Scientific Advisory Board Report

The visit was conducted January 30 and 31, 2012 at INESC-TEC.

The INESC-TEC Scientific Advisor Board included:

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The meetings were coordinated by Dr. José Principe. This report is an effort of all the above members.

This report is divided into three major parts:

- I- The overall scientific review of INESC-TEC.
- II- Recommendations to the Board of Directors.
- III- Reports for individual Unit activities.

I- Overall Scientific Review of INESC-TEC LA

I.1. General Comments

INESC-TEC Laboratory Associado (LA) has become a multifaceted Institution organized in 7 Units: Telecommunications and Multimedia (UTM), Manufacturing Systems Engineering (UESP), Information and Communication Systems (USIC), Power Systems (USE), Optoelectronics and Electronic Systems (UOSE), Robotics (ROBIS) and Innovation and Technology Transfer (UITT) that constituted the former INESC Porto, and 5 Laboratories: Laboratory of Artificial Intelligence and Decision Support (LIAAD), Center for Research in Advanced Computing Systems (CRACS), Unit of Industrial Management and Engineering (UGEI), Research Centre in Real-Time and Embedded Computing Systems (CISTER) and High-Assurance Software Laboratory (HASLAB) with a common support services infrastructure. Each internal Unit and the new Laboratories were born and grew independent of the others in a bottom up fashion. This evolution created Units and Laboratories with very different profiles, goals and perspectives, which enable each to exploit the local and short-term niches in the Portuguese market, but at the same time it is a challenge to design a coherent, long-term plan for the overall Associate Laboratory.

INESC-TEC defines itself as an interface Institution, creating and transferring technology from the highly skilled University environment to a mostly traditional and technology "challenged" Industry, Services and Public Administration, with an excellent moto: from knowledge based production to science based innovation. Each Unit has between 5 and 30 Ph.Ds, a varying number of University Professors and graduate students with, in most units, only one or two full-time staff. A Scientific Council structure was created for each Unit, with a coordinator, who integrates the INESC TEC Scientific Council representing all the faculty members in the institution. Each Unit has a coordinator, who along with the scientific council coordinator interacts with a Board of Directors. Across the whole structure we see predominantly academicians. The new Laboratories have equal standing to the original INESC Porto Units, except that they have more freedom in defining their own structure.

INESC-TEC received the Laboratorio Associado (LA) standing in 2002 by the Ministry of Science and Technology, which places it in a very selective group of Portuguese Research Institutions, and demonstrates the caliber of the research and the importance of the current areas of expertise for the Portuguese technology development. INESC-TEC grew meteorically in the last 4 years and can now be considered a large size research/technology institution with an annual budget surpassing 12 million euros and with 600 members (200 with Ph.D.s, approximately 50 staff), and five distinct facilities in Northern Portugal.

The Scientific Advisory Board (SAB) was very impressed with the management of INESC TEC LA because the same basic structure withstood a doubling in the LA size.

The LA status brought much needed stability in institutional funding, but we were very impressed with the six fold multiplicative factor achieved from the base funding (~ 2 million) to the overall budget of the LA, divided in 42% of total budget from direct contracts with industry and 30% of total budget in international activity. Plenty of examples of high profile projects with Portuguese Companies and international partners (ESA, BBC, Argonne Natl Labs, Red Electrica), interventions in the Portuguese shoe industry and the smart grid initiative with EDP, and the creation of 3 successful spinoffs (Fiber Sensing, Prewind and Tomorrow Options) show that INESC TEC is a presence in social relevant research. This is rare in the Portuguese LA universe and attests to the entrepreneurial spirit and effectiveness of INESC management as well as researchers' productivity. Moreover, it means that the formula found to blend academic excellence with entrepreneurial activities and technology transfer is working.

INESC TEC is consolidating its unique style of operation and is answering positively the SAB recommendations. To our critique that Units behave like "silos" INESC management now presents a bubble diagram with explicit scientific broad areas hierarchically organized in clusters, which is a step in the right direction. The creation of the UITT is also a response to a previous SAB comment that was directed towards addressing technology transfer as a science to spread best practices throughout the LA. Another sign of consolidation is the realization that INESC TEC footprint extends beyond pure academics, and as such, the metrics for its activity have to be enhanced with other criteria. The identification of four distinct activities within the institute (basic knowledge production, applied research, development and technology transfer/ valorization) is very important as well as the spelling out their respective metrics of success (journal papers/thesis, journal and conf papers, products/patents/licensing/ consulting/spinoffs), and the positioning of each Unit/Laboratory in this axis.

Another positive note is the internationalization of INESC TEC activities. INESC TEC has in 2011 28 international funded projects, and its international members include 3 faculty, 6 hired researchers, 2 invited researchers 8 trainees, as well as 49 grantees. INESC TEC is part of international programs with MIT, CMU and U. of Texas at Austin, and is expanding its activities to Brazil by partnering with two University consortia in Northeast and Southeast Brazil.

I.2. Units' Scientific Performance

INESC TEC is a multifaceted institution so there is a large variance of scientific performance across Units and Laboratories due to their different profiles. Research at UOSE is top notch overall and highly visible. Research at USE is world class in an increasingly vital area for society (energy). UESP research is still very good but the unit should consider modernizing its research portfolio to answer the industry's need for innovation. In this respect stronger collaboration with UGEI might help, since UGEI is understaffed for the breadth of topics it wishes to cover. UTM has activities in all the layers of the entire communication model, with pockets of excellence and exploitable results, but the added value given the breadth should be continuously monitored. The joint leadership of USIG turned the unit around and in the right direction. USIG has the

potential to become a very important resource for INESC TEC because of its unique ability to conduct end-to-end R&D in IT systems. The UITT has a clear role in INESC-TEC mission and in spite of its short existence it has a clear vision, good scientific production and relevant events for educating INESC TEC researchers about technology transfer. ROBIS is the newest Unit that fills an important role in INESC TEC because it designs advanced land and underwater vehicles that are launching pads for many of the INESC TEC expertise. ROBIS needs to find a more principled model to science based design to avoid falling in the role of a technology shop. Regarding the Laboratories, LIAAD is a strong group in the academic end of information systems, with a good publication record but a tendency for fragmentation and superficial treatment of topics. The integration with INESC TEC has been excellent and synergistic projects are currently underway. CRACS is also a strong computer science group covering topics in logic programming, information mining, parallel and distributed computing and web-based systems, that is collaborating with USIG but could benefit from a more coherent integration with INESC TEC. UGEI joined INESC with a strong background in operation management, operation research and information systems, with some overlaps with USIG but with a services focus and a very nice blend of topics, approaches and strong research publication. HASLAB joined INESC TEC recently with excellent credentials in fundamental computer science (formal methods, dependability and information security) and also emphasizes applied research and is effectively collaborating with INESC TEC. CISTER is the newest of the Laboratories with a focus on real time and embedded computing systems with a very strong international visibility in a growing area and with some technology transfer. However, it is still weakly linked to the INESC universe which constitutes a missed opportunity and requires attention.

INESC TEC has a sustained overall count of about 1 scientific journal publication per researcher/ per year, which shows progress from previous years, but it is still low by international standards. This culminates a successful effort to improve the journal publication of INESC TEC LA, as the statistics of the last five years clearly indicate: while the number of researchers doubled the scientific output increased five fold. This is very important because the national and international success of INESC-TEC LA is predicated in the visibility of its research, for which the publication record is an important indicator. However, the ratio journal paper/senior researcher is still below the international standards and a continuing effort is needed, although the number of conference proceeding papers is higher but it is not systematically reported by the Units. An honorable exception in the publication is UOSE with an excellent publication record. INESC TEC should look more closely at the scientific production because mean values are not good descriptors when the variance of performance is large…. We suggest that the full histogram of the publication per researcher is obtained, and that this information be made available to all the INESC researchers and grantees for self calibration.

The SAB also applauds the effort to attract international scholars, post docs and Ph.D. students to INESC TEC, currently around 10%. The internationalization of INESC TEC only helps the research enterprise and the institutional visibility, but we think that this internalization can still be improved.

