European Robotics Initiatives: Perspectives and Opportunities for Serbia

Uwe Haass, Life Member, IEEE

***Abstract*—Robotics is a pivotal technology permeating almost all sectors of industry and services. This paper presents a number of strategies on developing European excellence in robotics, from an EU point of view. The information is meant to motivate Serbian roboticists to identify a regional strategy for Serbia to join the leadership in European robotics again. Outset of these reflections is the European robotics initiative SPARC, its goals and its legal structure as a public private partnership between the European Commission and the European robotics association euRobotics. Preparing an annually updated European Roadmap on Robotics is one of the key activities of the association within the partnership. Within the last years, the focus shifted from research to spur innovation on all technology readiness levels. Non-technical instruments presented here are the European Robotics Week which brings robotics particularly to youngsters as a stimulus for engineering and entrepreneurship, but reaches out to all citizens to develop an understanding for the effects on society and economy. At the other end, strategies are prepared to mobilize the potential of regions. The European Parliament has started an initiative to develop a common legal basis for robotics in Europe, including liability issues and ethics. This would lend national and regional activities a common framework. The author suggests that Serbia can benefit from these developments tremendously by getting integrated into these European activities and come up with solutions tailored to the Serbian situation.**

***Index Terms*—Robotics; European Commission; Public-Private Partnership; euRobotics; SPARC; Roadmap; European Robotics Week; Entrepreneurship; Strategies for Innovation; European Parliament; Serbia.**

I. SPARC – The Partnership for Robotics in Europe

Within the last ten years, we have seen an enormous expansion of European robotics moving from manufacturing and automation into many other industrial and professional service sectors, mostly in maintenance, agriculture, health, logistics, mining, and public services. Improved technologies like sensor-based collaboration with humans and growing autonomy on one side, and, on the other side, steadily decreasing investment costs have made this possible – combined with a European mix of first-class research, the ability for interdisciplinary work, and public funding from the European Commission.

In order to improve the transfer from laboratories to applications, the European Commission engaged in 2013 into the Public Private Partnership "SPARC" with the European robotics community. A Public Private Partnership (PPP) is a particularly close type of cooperation in a strategic field of technology, whereby the "public" partner is the European Commission; the "private" partner needs to be a legal entity to fulfil the requirements for a contractual alignment. In case of SPARC, the "private" partner is euRobotics AISBL, a Brussels-based association representing European robotics industry, research, and academia [1].

Founded in 2012, euRobotics enjoys as of today 258 members from 33 European countries. Only institutions and organisations can become members, not individual persons. About 2/3 of the members are universities and research organisations, 1/3 industrial members including many SMEs.

With a volume of €700m funding from the European Commission under Horizon2020, and complemented with a threefold commitment of European industry, SPARC is currently the largest civilian robotics programme in the world. It is based on the political objective that Europe's position in robotics remains as advanced as today, with maximum benefits to the European economy and society.

The robotics market grows world-wide with more than 10% per year, and creates thousands of new jobs – not only in *manufacturing* robots, but also as a result of raising productivity by *using* robots. Statistics anticipate that the world market for service robots will surpass the market for industrial robots in 2023.

Within SPARC, a participatory process has been introduced to develop a European strategy for robotics. Under the umbrella of euRobotics, more than hundred experts participate in over 20 Topic Groups in shaping the European Roadmap for Robotics which serves the European Commission as a strategy for the robotics programme under Horizon2020. These Topic Groups are the backbone of the association. They discuss robotic markets, technologies, and also topics of basic research for the next generation of industrial and service robots. Beyond that, they also develop strategies how to establish value chains among producers of components, the role of SMEs and start-ups, the needs for ethical, legal and societal concern (ELSE), and innovation management for, and with, robots. So far, two experts from Serbia have contributed substantially to the Topic Group meetings.

Uwe Haass has been Secretary-General of euRobotics AISBL until his retirement on 1 February 2016. Since then he is working as a freelancing consultant, located at Breisacher Str. 2, 81667 München, Germany (e-mail: Uwe.Haass@roboconsult.eu).

