The Vision: Requirements Engineering in Society

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I. 25 Years of RE: Reflecting a Changing World

Industry and society are facing radical changes due to fast growing digital technologies and its ubiquity [7], [8]. Products and services will increasingly augment and integrate the real world with the digital world. This digital transformation has reached all business areas. Companies and consumers expect to obtain innovation, market penetration, cost reductions and more flexibility.

A recent study of the IEEE Software journal [1] showed that in 1984-1989 *programming* was the most referred term in this journal's articles. The first Requirement Engineering (RE) paper in IEEE Software journal was published on verifying and validating software requirements by Barry Boehm in 1984 [3]. Starting from 1990, *requirements* attracted increasing attention and the term was very frequent among IEEE Software papers.

Besides quantity, the content and emphasis of RE papers have changed over years. We no longer are just fascinated by a RE technology without looking "behind the scenes". An increasing number of research studies look into impacts on society and industries [6]. In the 21ˆst century, computational power, storage (memory), and communication capacity are in the hands of every online person in the society. While this brings the opportunity of using crowd and cloud computations, it also implies the responsibility of improving *the quality of life* in our society, and not limiting the discipline to address exclusively business-driven problems.

The relationship between RE and society is bi-directional. In this talk, we discuss the evolving role of RE by referring to a quarter century of impressive research. We discuss the increasing scope and responsibility of our discipline, serving as the bridge between the general public and technical teams and providing a response to the dramatic changes in our society.

II. Changing Requirements Decisions

RE is a decision-centric discipline [2]. New technologies such as mobile and wearable devices create a satellite data. Analyzing user communities, forums [4], social media [12], and app stores [17], provides a broad range of information that supports all types of requirements decisions. Not considering this satellite data for requirement decision making makes our developed software applications less helpful and desirable for general public. Extracting information from tweets about a wildfire emergency situation showed that existing wildfire mobile apps cover only 15% of essential features requested by the general public [21].

What's being decided? Requirements engineering will remain a decision-centric process, but the way decisions are made, the information they rely upon, and the people and stakeholder involved in the process will further change [18]. Analyzing social media to elicit the software requirements is a contemporary example. MAPFEAT [21] is a method to automatically transfer general purpose tweets (for example about wildfire) into software features by searching for user needs in mobile app stores.

How the decisions are made? We are moving from intuition to evidence. Daneva et al. considered the pathway of empirical RE research analyzed from a series of EmpiRE workshops [5]. RE involves numerous decision problems that now should be extended toward involving the general public. There is increasing emphasis on evidence as studied in empirical RE. More powerful embedded systems and mobile devices provide situational and personal data from the general public [14]. These all enable software engineers to move from their intuition into evidence. The analysis of app store reviews is a prominent example of that trend. Looking information extracted from social media is another promising direction. In a recent study, we proved that information combined from social media and app stores provides essential and complementary support for RE decision making [20].

Who makes the decisions? The importance of user and stakeholder involvement for project success has been analyzed by various authors [1]. Crowdsourcing is increasingly being discussed to enlarge the set of stakeholders and to elicit and manage requirements. Workshops like CrowdRE were designed to address the role of the crowd in RE. Social media and other communication channels allow almost unlimited access participating in the decision-making processes.

III. RE for Society: The Road Ahead

Software has a tremendous impact on society, and so does RE. Not understanding needs, markets and trends will ruin companies, but even entire countries, as we currently see when looking at the world map. Requirements engineering is the key lever to keep focus on what matters. We have asked decision makers worldwide to identify such trends [9]. In the sequel, we briefly discuss four of these trends.

RE for innovation: RE together with product management helps to balance cost and effort and thus maintain a sustainable

[1] http://obren.info/ieeesw/

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business. Innovation drives all companies and social economy. RE provides the framework for innovative products and the innovation pipeline. A good example is the current convergence of IT with many traditional business models. This digital transformation is moving products to connected services [9], [13], [15].

RE for safety-critical systems: There is no business if IT systems are perceived as insecure or even unsafe. Governments and companies are equally worried about today poor state of IT protection. Autonomous vehicles as well as connected medical systems are not trusted as long as there is no proven safety – which of course depends on cyber-security. Security RE, and more widely speaking correctly addressing quality requirements is pivotal across industries [7], [9], [19].

RE for digital health and aging society: Traditional requirement analysis is now replaced by careful understanding of users in social media. 19% of Twitter users and 56% of internet users older than 65 years old use Facebook. Understanding and investigating on their attitude and stated needs in a form of social media status by mining social media over time will support decisions for technology design [11], [16].

RE for smart things and cities: The Internet of Things, cyber-physical systems, and the trend towards digitalization have become the main source of new business opportunities. Robots cooperate with human workers; high-speed trains are flexibly configured according to volatile mobility demands, and smart grids self-manage demand and response of energy. Requirements to such systems are very different from what we are used to in the – limited – worlds of Apps, IT systems and embedded systems, as they connect these three areas. Future RE has to specify and model connectivity, distribution, flexibility, self-adaptation, and the usage of massive amounts of data [10], [19], [9].