The SAB feels that the scientific atmosphere in INESC-TEC needs reinforcement. The LAIs were started to complement and create synergisms across different Units, but the effort seems to have lost momentum. The Scientific council should be evaluating the situation and reinvigorating or dismantling the LAIs. In any case the INESC TEC researchers should take a more active role in promoting science within the Institute and towards FEUP, thru an Institute-wide regularly scheduled seminar series. This not only invigorates the scientific enterprise but also facilitates inter Unit collaborations. This should also be a forum for young researchers to practice their presentations and their attendance should be enforced before it turns into a habit.

I.3. Balance Depth / Breadth

Generally speaking the tendency is still to dilute resources. We saw everywhere examples of good depth and experience, but the relatively large breadth of the Units and the limited human resources endanger consolidation of core competencies on a long-term basis.

This dilution is not only a problem within the Units but also a problem in the composition of INESC TEC with its 12 Units and 4 cluster areas of activity (information, power and energy, communications and industry). This organization is preferred to the “silos”, but still lacks clarification because the mechanisms to create/hold/evolve the clusters are not defined. The SAB hopes this is not just a visually pleasant presentation mechanism. The point is that INESC must find a way to capitalize on its diversity, or instead it is necessary to focus efforts around well-specified medium to long term goals and synergistically use human resources among the Units to create an identity and make the organization more efficient and effective. Since this issue was not solved before, the recent increase in size made it more apparent, more critical and deserving of more attention. In early years, we mentioned that this could be accomplished thru the identification of institute-wide technical challenges to exploit the full potential of INESC TEC and be easily explained and understood to the non scientific Portuguese community. The current focus on energy and the microgrid can be such an Institute wide initiative because of the theme and the concentration of expertise/visibility. But underwater autonomous vehicles and oceanic exploration is another crucial area.

At the same time, we also saw the same basic technologies applied across many Units, which means that there may be redundancy of competences across the INESC TEC. A clear case is UESP and UGEI. An effort should be done to make an inventory of key technologies (e.g. computational intelligence tools, etc.) and organize cross fertilization amongst the users. Ideally one group could be the producer and enhancer of the required technology while researchers from other Units would be the users. This will benefit the Units that are closer to the science (they will be able to concentrate in more scientific issues and create the corresponding toolkits without an increase in manpower) as well as the ones closer to the valorization (just access the developed tools instead of recreating everything from scratch with better trained individuals).

It is also rather difficult for the SAB members to pin point how the Directors Vision is implemented across the Units, and vice versa, how the Units’ coordinators goals are

glued into the Directors Vision. Therefore it is important to periodic conduct a joint exchange of ideas such that the Institute vision is better translated in the Units goals. The SAB believes that the Units should also improve the way they assess their long term activities. Strategic thinking should be an integral part of the definition of the topics of submitted research proposals and their outcomes, definition of expertise thru Ph.D. topics, and hiring of human resources. It is important to recognize that a grant or a contract are just ways to obtain the funds to implement a medium/long term research goal and should not be confused with a goal in itself.

I.4. Gaps in Expertise

We will defer this point to the individual unit evaluations.

I.5. Balance between R&D and Exploitation

INESC TEC has mastered a style of organization well fitted to the Portuguese landscape. The most distinguishable feature is the inclusion of multidisciplinarity at the Units' level, which is well fitted to the reality that the solution of real world problems is beyond a single academic expertise. This is what the Director's presentation refers to the DNA of the Institute. The growth of INESC TEC and the high multiplicative factor of the base funding are proofs that the recipe is working. There are excellent examples of exploitation of past R&D efforts with the creation of start ups and large contracts, which are a very good sign of maturity and accomplishment. But of course this is also at the core of the dilution of resources mentioned above and so it needs to be constantly monitored.

The recent positioning of the Units and Laboratories in a linear scale with four levels that links scientific themes with exploitation of value is a very important landmark that can assist in defining proper balance between research and exploitation. It also can be a way to reevaluate the rating system for performance of the INESC TEC as a whole. Every activity should have its rating system developed in function of the expected outcomes for the phases of the research development path. This will help the low publication numbers per researcher mentioned above, but it cannot be regarded as an "excuse" to show better performance. Therefore the rating system has to be presented and justified in scientific terms with a comparison amongst similar institutes around the world. Therefore it should be a topic that the UITT should embrace, and to present a proposal for the next SAB meeting.

I.6. SWOT Analysis

The Director's presentation did not include a SWOT analysis of the INESC TEC LA. This will be highly beneficial and the SAB such an analysis in the next visit.

Strengths

- Meteoric expansion since the last visit
- Unique style of aggregating and leveraging scientific expertise to address real world problems ("INESC DNA")
- Improved rate of productivity and excellent multiplicative factor of base funding
- People Assets – vibrant mature and young researchers
- Several Integrative and cutting edge research projects
- Strategic vision for growth (inside and outside Portugal)
- Improved international visibility and attraction of international scholars
- Efficient Management + Support Services

Weaknesses

- Uneven quality of research. Some Units and Laboratories need:
    - More (new) focus+ critical mass
    - Identification of strategic goals
- Scientific productivity needs further improvement
- Poor articulation of Unit's SWOT analysis with Unit's vision and mission.
- Lack of a structural management approach to:
    - Create and assess mid-term R&D plans
    - Exploit diversity of expertise
    - Manage maturity of areas
    - Careers and Succession plans
- No IPR policy in place

Opportunities

- Internationalization of activities in Brasil
- Creation of other highly visible and "use-oriented" flagship projects
- External visibility can still be improved
- Strategic alliances should be pursued
- De facto integration of the new Laboratories

Threats

- Portuguese economic situation
- Unclear mission, vision and implementation plans
- Organization is mismatched to the new scale of the Institute
- Excessive dispersion of activity and unfinished incorporation of the new laboratories

II- Scientific Advisory Board Recommendations

The SAB presents below a set of recommendations to the Directors. This list addresses in different ways bottlenecks in the present structure and should be interpreted as guidelines/ suggestions for further analysis, internal discussions and possible implementation in the short term.

1. INESC TEC needs a vision and a mission statement. Currently there is no vision statement and a weak mission (interface institution is more of a definition than a mission). The SAB believe that "From Knowledge Production to Science Based Innovation" is the right motto… and a vision and a mission can be developed around it.

2. Exponential growth should be followed by a period of maturation to solidify the Institute and create an organization structure that is dimensioned to the new scale. The Board of Directors should focus more on the strategic planning of INESC TEC LA. The INESC-TEC Units and Laboratories should aim at Vision Alignment and Mission Convergence while compatiblizing cultures.

3. The Scientific Council is almost invisible in the life of INESC TEC. It should be restructured to orchestrate the diversity of expertise across the INESC-TEC Units and to drive the scientific policy. For instance, INESC TEC should have an inventory of expertise, and mechanisms to identify creators and users of technology across the institute to avoid duplications and promote the creation of general software packages to improve development time across units and laboratories. LAIs also need quite a bit of attention to be effective. The following recommendations are also within the Scientific Council sphere of influence.

4. "Clusters and Bubbles" are much better than the silos, but so far it seems more a presentation mechanism to show the Institute areas of activity than an actual new structure in the functional organization of INESC TEC. The clusters should have a mandate such as the development of joint five year research and implementation plans to speed up the integration of its units and laboratories. Moreover, they should create and maintain a portfolio of scientific and technology expertise, foster inter-unit collaborations, improve efficiency, and be a resource for new leadership.

5. The current scientific based performance metrics for the LA investigators are insufficient to measure the multifaceted mission of INESC-TEC. Progress was apparent in the definition of levels in the science to product valorization chain. So now it is necessary to create metrics within and across each level such that researchers can be properly measured by all their diverse activities. Perhaps UITT should be tasked to study and implement this recommendation, since it has to be a systematic study to be a substitute for the FCT scientific measures.

6. INESC TEC can now be considered a large research Institute and as such it has to streamline its image and create a lively and informative research environment. Here are some suggestions that will improve the dissemination of information and promote excellence.

    - Periodic Seminar Series with internal/external distinguished speakers with compulsory attendance for the grantees (until this becomes habit).
    - Each Unit/Laboratory should organize an Open House yearly.
    - Upon admission, new grantees should be introduced to the INESC TEC organization and culture.
    - Yearly Award ceremony for best (student / senior) papers, INESC TEC Project Award, INESC TEC Researcher of the year, INESC TEC Developer of the year, INESC TEC Staff of the year.
    - Revamp the website and create an automated way of collecting and updating the relevant information.
    - Produce a yearly Activity Report

III- Individual Units Reports

III.1. Unit: Power Systems

III.1.1. Evaluation of Unit's scientific performance

This is one of the most consolidated units of INESC with a long tradition and international reputation.