The resulting "Multi-annual Roadmap for Robotics in Europe (MAR)" is updated annually to reflect the development in robotics and current priorities [2]. The Roadmap Document is based on a Strategic Research Agenda (SRA) [3] which sets the framework for strategic discussions. The MAR is a key document which the Commission uses for deciding on the yearly call for proposals in the ICT area of robotics. Both documents, the SRA and the MAR, are used by many organisations as key reference for their own strategy in robotics.

II. European Robotics Week

The association euRobotics is not only active in drafting the Roadmap and proposing funding programmes to the Commission. It is equally active in building the robotics community in Europe with presentations at industrial fairs (such as AUTOMATICA) and conferences, organising the annual European Robotics *Forum* with more than 600 participants – which has become the most important networking event in robotics in Europe – and awarding entrepreneurship and technology transfer.

Special attention is being given – also from the European Commission and recently also from the Committee of Regions – to the Annual European Robotics *Week* ERW which takes place in the last full week of November in each year. ERW has the following objectives:

- to motivate towards robotics and entrepreneurship and ingenuity,
- to motivate children to learn STEM subjects (science, technology, engineering, and mathematics),
- to open the doors of the research centres and discuss robotics with media and – the citizens: to show the potential and eliminate any exaggerated fears and present what robots can do and can't do,
- to have objective discussions if, and under what conditions, robots "steal jobs", and what needs to be done that "robot create jobs".

During ERW, events are launched with the purpose to bring robotics to children, school pupils, and the general audience. Examples are open door days in factories and research institutes, contests with little robots, discussions in museums and in companies, guided tours, TV shows, public hearings etc. The events should also raise awareness of the population for technical training as a chance to keep, or gain, a job. In 2016, there were more than 650 events all over Europe during ERW with tens of thousands of participants.

All the events are listed in a catalogue. The catalogue for 2016 listed six events in Serbia. It is hoped that participation in Serbia will increase in 2017 and the following years. Robots in schools and in professional training have a particularly educational value, because they combine creativity, software, and hardware – robots move, have a physical "purpose" and can be touched. Robots are doing something humans can see and relate to from their daily life.

Events during European Robotics Week can initiate entrepreneurship, creativity, and may lead to inventions and start-ups. In any case, they bring excitement to kids and adults. European Robotics Week has been proven to be an important "bottom-up" initiative in many countries and regions of Europe to pave the way for robotics in industry and society, and support innovation and entrepreneurship.

III. Regions and Robotics: a key to innovation

So far there is evidence that SPARC has stimulated a very active European robotics community with substantial growth rates observed by both users and producers of robots. For the remaining years under H2020, the strategy of the Commission focusses much more on (i) the integration of robotics into the DEI initiative (Digitizing European Industry), and (ii) regional Digital Innovation Hubs (DIH) as a consequence of the very unbalanced geographical situation of robotics in Europe. DIHs are to stimulate innovation, entrepreneurship, the creation of jobs in regions which have the potential, but suffer from non-technical barriers to evolve. Robotics is seen as having high potentials for the regional development to the benefit of its economy and society ("smart specialisation"). These developments may be relevant also for Serbia.

When politicians try to respond to unpleasant economic figures, such as unemployment figures, they usually ask for innovations – often without knowing how innovations come about, how they are "created". In many European states, the unemployment figures – especially of young people – are intolerably high. Among OECD and EU member states, innovation is usually "measured" by using 24 indices defined in the "Oslo manual" [4]. These indices are typically composed into a "country index".

The indicators can be divided into *input* indicators (such as money spent for R&D) and *output* indicators (such as patents applied). The procedure is generally well accepted, but there are two important issues:

(1) The resulting "index" shows a static picture; important is a comparison from year to year. For example, Serbia is improving and, in 2016, has gained a middle position among "moderate" innovators, right after Slovakia and before Poland.

(2) In order to identify strengths and weaknesses in detail, each single indicator should be looked at and compared with the ones of "strong innovators".

Another source for a more detailed analysis on innovation performance is the 2016 UNESCO Report on Science [5]. For Serbia, the report lists, among many other details, the following *positive* results such as

- innovation performance has greatly improved since 2010,
- there is now greater collaboration among SMEs,
- youth education at the upper secondary level,
- growing employment opportunities in knowledge-intensive sectors,
- growing expenditure in non-R&D innovation (i.e., efficiency driven).