RE for collaboration: Development and operations of software-driven systems converges and needs a continuous RE. Continuous evolution of such systems demands modeling dependencies and risk on performance, safety, and availability. Failure is not an option for such systems. Often human life is endangered when physical processes are no longer under control and essential infrastructure of our modern society becomes unavailable. It makes a difference if an app or ERP system fails, or if we have shortage of clean water or a power failure. Resilience thus is a core requirement, often with decades of continuous operation. Collaborative tools facilitate the necessary flexibility. They also allow new eco-systems such as for pen innovation [9], [13].

IV. Discussion

A little rebellion now and then is a good thing, as Thomas Jefferson once remarked. Do we need a new RE? Not to our point of view. But we need to better position RE at the center of all engineering disciplines and application domains. RE not only has to be addressed across study programs but also needs a stronger emphasis in companies and society. Times are gone when RE was only about specifications, tools, and modeling. RE in society creates new challenges along the value, human engagement and enabling processes.

This talk intrigues discussion about how RE as a discipline is impacted by the digital transformation – and how requirements engineering will help societies succeed in their digital innovations and transformations. Considering the changes in RE decision process we discuss (but not limit the discussion) to **value** (elicitation of value to evoke knowledge, user needs, and business rationales), **human interactions** (visualization, usability and human factors in RE), **resilience** (business continuity and risk mitigation, e.g., in case of cyber-attacks), and **dependencies** (user experience across consistent services) for better RE in society.

References

[1] U. Abelein and B. Paech. Understanding the influence of user participation and involvement on system success–a systematic mapping study. *Empirical Software Engineering*, 20(1):28–81, 2015.

[2] A. Aurum and C. Wohlin. The fundamental nature of requirements engineering activities as a decision-making process. *Information and Software Technology*, 45(14):945–954, 2003.

[3] B. W. Boehm. Verifying and validating software requirements and design specifications. *IEEE software*, 1(1):75, 1984.

[4] J. Cleland-Huang, H. Dumitru, C. Duan, and C. Castro-Herrera. Automated support for managing feature requests in open forums. *Communications of the ACM*, 52(10):68–74, 2009.

[5] M. Daneva, D. Damian, A. Marchetto, and O. Pastor. Empirical research methodologies and studies in requirements engineering: How far did we come? *Journal of systems and software*, 95:1–9, 2014.

[6] C. Duarte and T. Gorschek. Technology transfer - requirements engineering research to industrial practice: An open (ended) debate. *RE 2015*, pages 414–415, 2015.

[7] C. Ebert. Looking into the future. *IEEE Software*, 32(6):92–97, 2015.

[8] C. Ebert and C. Duarte. Requirements engineering for the digital transformation: Industry panel. pages 4–5, 2016.

[9] C. Ebert and K. Shankar. Industry trends 2017. *IEEE Software*, 34(2):112–116, 2017.

[10] J.-P. Exner. The espresso-project-a european approach for smart city standards. *Lecture Notes in Computer Science*, 9788:483–490, 2016.

[11] S. Fricker, C. ThÃmmler, and A. Gavras. *Requirements engineering for digital health*. 2015.

[12] E. Guzman and W. Maalej. How do users like this feature? a fine grained sentiment analysis of app reviews. In *Proc. RE2014*, pages 153–162. IEEE, 2014.

[13] J. Horkoff, N. Maiden, and J. Lockerbie. Creativity and goal modeling for software requirements engineering. *Conference on Creativity and Cognition*, pages 165–168, 2015.

[14] B. A. Kitchenham, T. Dyba, and M. Jorgensen. Evidence-based software engineering. In *ICSE*, pages 273–281. IEEE Computer Society, 2004.

[15] J. Linåker, B. Regnell, and H. Munir. Requirements engineering in open innovation: A research agenda. volume 24-26, pages 208–212, 2015.

[16] L. Liu, L. Feng, Z. Cao, and J. Li. Requirements engineering for health data analytics: Challenges and possible directions. *RE*, pages 266–275, 2016.

[17] W. Maalej and H. Nabil. Bug report, feature request, or simply praise? on automatically classifying app reviews. In *RE*, pages 116–125. IEEE, 2015.

[18] W. Maalej, M. Nayebi, T. Johann, and G. Ruhe. Toward data-driven requirements engineering. *IEEE Software*, 33(1):48–54, 2016.

[19] L. Martins and T. Gorschek. Requirements engineering for safety-critical systems: A systematic literature review. *Information and Software Technology*, 75:71–89, 2016.

[20] M. Nayebi, H. Cho, H. Farrahi, and G. Ruhe. App store mining is not enough. In *Proc. ICSE*. ACM, 2017.

[21] M. Nayebi, M. Marbuti, R. Quapp, F. Maurer, and G. Ruhe. Crowdsourced exploration of mobile app features: A case study of the fort mcmurray wildfire. In *ICSE*. ACM, 2017.

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