Since the last SAB evaluation in 2008 the unit has grown keeping the same number of faculties (14 half time University professors, faculty) but hiring 6 researchers and growing from 17 to 41 full time grant holders.

The Unit has been organized in 5 technical areas and new faculty members have been appointed as area leaders. This is a good choice for sharing responsibilities and to prepare potential unit leaders for the future. The unit coordinator continues to be Prof. Matos while Prof. Lopes, previously unit coordinator too, has been appointed as INESC Director. In addition a Unit Council formed by the unit coordinator and area leaders is working as a new collective mechanism for unit management and decision making.

The number of PhD students and number of concluded PhD theses in average remained at the same level as in the previous period (17 PhD full-time students and 5 PhD theses completed in 2009-10). However the number of PhDs (20) and grantees (41) has significantly increased in 2011. It is expected that this will produce results in scientific productivity in the next future.

The number of publications in international journals is in average stabilized during the last four years (around 16 papers per year). However in 2011 the publications in conferences almost doubled previous year numbers.

The exploitation of results measured through direct incomes from industry contracts and R&D services have steadily increased in the period 2009-2011 accounting for 75% of the total incomes of the unit.

The Unit continued involved in the two PhD programs MIT-Portugal in sustainable energy and CMU-Portugal in engineering and public policy.

It is also remarkable the new initiative on establishing a Laboratory for Smart Grids and Electric Vehicles in the new building with already allocated funds for the necessary equipment.

III.1.2. Balance between depth and breath

The Unit has made remarkable progress in the area of Smart Grids in the last four years. New techniques and applications has been developed in the areas of planning and

forecasting of renewable energy, electricity markets, distribution systems and distributed generation, microgrids, and electric vehicles.
There is an opportunity to rename and align the areas of activity around the vision of the Unit focused on Renewable energy integration and Smart Grids. This will provide a more strategic view of the Unit and a more market oriented presentation.
The leadership of the Unit together with the rest of units is still needed for the formulation of an INESC TEC flagship project on Smart Grids with high technological and social impact.

New European projects funded by the Research Framework Program, together with a new open line in the USA and new opportunities in collaboration with INESC in Brazil will continue with the internationalization process conducted by the Unit.

III.1.3. Gaps and required expertise

The number of faculties in the Unit has almost remained stable during the last years while the number of grantees has almost doubled. It is important for the quality of the supervision and the scientific work the Unit increases the number of senior researchers and post-docs.

The financial health of the Unit is ensured through the incomes coming from projects, especially from R&D services and consulting, therefore part of these funds could be allocated for hiring senior scientists and research staff.

III.1.4. R&D tech/transfer

As it has been stated the incomes from R&D and technology transfer contracts have steadily increased in the last years. The Unit has continued contributing with operational margins to the sustainability of INESC TEC.

The new initiative of creating a Laboratory for Smart Grids and Electric Vehicles is a good opportunity to envision new services and offering specialized training. These resources could be relevant to contribute to the financial sustainability of the Lab. The funds for new equipment has been already committed, however annual operational and labor costs of this type of infrastructures are expensive and new income sources should be planned in advance.

III.1.5. SWOT Analysis

Strengths

- The Unit is well consolidated and with a good scientific level
- Good balance between European and national projects, and other R&D activities

- Financial growth ensured by incomes from R&D services and consulting
- International cooperation and recognition
- High number of PhD students and grantees

Weaknesses

- Research publications in journals are still low
- Limited number of senior researchers and scientific staff required to lead projects and PhD supervision
- Research excellence and fellowship are not explicitly recognized

Opportunities

- Ensure future leadership of the Unit by intensifying the role and giving responsibilities to area coordinators
- Promote new specialized training services around the new Lab infrastructure in Smart Grids and Electric Vehicles
- Intensify international cooperation with projects in Brazil, USA and Europe
- Provide leadership to gather INESC TEC skills into a flagship project on Smart Grids

Threats

- The expansion of the Unit could be limited due to the lack of new qualified research staff
- Economic crisis could negatively affect research national funds and other R&D incomes

III.1.6 Recommendations

- Define an integrated flagship vision of the different areas of activity, for instance around “Renewable energy and smart grids”
- Increase the number of publications in journals (stable in the last 4 years but still is low). Annual control of published papers by PhD students and define a target for PhD defense
- Consolidate the role of area leaders in the management of the unit (preparation for future unit leadership)
- Establish a strategic plan for financial sustainability of the new Lab infrastructure (Unique Selling Proposition)
- Promote training services in collaboration with UITT
- Take advantage of the growth of technology transfer activities for allocating more funds for hiring senior researchers and post-doc staff (scientific production)

- Lead INESC TEC units in a collaborative vision for definition of initiatives and projects in the area of Smart Grids
- Continue with the internationalization through European programs and new projects in Brazil and USA

III.1. Unit: Telecommunications and Multimedia

III.1.1. Evaluation of Unit's scientific performance

The Unit includes activities that span the entire layered communications model :

Applications (Information Processing and Pattern Recognition)

Services (Multimedia Communications Technologies)

Network (Mobile and wireless, Internet Architectures)

Physical (Optical and electronics technology)

The Unit is well prepared to deal with overall systems issues, by itself and in cooperation with other Units. The Unit has already undertaken a number of projects jointly with other INESC TEC Units. However, the benefits to the Unit and to INESC TEC from having disparate areas in the same organisation requires investigation

III.1.2. Balance between depth and breadth

The ability to cover all the layers of the communication system can be an advantage but only if the synergy between areas is effectively exploited. Specific comments to each area follow:

Information Processing and Pattern Recognition
The area has a broad mandate
It has shown that it can rapidly develop expertise in new areas
The link between activities and projects should be well aligned with the expected needs of customers

Multimedia Communications Technologies
The area retains its consolidated excellent command of relevant technologies
Even though major players dominate portions of the market, the area should step up the identification of niches of opportunity
Joint activities/projects with Information Processing and Pattern Recognition, and Communications Networks are encouraged

Communications Networks
A clear mission and well defined objectives
Plans laid down at previous SAB meeting properly executed
More attention to scientific contributions required

Optical and Electronics Technologies
Excellent expertise that enables a broad range of potentially valuable projects with good results
Need to focus on promising activities to exploit the size of the group
The scope for synergy between the activities of the area with other areas is not clear

III.1.3. Gaps and required expertise

The expertise of the unit seems capable to cover well the current activities.

III.1.4. R&D tech/transfer

It is generally hard to target R&D tech/transfer in this area populated by major players. Still the proximity of Information Processing and Pattern Recognition, and Multimedia Communications Technologies opens the way to the development of classes of applications targeted to devices in broad use where the component technologies can be put to immediate use, while opening up new avenues of research.

III.1.5. SWOT Analysis

Strengths

The Unit has expertise spanning all layers of Communication from the physical to the application layer

Weaknesses

The Unit does not seem prepared to fully exploit the synergy between its different components

Opportunities

Some of the areas of the Unit are very close to the market and can develop solutions that are much in demand by the market

Threats

This is a mature area where major players can deploy unequalled firepower

III.3. Unit: UESP-Manufacturing Systems Engineering

III.3.1. Evaluation of Unit's scientific performance

The Manufacturing Systems Engineering Unit (UESP) works on Operations Management and Enterprise Information Systems issues closely related to applied research projects and Technology Transfer and valorization. The Unit is covering three main scientific topics such as Collaborative Network Management, Information and Knowledge Management in Collaborative Networks, Operations Management and Logistics and Operations Research and Decision Support. The actual list of running and envisaged research projects shows a good positioning in scientific research activities as well as a high amount of post-graduation theses supervised by members of the unit. Obviously the unit is trying to raise the number of publications, having understood, that the 2011 results are not sufficient for stable and broader scientific recognition.
During the last years, UESP has gained a balanced team (Team Composition: 54(2010)-54(2011)-57 (plan 2012)) as well as a good financial situation. The obtained financial balance for 2011shows up with app. 30% national programs, 30% EU and 30% consultancy and gives a certain security against possible future changes in funding priorities from different stakeholders.