The following *problems* have been identified, though:

- highly fragmented innovation system (not coordinated);
- innovation "only" efficiency-driven, not R&D-driven;

- poor connection of R&D with the rest of economy and society;
- lack of a culture of technological entrepreneurship in universities and the government sector;
- absence of an evaluation culture;
- persistent brain drain of highly educated individuals.

If we want to give Europe a higher internal stability, great differences in the economic performance and welfare need to be avoided. We need to make sure that no country, "no region is left behind". This is the core of the EU "Cohesion policy".

Robotics has a particularly high potential to spur innovation: (1) robotics is a "pivotal" technology which is in the process of penetrating almost all sectors of industry as well as civil and private services, from logistics to healthcare, from mining to construction, from agriculture and food processing to maintenance and cleaning. So there is ample room for ingenuity and markets. (2) The prices for robots and components, including software, has dropped in the last 4 years by almost 50%; components for perception, locomotion and navigation have become achievable for many purposes; (3) some standardization efforts such as ROS (Robot Operating System) have developed possibilities to bypass or compensate for proprietary systems, and (4), not all robots require high-precision, high-technology components; in some applications, this may be true, but many applications do not require systems of high sophistication.

The effects of robotics on employment are still debated in politics and media. In general, there are two theories: Hypothesis A is the "Release theory" (during each industrial revolution, jobs are lost on a massive scale), and Hypothesis B: "Compensation theory" (new products, new markets expand the demand, especially with additive innovations; after a few years, people find new jobs in growth industries).

Most recent studies differentiate between types of jobs, training, organizations, etc., for example they show that ICT may make jobs obsolete more likely in simple office jobs, especially with the advent of Artificial Intelligence in administrative software. Robots, however, have increased productivity between 20 and 50%, with the result not only in more jobs in manufacturing, but also before and after manufacturing, such as sales and logistics. All studies conclude that education and training is very important, to improve the chances of workers and employees to adapt to changing technologies.

Countries where robots are produced have an even better chance to create new jobs than those where robots are used. Recent studies show that regions may have, or may develop, excellent opportunities for innovation – with robotics. Given the fact that the market for service robots will outperform the market for industrial robots within the next 5 years, and looking at the spread of developers of service-robots beyond the traditionally strong industrial regions in Europe, innovation and ingenuity become more important than mass production. Here, regional activities are given many opportunities.

Fig. 1 shows the simplified result of a SWOT Analysis of European Robotics which includes strategies for avoiding threats and weaknesses, and others to amplify chances and opportunities.

	Opportunities: • Speed of innovation and markets • Diversity of robots	**Threats:** • Competition • Financial crises • Users' animosities
Strengths: • Interdisciplinary • Cooperation of Research and Industry	**Strategies:** • innovation measures • Networking • Standardisation • Regional Technology Transfer	**Strategies** • Learn from others • Offensive marketing • Public Relations of European success
Weaknesses • "Valley of death" • value chains do not exist • Investment • Entrepreneurship	**Strategies** • Build Value Chains • Show return on investment , creation of jobs	**Strategies** • Networking • Get users on board • Involve schools, education

Fig. 1. Simplified SWOT analysis for Robotics in Europe. Regional activities have a high potential to spur innovation, because the strategies shown (especially those in red) take advantage of the proximity of stakeholders.

A recent unpublished survey by the German Fraunhofer Institute IPA shows that regional Technology Transfer happens mostly face-to-face, that is within a travel distance of 20 - 200 km. People in the region have a similar tradition, similar history, culture. They also have a "regional patriotism".

A regional cluster, or a hub, then ideally consists of local industries and services, institutions of education and training that understand the needs to focus curricula to the competencies needed, supported by local government and the regional population. The idea is to bring about a climate of innovation and optimism, to develop a regional roadmap and strategy which is also referred to as "smart specialisation". Then a technology-transfer centre is needed which also serves as a show-room for robotics to potential end-users. Start-ups will get a chance to work in this centre for the first few years. The centre is the needed because robotics requires several disciplines to work together; it requires a workshop with tools, equipment and technicians, and, knowledge of the applications (manufacturing, agriculture, logistics etc.,) which are planned to be supported with robotics. The centre will also cater to regular meetings of all "roboticists" taking part in this regional initiative. These meetings, organised in a friendly environment with food and drinks, will be open to everybody – once in a while also to roboticists from neighbouring regions and partners in Europe. This will create further interest, and new ideas are generated.

