2nd IFAC Conference on Cyber-Physical-Human Systems (CPHS)
Panel Session “"Interface between engineers and social-scientists: Low-hanging fruits, language barriers, and synergy"

Opening Remarks

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Let me begin with the simple observation that cyber-physical systems will be integrated with other existing and future technologies to create products and services used by humans and organizations. Smart and connected vehicles, low carbon renewable electric grids, and drones are great illustrations for such integrations. The point is that CPS technologies won't be standalone and isolated, rather they will be parts of larger systems.

Next, component technologies, products, and services will shape and be shaped by the society in iterative cycles involving design, manufacturing, economics, social identities, groups, organizational structures, markets, and government policy and regulations. The products and services enabled by CPS hold enormous potential for positive impacts on people and society but there are also many areas of major concerns ranging from loss of jobs, future of work, privacy, human rights, security, and social structures. These issues become even more daunting when we realize that some of the most important dynamics in technology-society interactions evolve over years and decades.

The challenge for engineering researchers and practitioners is, on the one hand, to understand the role of fundamental knowledge, algorithms, and architectures for cyber-physical systems as components of integrated technological products and services and on the nature of customer, market, economic, social, behavioral, and policy dynamics, on the other. The resulting insights then can feed into the basic research and engineering design aspects of cyber-physical systems. For example, there are very interesting possibilities of mutually beneficial interactions between cognitive scientists and autonomous vehicle control systems engineers to address myriad problems in safety of mixed autonomous-human traffic negotiations. As another example, we need to better understand longer term impacts on jobs and nature of work as automation of knowledge work is enabled by advances in cyber-physical systems augmented with machine learning and artificial intelligence.

There are significant barriers in achieving these mutually beneficial productive interactions. Let me begin with the issue of language. Cyber-physical systems experts are comfortable with the language of mathematics, discrete and continuous. While some of the social-economic-behavioral sciences are mathematical in nature and therefore amenable to modeling tools, to realize the true social benefits and guard against (unintended) negative social impacts from these emerging technologies, products and services, I believe that the discussion will need to involve much broader cross-section of social sciences. These are not likely to be familiar

territories for CPS engineers and computer scientists.

Another barrier arises from distinctive cultures and value systems of the fields of engineering and social-behavioral-economic sciences. These value systems and cultures affect what is regarded as high quality research, what is published in peer-reviewed journals and conferences, what is deemed worthy of scarce research support from funding agencies, challenges in forming high-functioning teams, etc.

In order to identify synergies, we need to begin with clearly recognizing the need and value of the engagements between our respective communities. In this regard, I can say that public and policy makers are already favorably disposed. For example, policy makers have a very high regard for infrastructure resilience programs, such as earthquake and multi-hazard research which naturally draws from engineering and social sciences. And the public backlash against some of the web 2.0 areas such as social networking technologies shows the need to understand and prevent intended and unintended negative outcomes.

As far as low hanging fruits are concerned, here are some possible avenues. Federal agencies, NSF in particular, have encouraged collaborations between engineers, computer scientists, and social-behavioral-economic scientists. Such programs are risky, and in times of tight budgets, they may shrink. It would be good to share great "exemplars" of such collaborations to encourage and inspire others to follow and showcase successful paradigms. Integration of research and education in programs such as the National Research Traineeship (NRT) that support such collaborations is another possible avenue.

Finally, and much more importantly, we will need to educate the next generation of engineers to be sensitive and aware of the larger socio-economic milieu in which their work will take place. It is important to fight the natural tendency towards "technological determinism" and take the position that technology and society are inextricably linked and they influence each other's evolution.