III.3.2. Balance between depth and breadth

The unit is covering a very broad range of different topics, all of them more or less relevant for actual manufacturing issues, but the unit should clearly focus on what are actually THE relevant topics in scientific and industry related activities; which are innovative, upcoming new topics and in which topics the unit has actually deep knowledge and expertise and they would like to pursue. Some of the topics, UESP is still covering, like cutting and packing, are "traditionally" treated, i.e. not in the sense of new scientific approaches, but for industrial consultancy purposes.

III.3.3. Gaps and required expertise

Due to UESPs long tradition of fields of competencies like "cutting and packing", "performance management", "layout design" it is now necessary to take into account the companies actual "need for innovation" in order to create and develop new and innovative expertise for the Unit itself.
Some opportunities might be the recognized possibilities to work with ID-tags like RFID, which make industrial objects intelligent (Smart) and thus can support completely new approaches on production planning and control (High resolution production management). Innovation, Agility, Adaptivity, Smart factories, these are possible future trends, that UESP should be able to deal with.

III.3.4. R&D tech/transfer

The recently developed approach on intervention sectors such as

-collaborate and network
-optimize and decide
-operate and manage

could help UESP to clarify and specify the large variety of unit relevant topics for the future by aligning and perhaps reducing the 16 named competencies. Furthermore the unit should discuss and decide on the industrial target domains they would like to be recognized in.
Fast moving consumer goods (FMCG) networks work completely different from Manufacturing or OEMs. This could be a real chance for UESP to show how its long time knowledge and experience could be transferred from one branch to the other, while helping companies to become more competitive.

III.3.5. SWOT Analysis

Strengths
Long time experience in industrial related topics
Stabile work force with experienced researchers
Good (financial) balance between funded projects and consultancy

Weaknesses
Broad range of different, not always coherent fields of competencies
No link to ROBIS for possible intelligent manufacturing issues

Opportunities
Companies need for innovation
New involvement with UGEI, which is also covering decision support systems and performance management. This could lead to a higher critical mass

Threats
Clarify the Units experience and strengthen the future portfolio

III. 4. UNIT: UOSE – OPTOELECTRONICS AND ELECTRONIC SYSTEMS

The research activities of this unit have been focused on the following areas in recent years:

- Optical Fibre Sensors
- Imaging
- Integrated Optics and Microfabrication
- Electronic and Optoelectronic Systems Integration

The unit is internationally well-recognized in the area of fiber optic sensors and strives to establish itself in Optical Imaging, Integrated Optics and Microfabrication, and Optoelectronics System Integration. The numbers of joint papers and joint projects are clear indications that this unit has been active to developing international collaborations and has been very successful in this regard.

The UOSE unit's expertise and infra-structures are valuable assets to be utilized by other units, in particular Telecommunications and Multimedia, Power Systems, Manufacturing Systems Engineering, and Robotics.

The quality of research in almost all areas of research, fiber optic sensors, integrated optics, etc. is very high. The unit has an established track-record and international recognition in the area of fiber optic sensors. The unit has obtained financial support for necessary infra-structure in the area of Integrated Optics and with its international collaboration it could achieve visibility.

In the past few years companies have been formed based on the expertise gained in this unit and they have had positive economic impacts in the Porto area.

The unit continues to improve its micro-fabrication infra-structure.

The unit continues to maintain, and in some areas improve, the talent level which is reflected on the quality of research and development activities. In the past four years they have received 7 patents for their innovative work. During 2008-20011 the unit members have published 156 papers in peer-reviewed journals and 266 papers in conference proceedings. The unit is also very active in its educational activities by providing research opportunities to many M. Sc. and Ph. D. students. Some specific students' achievements are:

Programa de Estímulo à Investigação (Fundação Gulbenkian)

- ✓ Ricardo André, Optical fiber nanowires, 2010
- ✓ Cláudia Ferreirinha, Lab-on-a-chip: Rapid detection of E.coli, 2011

Best student oral presentation

- ✓ Luís A. Fernandes, J. R. Grenier, P. R. Herman, J. S. Aitchison and P. V. S. Marques, "Femtosecond laser fabrication of birefringent directional couplers in fused silica", Photonics West Conference, 2010

SPIE Scholarship

- ✓ Luís Fernandes, SPIE Scholarship in Optical Science and Engineering , 2010-2011

AOP' 2011 Student awards

- ✓ Marta Ferreira, Torsion based on a high-birefringent Sagnac loop interferometer, 3rd prize
- ✓ M. Zibaii, Controlling the sensitivity of a non-adiabatic tapered optical fiber for measuring the refractive index using all fiber Sagnac loop interferometer, 3rd prize

This unit has successfully incorporated previous recommendations of Advisory Board and has clear strategic plan for the next 4 years.

III.4.1. Evaluation of Unit's scientific performance

There is an excellent research and development activity in the area of fiber optic sensors. The unit is one of leading research group in the world, and is well aware of competition elsewhere in Europe and in the world. There are clear evidences of a very high level of innovation in the work of the group. The group has expanded the application domain of its sensor expertise into chemical, biochemical and biomedical sensors.

The research work in the area of integrated optics has improved significantly in recent years. The thin film research work has resulted to new discoveries which may lead to more efficient solar cells. This is not only scientifically very important, but also will enable the unit to apply this new found knowledge in multitude of application areas beyond solar cell.

III.4.2. Scientific Breadth versus Depth

The breadth of coverage is very good in the unit's traditional strength of physical sensors. The decision that was made several years ago to expand research into areas of chemical and biological sensors has been proven to be an excellent strategic move and now has become a major part of the sensor activities. Overall, unit's members possess excellent knowledge of fundamentals in the area of optical sensors and have very good appreciation of the future direction of this field.

The expertise gained in the areas of integrated optics and micro-fabrication, and electronic and optoelectronic systems integration is very impressive. In the past two years the unit has made conscious effort to focus this diverse expertise and capabilities onto areas of sensors, solar energy, and direct writing of optical devices.

In a very short time the unit has expanded in the area of imaging and currently has two major activities; optical coherence imaging and compressive imaging. The applied nature of these activities and the valuable knowledge gained in this area in a short time would enable the unit to interact with many other units within INESC.

III.4.3. Gaps in required expertise

There are no major concerns relating to gaps in expertise; there is an appropriate emphasis on architectures and applications capabilities rather than simply on scientific fundamentals, reflecting the industrial/applications focus of the group. Some of the group members have been instrumental in the establishment of optics companies in Porto region. This is a good indication of the application values of some of the research work carried out in this group. At the same time these efforts have resulted to very valuable experiences for the unit and INESC Porto.

III.4.4. R&D tech/transfer

As mentioned the technologies developed in the unit have been the foundations of a couple of companies formed in recent years. There has been a few other projects that has been transferred to private sector; they are:

- Temperature sensors for high voltage & inclinometers
- Optical filters for CO_2 detection
- Instrumentation of Kayaks with sensors for fabrication optimization
- Non-contact measurement of micrometric films embedded in transparent materials

However, the potential is even more than what has been exploited in the past, particularly in the areas of solar energy, chem/bio sensors, and imaging. It is expected that the experienced gained in the past will help more technology transfer to occur in the future.

III.4.5. SWOT Assessment

Strengths

The unit has exemplary record in the area of fiber sensing and has developed expertise in the areas of imaging, thin film, micro-fabrication, integrated optics, and chem./bio sensors with a lot of potential. In all these areas the unit enjoys the benefit of collaborating with major international research centers. The unit possesses a unique research infrastructure, which can be utilized by regional industries and other units at INESC.

Weaknesses

As stated in previous evaluation “this unit posses invaluable talent level, know-how, experience and the infra-structure to make contribution to the scientific community as well as playing a key role to advance technology in the area of optoelectronics and fiber optics. It is not clear if other units at INESC-Porto or other national research centers are fully aware of this unit’s capabilities.” At the same time unit’s self evaluation indicates that attracting young talents has become a challenge. It is important to note that both these two issues stem from lack of appropriate visibility.

The infrastructure developed for Integrated Optics is expensive to establish, maintain and run, hence there should be a concerted effort to make this unique capability available to others users to justify this high cost.

The unit identifies small number of submissions to European project as a weakness, but we think lack of diversity of funds is the real issue. This problem could be resolved through collaborative research projects with other units within INESC and through international collaboration.