IV. European Parliament: Legal Issues in Robotics

In January 2015, the Legal Affairs (JURI) Committee of the European Parliament decided to establish a working group on legal questions related to the development of robotics and artificial intelligence in the EU, with a focus on civil-law aspects. The group held ten meetings between May 2015 and September 2016, and heard advice from a number of stakeholders, scientists and lawyers. In January 2017, the JURI

Committee adopted its report with recommendations to the Commission, on 'Civil law rules on robotics' [6].

The report calls upon the Commission to propose EU legislation defining a 'smart robot'. It also proposes to introduce a system of registration of advanced robots that would be managed by an EU Agency for Robotics and Artificial Intelligence. This agency would also provide technical, ethical and regulatory expertise on robotics to public actors. The report proposed, as an annex to the resolution, two draft codes of conduct – a Code of Ethical Conduct for Robotics Engineers and a Code for Research Ethics Committees. This is the first and most comprehensive suggestion for laws on robotics in Europe.

It is important to know that only the Commission can start a legislative initiative. The Parliament can issue only a report explaining the need. The Commission then has 3 months of time to become active. A public consultation on the suggested civil-law rules for robotics lasted until April 2017, with separate questionnaires for the general public and for experts. The results are expected to be published in the autumn of 2017.

V. Conclusion

This paper concludes with a number of recommendations for the development of regional and national strategies for taking advantage of robotics. These have been presented in a recent workshop [7] and are summarized as follows:

1) Develop a Regional Roadmap

Robotics is a rapidly advancing technology which will soon be ubiquitous in our lives: applications range from manufacturing to the health sector, from agriculture to mining, from maintenance of industrial plants to construction of buildings, from rescue to transport and logistics. Robots look different and do different things. Regions should develop a regional strategy (a "roadmap") with the aim to identify strengths and objectives around their existing core competencies. It is important that regional stakeholders ranging from universities to industrial application experts cooperate.

2) Locate a Technology Transfer Centre

The regional community needs to be given a forum where to meet and to exchange and develop views, progress, partnerships, so-called "innovation hubs". Ideal are existing technology transfer centres, universities or polytechnic schools. Ideal are regional locations to work together, such as technology transfer centres, or central robot laboratories, with offices for the various groups. This has the advantage of creating a community and sharing experience. If possible, also open to visitors at certain times.

3) Management of the regional innovation hub, regional agreements / contracts

It is important to draft an agreement about partners, their responsibilities, and the rules for using the central hub and its equipment.

4) Entrepreneurship and start-ups

Have a special focus on entrepreneurship, the creation of start-ups and the integration of SMEs in robotics. These are very important stepping stones for the regional development.

Start-up companies should be given inexpensive space to rent – possibly within the building or complex of the transfer centre.

5) European (and other) Funding Programmes

European Funds, such as from the funding programmes of the European Commission should be applied for and used for supporting infrastructure, science, education, innovation, cooperation, and outreach to the population. Take advantage of these funds. Some require that the initiative starts on the regional level.

6) Open your doors to the population, discussion on jobs and economy, invite schools

Organise exhibitions, open door days of your institution, and invite the local population (free entrance). Invite also your partners from other parts of Europe to be present with exhibits and robots. Organise (slide, video) presentations in public educational institutions, like evening classes, theatres, etc

Organise events for children and students, such as robot competitions, or just for fun. Invite the media/press to all of these events. Include in your presentations the effects of robots on jobs. If necessary, get recent studies from euRobotics in Brussels.

7) Marketing to regional industry and beyond

Robots can lead to higher productivity and at the same time create many new jobs. In order to avoid a polarisation of the society, any innovation strategy needs to take into account, and integrate, the whole society, most importantly educational and training organisations as well as existing industry. This can be done often much quicker on a regional level.

Acknowledgment

The author is grateful to many experts in those fields which are covered in this paper only briefly, with whom many discussions have become the basis for further work on innovation with robotics. The gratitude includes also the appreciation of having learned very much from Serbian experts about robotics in Serbia – from excellence in the past to the prospects for tomorrow.

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