.

The design ideas are now being materialized into the User Interface of the first prototype. We are proposing and exploring solutions with focus on: a) Tailorability to

different audiences; b) Multiplicity and multimediation of physical and logical devices to reach as much people as possible through different media (audio, video and libras for example).

Some design solutions come directly from the participatory practices and some are invariants of an already established web language (as for example the logo position in the page layout). The very first beta version of the inclusive social network system is about to be launched with just basic functionalities to feed the investigation and new cycles of the development process.

### DISCUSSION AND IMPLICATIONS FOR THE CURRICULA

“What new and original science is being created with the Projects?” A new Science of Design, inspired by Organizational Semiotics [14], aligning system development to social practices with the end user. Thus, in the proposed model software (and hardware) development and participatory practices have a symbiotic relation.

We understand systems design from a social perspective, as a movement that starts in the society, crosses the informal and formal layers of signs, towards the construction of a technical system, returning back and impacting the society. This science demands new methods, artifacts, objects to think with ...some are represented in Figure 4.

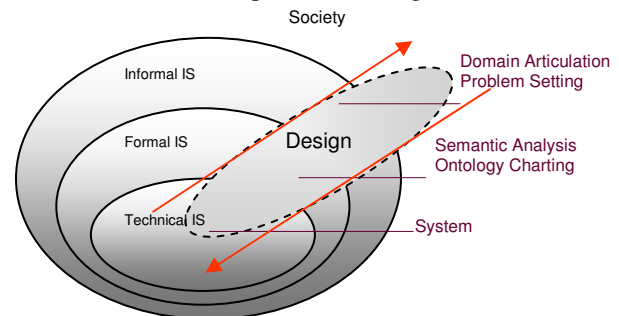


FIGURE 4

A SCIENCE OF DESIGN INSPIRED BY THE SEMIOTIC ONION

When we are working in the semio-participatory workshops we are going from the social world to inside the (technical) system. Semantic and Norm Analysis are in-between - belong to the formal layer. When we are launching a beta-version of the software we are in the opposite direction, returning back the product that will impact that society.

The SBC 4<sup>th</sup> Challenge in general and the proposed model of combined research and development, in particular, have implications and demands efforts in several dimensions:

- At the conceptual level: there is a need for theories formalizing inclusive approaches to the design of information and communication technology, especially considering the Web domain and

applications *for all*;

- At the methodological level: there is a need for new process models for software development (and its interfaces) which see the software applications under a socio-technical lens;
- At the educational level: as a consequence of the previous dimensions, there is a need for rethinking curricula, especially for the computing engineering and related fields, to enable our professionals a wider understanding of the products of technology they are building, sensible to the different needs, competencies, and social values of systems.

Would it demand a Macro-Computer Science?

The reference curriculum for graduate studies in Computing and Informatics proposed by SBC (The Brazilian Computing Society) already suggests in its general aspects: *Humanistic education, allowing the understanding of the world and the society*. Moreover, in its ethic-social aspects, the reference document recommends: *To facilitate the access and the dissemination of the knowledge in the computation area; and To have a critical and consistent humanistic vision on the impact of its professional performance in the society*.

While it takes a long way to put into practice the recommendations, several curricula proposals in the world are going towards a ‘human-centered computing’. Although a thorough analysis is out of the scope of this paper, it is worth mentioning the efforts of several traditional universities to experiment new ways of achieving the socio-technical balance in different ways, e.g.: by integrating principles of human-computer interaction throughout the curricula [15], by implementing inter-disciplinary curricula [16], by proposing threads of different nature [17].

## CONCLUSION

Although information is more and more available through technology, it is not everyone who is able to access it. Moreover, literature has pointed out that the barriers to access knowledge do not have a technological nature, but rather social and economical ones. The SBC 4<sup>th</sup> Challenge on Computer Science Research in Brazil motivated us to study the problem and propose solutions for “The Participative and Universal Access of the Brazilian Citizen to Knowledge”. This paper presented the theoretical basis and practical approach we are conducting to address this particular challenge regarding system design. Two different Projects illustrate the approach. The paper ends up by raising issues regarding the implications of this socially aware computing in the curricula of computing engineering and related fields.

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