Opportunities

The unit has identified the following opportunities:

- The application areas for Unit’s technologies has diversified, consequentially a larger use pool can be foreseen.
- There are some realistic prospects for future collaborations with companies/industry from the North of Portugal, in imaging and measurement.
- There are major opportunities as Brazil industry demand for sensors operating remotely and in extreme environment has increased.

In addition, the unit could explore opportunities with other units within INESC in the areas of energy and robotics. Finally, the units would benefit from establishing organized relations with other research centres in the areas of life sciences and health to further explore the applications of technologies developed in the unit.

Threats

Decline in public funding to support research and development requires a new emphasis on diversity of funds. However, this will bring about a new challenge; that is the balance between long-term scientific research and short objectives dictated by the sources of funds. Although, this is a threat but the units could become stronger if succeeded in facing this challenge.

The infra-structure developed in the area of micro-fabrication has a significant maintenance cost that the unit should bear. However, this infra-structure is very useful for researchers in other disciplines and if it was made available for use to others, the cost would be distributed and could be managed.

III.5. Unit: Innovation and Technology Transfer (UITT)

III.5.1. Evaluation of Unit's scientific performance

UITT appears to be scientifically productive given the size of the staff and the age of the program. For 2011, UITT produced 39 publications consisting of the following:

-24 Refereed journal articles
*Main journals: Research Policy, Tec novation, Scientometrics
-11 Refereed Conference proceedings
*Main conf.: ISPIM, ICTPI, IAMOT
-4 MSc dissertations

UITT has formed research collaborations with universities in Brazil as well as with MIT, the University of Texas, and CMU. The UITT/COHiTECH collaboration has received international recognition (such as Stanford University's 2006 Price Foundation Innovative Engineering Entrepreneurship Educator's Award).

UITT expects a slight drop in productivity (number of papers) from the 2011 level due to the end of a large contract, but the unit appears to have established a reasonable level of productivity for this relatively new and relatively small organization.

III.5.2. Balance between depth and breath

UITT appears to have taken a reasonable approach towards building a balance among the research topics mentioned above, the expert consulting activities, the commercialization activities and the establishment and nurturing of the new MS Degree in Innovation. The Unit faces challenges in supporting (financially) the fruition of its vision for research, out-reach, and in-reach activities. The faculty and staff appear to understand this challenge and appear ready to address the challenges.

III.5.3. Gaps and required expertise

UITT has amassed a strong program with the capability to produce quality research, graduates, and consulting. Given the recent completion of a large research grant, UITT should consider strengthening their current activities before expanding in new areas.

III.5.4. R&D tech/transfer

The Innovation and Technology Transfer Unit (UITT) has developed a clear vision and mission. According to the UITT, the Unit performs research, offers executive education and consulting in the following areas:

1. Technology and Innovation Management

2. Engineering Systems Design (Flexibility)
3. Technology Entrepreneurship
4. Technology policy

UITT also promotes technology innovation and technology commercialization at INESTEC. UITT has also introduced a successful degree program in MSc Degree in Innovation. The growth of UITT and the technical direction taken by the unit appears responsive to and consistent with recommendation previously provided by the Science Advisory Board.

III.5.5. SWOT Analysis

Strengths

UITT has a clear vision for the future and has built a strong staff capable of addressing its vision. The faculty appears to have an understanding of the steps necessary to fund its vision. The Unit has built a network in Portugal, in Europe, and in other parts of the world (particularly in Brazil and in the United States) that offers a great potential to expand its reach and contributions (in science, education, out-reach, in-reach, and technology commercialization).

UITT appears to have developed a network of contacts in INESCTEC that could build a strong base for UITT to play a catalytic role in interdisciplinary research as well as in technology commercialization.

Weaknesses

As stated above, UITT faces a challenge in funding the continuation and growth of its activities in science, education, out-reach, in-reach, and technology commercialization.

The relationship is unclear (to the Science Advisory Board) between UITT and the Technology Transfer offices of related universities, and it is unclear how UITT is taking advantage of these relationships.

Opportunities

UITT has built a network of collaborators inside INESC TEC, as well as with institutions and companies in Europe, in Brazil, and in the United States. This collaboration provides a basis to clearly identify the unique contributions that UITT can make both in the academic and commercial realms. UITT faculty appear understand the importance of funding from EU organizations.

Based on its existing (and apparently growing) collaborations in INESCTEC, UITT has the potential to play a lead role in driving interdisciplinary research, consulting, and

educational programs in INESCTEC. INESCTEC has apparently been successful in significantly increasing research program across the disciplines and in seeking funding to support the resulting research. Many of the researchers (and their graduate students) have interest in the commercialization of their technology (or at least in their technology being used by society), but they have no clue of how to make that happen. Furthermore, they may not have interest in driving the commercialization if they knew how. This provides a rich opportunity for UITT to take advantage of 1) their understanding of technology innovation and commercialization, 2) their strength in flexible design, 3) their existing contacts with research, 4) the new MSc in Technology Innovation, and 5) the needs and resources (or lack thereof) of technology transfer offices. This provides an opportunity to develop mutually beneficial programs that allow MSc students to work with researchers and with research faculty to understand and drive technology innovation and commercialization. This "innovation and commercialization laboratory" could be a focal point clearly marking INESTEC and UITT as leaders in the field. This will, however, require the cooperation of all parties.

The Science Advisory Board did not visit with any technology transfer offices. The next item, therefore, is conjecture. University technology transfer offices are a relatively new addition to university activities. While many universities are more than 100 years old, technology transfer offices are generally a fraction (and frequently a small fraction) of that age. As a result, policies and procedures are less mature that most university activities. Given to possibility of close interaction with faculty and students on research activities, UITT has an opportunity to support commercialization by assisting the development of university policy and procedures for technology commercialization. This would, of course, involve the close cooperation of both university administration and university technology commercialization offices.

By continuing to nurture the combined approach of mutually supportive intellectual, service, project out-reach, and in-reach programs, UITT has an opportunity to distinguish itself in an otherwise crowded field.

Threats

All of these programs require funding. Funding from Portugal may continue to be difficult, and (depending upon the political and economic environment) may prove increasingly difficulty. UITT faculty certainly understand this situation and have expressed their intent to increase their efforts in obtaining EU funding. This will be necessary. Other universities, however, have certainly come to the same conclusion. The funding environment, therefore, will continue to be a challenge.

III.6. Unit: Information and Computer Graphics Systems (USIG)

III.6.1. Evaluation of Unit's scientific performance

Since 2008 the unit has grown to include fifty two members, of which thirteen hold PhDs. This has resulted in an increase in the total number of publications by nearly a factor of four. In addition, the number of publications per PhD per year has increased from three to as much as six (in 2010). The number (5) of best paper awards in the last two years is quite impressive. These are positive signs that one of the previously identified weaknesses of this unit is being addressed. This issue needs continued attention and leadership so that further improvements are obtained on a consistent and sustained basis. Included in these needed improvements, should be efforts to increase the number and quality of journal papers. The unit is very well funded, with more than two projects per PhD per year and nearly 100K Euros per PhD per year. The success in competitive projects suggests that this may result in increases in technical productivity, hopefully leading also to larger numbers of technical publications. This should be a goal of the USIG leadership and those managing the projects. Currently, though there are a large number of grant holders, it seems that only a small number are PhD students – where possible this should be increased as PhD students are themselves indicators of scientific performance, produce scientific results and publish papers.

III.6.2. Balance between depth and breath

USIG describes itself as consisting of three subgroups of researchers covering each of the areas of computer graphics, software engineering and information management systems. Within each of these areas the unit is doing very well, particularly with respect to being able to attract funded projects, engaging in collaborations nationally and internationally, being visibly involved in professional organizations and conferences, and providing services to industry. Each of these groups has identified timely important topics of future work and opportunity for which the unit researchers are well positioned to make contributions. The unit has also benefitted greatly from adding investigators from other institutions (IPP, UM, FEUP and FCUP) and the joint leadership of Fernando Silva and Antonio Gaspar. The missed opportunity is in the integration of the activities of the three groups (where possible and sensible) and in adding other competencies to enable the unit to present itself as one that conducts end-to-end R&D in IT systems. As such, it would have the potential to become an aggregating unit in the larger INESC-TEC world and a unique unit in the national space (and beyond). Part of this possibility is already emerging in the diagram of internal collaboration in the USIG presentation.

III.6.3. Gaps and required expertise

There are no glaring gaps in expertise needed to enable the individual groups within USIG to pursue their proposed topics of work. However, if the unit decides to pursue R&D in end-to-end systems then it may need ad-hoc involvement of other researchers in a variety of areas such as embedded systems, distributed systems, security, etc.

Fortunately, INESC-TEC does have such experts in other units, further making the case for the potential aggregator role that USIG could play.

III.6.4. R&D tech/transfer

USIG's profile in the knowledge-to-value production chain is tilted towards development and tech transfer activities (65%) versus activities on basic and applied research (35%). This is not necessarily bad if the absolute (vs. relative) measures of scientific production continue to improve. USIG tech transfer skills and experience could be of great value in partnerships with other units that are better positioned to do basic research and lack the experience and structure to move their results into practice. USIG should further develop its vision and mission considering its IT system engineering strengths in collaborations with other INESC-TEC units.

III.6.5. SWOT Analysis

The SAB largely agreed with the SWOT analysis as presented by USIG.

Strengths

- Large experience in ICT consulting
- Success and experience in technology transfer
- Scientific competencies in Computer Graphics, Information Management Systems, Information Retrieval and Software Engineering
- IT system-oriented R&D of practical relevance to other disciplines and society
- Substantial experience in eGovernment

Weaknesses

- Small projects leading to unbalanced funding
- Low quantitative measures of scientific productivity (papers and PhD students)
- Unit seems to function as three separate groups
- Team dispersion geographically

Opportunities

- Funding and teaming opportunities for large programs
- Increasing need for "smart "systems in infrastructure, government, industry, etc
- Engagement of new PhD students
- New collaborations and programs nationally and internationally

Threats

- Economic crisis affecting funding from government and industry
- Human, time and resource costs of IT systems development
- Impact of imbalance of research and tech transfer efforts on further improvements of scientific production
- Increased competition nationally and internationally

III.7. Unit: UGEI-Industrial Management and Engineering Unit

III.7.1. Evaluation of Unit's scientific performance

The unit seeks to specify and develop novel systems that operate in an efficient and reliable manner and therefore uses mainly approaches from operations management, operational research and information systems. Thus the group covers a very broad area of multidisciplinary topics in industry relevant branches like health, retail, mobility and manufacturing.
They provide a very good and structured approach from service engineering and design through decision support and intelligent systems to performance management and business intelligence, which would help to be an accepted partner by industry.
The list of ongoing projects (Jan 2012) shows a balanced starting position for further development.

III.7.2. Balance between depth and breath

The intended breath of the units expertise is understandable, but the depth will be hardly reached following the presentation which shows the combination between researchers and primary and secondary research lines. It is obvious that there is not critical mass in service engineering and design available as well as in Business intelligence.
The four industry branches are covered in a balanced manner.

III.7.3. Gaps and required expertise

The SAB strongly recommends UGEI to share and exchange its mutual expertise with UESP in decision support, networks and performance management systems; with USE with its strong expertise in planning and forecasting and perhaps ROBIS with possible fields in service and industrial robotics.

III.7.4. R&D tech/transfer

According to the reviewers opinion the Unit works much closer to industry relevant problems than shown in their own positioning in the knowledge-to-value-production chain. Regarding the limited number of senior researchers, the apparent potential for innovation and technology transfer is much bigger than realized up to now.

III.7.5. SWOT Analysis

Strengths
Relevant, industry driven topics
Good combination between research lines and branches
Good publication ratio

Weaknesses
Go for critical mass

Find suitable (international) partners to catch up speed in Service Engineering
Financial situation strongly related to National Programs
What about EU funded projects?

Opportunities

Technical Services and Service Science is an EU relevant topic

Threats

Large overlapping with other existing INESC TEC Units, especially with UESP

III.8. Unit: Center for Research in Advanced Computing Systems (CRACS)

III.8.1. Evaluation of Unit's scientific performance

CRACS has a consistent record of excellent scientific performance, sustained since 2008, as evidenced by the typical measures of scientific productivity. The total annual number of publications has grown by 20% since 2008, including a 57% increase in the number of journal publications. The average number of six publications per CRACS member (with a PhD) has held steady since 2008. The quality of the journals and venues where these publications appear is very good, and several books have been authored or edited by CRACS members. The number of PhD students is increasing but still relatively low (one per two CRACS members in 2011) and apparently compensated by the number of Master's students (which has oscillated over time). The number of projects and associated funding has steadily increased since 2008 in all categories, averaging more than one active project per member per year (in 2011). The international visibility of CRACS researchers is very good and increasing, as evidenced by their involvement as organizers, chairs and committee members of twenty one conferences in 2011, which include several highly prestigious international meetings. CRACS has established numerous international collaborations with institutions in Europe and USA, further confirming the growing technical visibility and quality of the Center's research.

III.8.2. Balance between depth and breath

Since 2008 the CRACS scientific activities have evolved from being mostly associated with logic programming to being more balanced and covering also information mining, parallel/distributed computing and Web-based systems. Building on the continued strength and recognized quality of research on logic programming, these other areas are now established in their own right. The CRACS research portfolio is now both strong and diverse, thus minimizing the risk of changes in funding and/or importance of a single research area. The SAB is of the opinion that this research profile is a healthy one that will continue to serve CRACS well. This aligns well with the stated mission of CRACS. However, continued attention needs to be paid to solidifying this profile which may require continued mentoring and leadership by the senior members of the Center. CRACS has also shown promising progress in engaging in collaborations with INESC-TEC, with some ongoing joint projects and newly submitted ones. This needs to continue to be incentivized and built into the operational structure and practices of the CRACS.

III.8.3. Gaps and required expertise

There are no obvious technical gaps in the competences of the current body of CRACS researchers that could prevent CRACS from pursuing its stated goals. However, it would be desirable to increase the critical mass of researchers in the core areas of CRACS research. In other words, the gap is in human resources which appear stretched to the limit. In addition, it would be desirable for CRACS researchers to engage with other

researchers within INESC-TEC whose expertise could be used to either expand or complement CRACS competencies.

III.8.4. R&D tech/transfer

CRACS acknowledges that its activities in the knowledge-to-value production chain are tilted towards basic knowledge and applied research (80%) versus development and tech transfer (20%). This is not necessarily bad as long as knowledge creation and research results are not lost forever, i.e. as long as CRACS creates mechanisms and collaborations that enable development and tech transfer to occur within INESC-TEC. This could be a win-win situation for CRACS and other INESC-TEC entities, by allowing each of them to do what they can (and like) to do best, simultaneously contributing for the interweaving of CRACS and those entities. In this regard, it would be desirable for CRACS to propose a vision for the Center along with a fitting mission, both of which should account for the larger context, vision and mission of INESC-TEC. As pointed out in the presentation about CRACS (albeit in an understated manner), impressive software systems and tools have been developed by CRACS researchers. These "free products" are used throughout the world, thus making it clear that CRACS is not doing science that is disconnected from practice. CRACS should continue supporting these software products because they add to its international (and national) prestige. In addition, it should engage with INESC-TEC units which can help leverage these and other capabilities where tech transfer and commercial valorization are possible.

III.8.5. SWOT Analysis

The SAB largely agreed with the SWOT analysis as presented by CRACS. The items below reflect this agreement as well as some additional points raised by the SAB.

Strengths

- Sustained excellence in scientific performance
- Internationally recognized research and tools in several domains, including logic programming, machine learning and parallel/distributed computing
- Stable competent leadership
- Emerging research strengths in new interdisciplinary domains such as health informatics, web information systems, e-learning and security

Weaknesses

- Insufficient human resources for continued growth and new initiatives
- Under-leveraged integration with INESC-TEC
- Low number of PhDs
- Unclear strategy for technology transfer

Opportunities

- Address human resource limitations through partnerships with other INESC TEC units and/or creative administrative actions (when growth is not possible)
- Pursue fewer but higher-funded longer-term projects at European level
- Participate in INESC-TEC interdisciplinary projects and activities
- Investigate mechanisms to free CRACS members from activities that limit their ability to carry-out research

Threats

- Economic crisis is likely to affect current sources of CRACS funding
- Diversify funding sources to manage risks related to cuts in FCT and other typical funding sources for CRACS.
- Several CRACS members appear to be thinly spread among many efforts
- No slack in human resources, limiting ability to launch new initiatives or recover from unexpected problems in funding, staff departures, etc.

III.9. Unit: CISTER

III.9.1. Evaluation of Unit's scientific performance

CISTER competes with the best groups in its area across the world and attracts international researchers. CISTER already has a good critical mass of researchers, with around 50 people, which includes 14 PhDs, 3 administrative or support staff on permanent contracts. They have been qualified as "Excellent" among all Research Centers in 2002 and 2007 (only two centers received such designations), so they can be considered a strong research resource. Their integration in INESC-TEC is a great opportunity for complementary expertise on both sides, especially since CISTER understands own limitation in technology transfer arena. CISTER plans on growing the size of their unit by 50%-60% in the next few years which may be excessive.

III.9.2. Balance between depth and breadth

The balance between depth and breadth in CISTER is quite good although the scientific foot print may be excessive. CISTER is a leader in embedded systems and real time operating systems but also is interested in wireless sensor networks, and multicore systems.

III.9.3. Gaps and required expertise

None perceived in terms of scientific background. But the inexistence of a Ph.D. program at ISEP is a gap.

III.9.4. R&D tech/transfer

There is currently some technology transfer, but the potential of CISTER is far higher and the partnership with INESC-TEC is very timely.

III.9.5. SWOT Analysis

Strengths

CISTER expertise and visibility in embedded systems and real time operating systems is very strong and unique in INESC-TEC.

CISTER has impressive, newly renovated building with about 2000m^2 of space, good for work (both students and non-students) and will allow for the group to attract invited scholars.

Weaknesses

CISTER needs a clearly-defined vision, mission, goals, and metrics, in order to enable more quantifiable gains. A clear statement of the vision for the next few years of where

CISTER is heading and its mission within the Portuguese community should be developed, in conjunction with a set of goals that will define the path to achieve the pluri-annual plan to be developed.

The absence of a doctoral program at ISEP is a weakness.

Opportunities

CISTER has a great opportunity to create startups and get involved in tech transfer, given that the embedded systems is a growing sector of the economy, with a predicted 14% growth per year. This E$60B market (in 2006) accounts for 98% of current processors being deployed. Since CISTER would like to expand their technology transfer abilities the partnership with INESC TEC and its diverse units is a great opportunity (specifically ROBIS and UOSE).

Given the stature of CISTER, increasing and diversification of funding, in the form of more EU programs and more grants and contracts would allow for a more stable funding cycle and more stable sources of funding, which can increase the stability of the unit and increase its ability to grow as desired.

Threats

One of the CISTER's goals is to grow by 60% (which is feasible given the space and visibility they currently have), but there is uncertainty about the sources of funding (future and retention at current levels) due to the economic woes of the European Union. Given that the EU sets the directions for the ARTEMIS plan, but the funding comes directly from the Portuguese government, this puts a damper on a large percentage of funding that is currently held by CISTER.

The relationship between the two (INESC-TEC and CISTER) should be more well-defined, so that there is a clear understanding of the contributions of this unit to the larger, umbrella Associated Laboratory.

INESC-TEC has been pushing for an increase in journal publications, while the real-time community (and computer science as a discipline in general) values the contributions of highly-visible conferences more than archival journals (given the delays in publications of journal articles); reaching a compromise that would satisfy INESC-TEC's and CISTER's goals and align one with the other, is imperative.

III.10. Unit: High-Assurance Software Laboratory (HASLab)

III.10.1. Evaluation of Unit's scientific performance

HASLab is a research unit based at Universidade do Minho, in Braga, which has evolved from the Centro de Ciências e Tecnologias da Computação (CCTC) and the Departamento de Informática at that university. At the time of the visit, HASLab had just joined INESC-TEC. Therefore, this report is essentially about the R&D record of this new unit and the way the SAB perceives its integration in INESC-TEC's ecosystem.

HASLab has excellent credentials in fundamental research in Computer Science, mainly in the areas of formal methods, dependability and information security. Their senior staff are members of several scientific organizations (for example, Formal Methods Europe and IFIP) and conference committees, and they have developed an impressive network of academic partners among top European universities, which ensures a good visibility in the international community and an active participation in the fora that are shaping research in those areas.

HASLab also has a very good reputation in applied research, which the team has developed as coordinators or partners of EU or FCT-funded projects (the number of which suggests that a good culture of writing research proposals is in place) as well as technology-transfer projects with industry. Their research plans have been endorsed by a range of Portuguese companies that have a strong R&D profile, reflecting a good number of long-standing collaborations.

At the time of the visit, HASLab had 23 faculty members, 33 grantees, and 3 technicians or support staff. There is a good mix of different levels of academic seniority within the team and a good involvement of young researchers in their research activities.

The unit participates in the MAP Doctoral Program in Computer Science organized by the universities of Minho, Aveiro and Porto. The number of PhD students has been increasing (34 reported for 2011), but the number of theses defended has been somewhat erratic. The percentage of external students is also low. Notwithstanding the high quality of the theses supervised by the team (the SAB was particularly pleased to learn that a recent graduate of the team had won the 2010 IBM Scientific Award), the SAB considers that the unit could reconsider its supervision procedures and consult with other units of INESC-TEC on best practices and ways of attracting external students in general, and international students in particular, for example by exploiting the unit's network of academic partners.

The plans submitted by the team aim at increasing its research productivity, which they consider to be below their potential. The SAB agrees that this should be one of priorities of the unit. While it recognises that both individual team members and the unit as a whole are subject to metrics-based assessment of performance, the SAB recommends the unit to take a balanced approach to publishing that can maximize the potential for

networking with their peers through participation in conferences and impact through the submission of extended, definitive versions of their papers to good international journals.

III.10.2. Balance between depth and breath

The plan submitted by HASLab is to focus on Trustworthy Systems, which exploits the expertise developed by the team on formal methods, dependability and information security, and responds well to socio-economic needs. The SAB considers that the profile of this new unit fits the range of interests and competencies already developed at INESC-TEC very nicely and offers an excellent potential for developing synergies with several other units that have complementary interests, thus strengthening the overall profile of the institute in computer science and increasing the opportunities for collaborating with industry.

Although the unit has already identified some target areas for their R&D activities – safety-critical systems, cloud computing and smart grids, the SAB recommends that the domains of application to address in the short and medium term be refined and prioritized after the team has explored a bit further the opportunities that exist within INESC-TEC for interdisciplinary R&D with the other units and for engagement with companies.

III.10.3. Gaps and required expertise

The unit has ambitious plans for expansion, which they consider to be essential for achieving stronger leadership in its scientific area and prominence in the ecosystem of regional R&D players, notably among leading companies. The SAB understands the importance of achieving a good critical mass and range of expertise within the team but considers that this expansion should be reassessed in the light of the opportunities that the integration in INESC-TEC offers for the team to draw new resources from collaborations that it can establish with other units.

III.10.4. R&D tech/transfer

The plans submitted by the team aim at unlocking their potential for applied, multidisciplinary R&D, which would allow the unit to move further downstream in the knowledge-to-value production chain. The SAB agrees that this should be one of priorities of the unit and endorses the opportunities that the unit has already identified for technology transfer and valorisation, both nationally and internationally.

III.10.5. SWOT Analysis

Strengths

Excellent reputation in their scientific areas and solid presence in the international community.

The focus on Trustworthy Systems exploits well the expertise developed by the team on formal methods, dependability and information security, responds well to socio-economic needs, and offers an excellent potential for developing synergies with several other units within INESC-TEC.

Good involvement in national and international projects, in collaboration with both academic and industrial partners.

Stable team with a good mix of different levels of academic seniority and involvement of young researchers.

Weaknesses

R&D would benefit from stronger management and coordination: doctoral program, publications, grant applications and, in the future, knowledge transfer and valorization activities.

Capacity for attracting international scholars and students.

Opportunities

The focus on Trustworthy Systems is well aligned with national and international policies for developing the role in ICT in critical infrastructures.

The regional and national industrial landscape number offers a number of dynamic companies that would benefit from stronger R&D collaborations with the unit.

The expansion of INESC-TEC to Brazil, a country that hosts internationally-strong research groups in the area of Trustworthy Systems, and has sizeable companies that develop critical systems.

Threats

The uncertainty on the availability of funds for R&D that derives from the state of the Portuguese economy (both in terms of governmental budget and capacity of companies to invest in R&D).

The fact that HASLab is relatively distant from the central hub of INESC-TEC could raise some risk of isolation.

III.11 Unit: Artificial Intelligence and Decision Support Lab (LIAAD)

III.11.1 Evaluation of Unit's scientific performance

A strong point of LIAAD is its sustained good results in research. The rate of about one journal paper and two conference papers per researcher is not very high but is a good result considering the manpower that is effectively available for research.

Some subgroups in LIAAD publish more than others. This requires active attention by the LIAAD and INESC coordinators. If a line of work is less successful then it could be merged with another or shift focus to industrial projects or consulting.

III.11.2. Balance between depth and breath

An issue that was observed and also mentioned by the group is a tendency towards "fragmentation". This is due to several factors: the wide range of approaches, methods and applications that LIAAD is covering, the geographical distribution of the group over many locations, former junior researchers who develop their own area of expertise and social environment. Topics that in LIAAD are addressed by a group of 3 or 4 persons are in other places covered by a complete department. This holds for causes a lack of critical mass. It is also part of a tradition to not commit to any theoretical perspective nor to a specific application area of Machine Learning, Data Mining and Decision Making. The broad coverage is both a strength and a weakness. In the context of INESC a broad coverage is a strength since a wide range of industrial problems can be addressed. At the same time it makes it difficult to work on more fundamental research issues that do require a theoretical viewpoint to achieve scientific depth. From this perspective there is some tension between the idea that LIAAD has of itself as a mostly research oriented group and the applied character of the actual work.

III.11.3. Gaps and required expertise

The SAB sees no specific expertise missing in LIAAD.

III.11.4. R&D tech/transfer

LIAAD views itself a focused on research but in fact much work is at a technology level, between research and application. The scientific depth of the work varies between

groups. There seems to be more possibilities for technology transfer, commercial activities and consulting than are currently exploited.

III.11.5. SWOT Analysis

Strenghts

The integration of LIAAD into INESC is going very well, better than some of the SAB expected three years ago. LIAAD participates in several projects with other units and plays an active role in two "action lines" across units. LIAAD positions itself at the "scientific" end of the knowledge production chain. It also runs some minor consulting activities. Inside INESC some of its output is fed into other units such as for example USE and UESP.

Weaknesses

Some degree of geographical dispersion has always been an aspect of LIAAD because if its history as collaboration between groups in different institutes but a common home would help the collaboration within the group and also reinforce its identity in the environment of INESC and the University of Porto.

Opportunities

It would be good if INESC could help LIAAD find a single location, a home. This would work against fragmentation and improve communication.

As suggested by the group itself, it should be possible, especially under normal economic conditions, to exploit LIAAD's broad range of experience and expertise to expand activities at the valorization end of the "knowledge production chain".

More sense of direction and unity in research could be achieved by agreeing to jointly address one or two "big" problems. This could also avoid the tendency to let research be guided by applications and it can help to increase scientific depth. A possible approach is to specify an internal knowledge value production chain for LIAAD activities. Another possibility is to develop the cross-unit action lines into research groups with critical mass, with participants from LIAAD and other groups, headed by senior researchers. Also the new Robotics group will provide opportunities for new R&D.

Specific actions can be to increase the number of journal publications (to encourage scientific depth) and to use INESC's network to develop more commercial activities and use the benefits to support research. Another opportunity is to participate in INESC's activities in Brazil.

Threats

The future lack of funding from CFT is a problem. The direction that is already taken, putting more emphasis on European funding and industrial activities, and possibly also activities in Brazil with INESC, are ways to counteract these threats.

The topics of LIAAD, Data Mining, Data Analysis and Statistical Methods, Modeling and Optimization, Decision Support are currently being incorporated in many other areas. In the context of INESC for example UESP works on optimization problem, USE on optimization and Data Mining and almost all areas encounter data analysis and decision making. LIAAD thus runs that its topic of expertise evaporates into that of other units. To avoid that, LIAAD would benefit from one (or a few) more research topics at the high end of the “knowledge value production chain” that goes beyond the more applied technical expertise in other units.

III.12. Unit: ROBIS

III.12.1. Evaluation of Unit's scientific performance

ROBIS is an interdisciplinary, inter-institution (both ISEP and FEUP) unit with very broad range of activities with great growth potential, as exemplified by the many new contracts already in place. ROBIS has two RoboCup teams in the medium robot category, allowing for good visibility of the unit in the international robotics community.

Alongside the growth experienced and to be experienced, ROBIS has also steadily increased its publication rate, having published in good area journals 6 papers in the last year. This is not sufficient, but it is adding two journal papers per year in the last 4 years, which is a good trajectory. The presence in robotics conferences is better with 25 papers per year in the last 2 years. The group has decided to focus more on journals instead of conf due to the cost of conferences and the recognition of journal publications, aligning its publication goals with the INESC-TEC publication goals.

III.12.2. Balance between depth and breadth

ROBIS is a unit that focuses on robotics at large, but mainly on applied robotics research, design and implementation. ROBIS has solutions in the areas of land, water and industrial robotics. The range and professionalism of the projects undertaken by ROBIS is impressive. However, the coverage of the scientific topics is pretty "thin", and needs attention.

III.12.3. Gaps and required expertise

The unit would benefit from a more science oriented approach to autonomy. Multipurpose architectures or algorithmic methodologies instead of piecemeal development for each application should be pursued.

III.12.4. R&D tech/transfer

The MARES and triMARES underwater robot that won a bid from PETROBRAS, the Brazilian petroleum giant, bringing in almost one million euros, almost 10% of the total INESC-TEC income for 2011. Large projects such as these are a particularly good revenue stream for INESC-TEC and for ROBIS, so that it can sustain its growth. In fact, ROBIS is the only unit within INESC-TEC that has guaranteed growth of approximately 30% for the 2012 year, both in terms of contracts and in terms of personnel growth—from 44 to 53 people in the group (a good size with a productive critical mass, with 10 PhDs and 23 grantees).

III.12.5. SWOT Analysis

Strengths

The unit has an enormous ability to develop useful engineering platforms that focus INESC TEC expertise and meet industrial needs. An example is the RoboVigil project with UTM and USIG, which produced several journal and conference papers, and is one of INESC-TEC's showcase systems.

Technologies being developed are at the forefront in the world as exemplified by the success to market triMARES.

Weaknesses

The unit seems to have many different projects and should strive for consolidating its expertise and capitalizing on it. It is possible that the unit is already doing it, by focusing on its environment perception ability and goals, but it needs to articulate it better for itself and for the other units.

The unit has two spaces, two areas, and seems to have somewhat disconnected projects (e.g., two robocup groups competing with each other)

Opportunities

By collaborating more with outside units, such as CISTER and UOSE, and seeking outside expertise (e.g., power/energy), ROBIS could consolidate its position in a clear path to success within INESC-TEC and within the Portuguese scientific community.

ROBIS is in a unique position to enhance (e.g., it already has a multi-unit proposal in Tec4Sea) its share of the EU projects with the new EU programs being launched, that focus on applied research and on technology transfer. This could also bring a different revenue stream into the unit.

The work being developed requires an increase of the scientific output with respect to papers in international high-quality conferences and journals, as well as technology transfer to industry allowing for higher visibility of the group.

Given the practical nature of projects being conducted in this unit more attention could be paid to commercialization of the projects. This could have a high economical and social impact in the Portuguese economy by starting new companies and enhancing the competitiveness of existing companies. An example is the plan to commercialize the triMARES underwater robot.

Threats

The unit does not have yet a common strategy, so an effort to bring the two groups closer together is necessary.

The in-balance between the theory and practice may reduce the unit to an engineering shop.

Signature Page

The Scientific Board Members

Dr. José Principe

_____ Date _____

Dr. Leonardo Chiariglione

_____ Date _____

Dr. Faramarz Farahi

_____ Date _____

Dr. José Luiz Fiadeiro

_____ Date _____

Dr. Tomas Gomez

_____ Date _____

Dr. José A. B. Fortes

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Dr. Daniel Mossé

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Dr. Steven Nichols

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Dr. Maarten van Someren

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Dr. Volker Stich

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