

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

Panel Members

Urbashi Mitra (Chair)	University of Southern California, United States of America
Andrew F. Laine	Columbia University, United States of America
Beth Kolko	University of Washington, United States of America
Carles Sierra	Institut d'Investigació em Intel·ligència Artificial IIIA), Consejo Superior d'Investigaciones Científicas (CSIC), Spain
Hai Helen Li	Duke University, United States of America
Haizhou Li	National University of Singapore
Rama Chellappa	University of Maryland, United States of America
Samir El-Ghazaly	University of Arkansas, United States of America

R&D Units

Centro de Electrónica, Optoelectrónica e Telecomunicações (CEOT)	Universidade do Algarve (UAIG)
Centro de Investigação em Digitalização e Robótica Inteligente (CeDRI)	Instituto Politécnico de Bragança (IPBragança)
Centro de Investigação em Estudos Interdisciplinares (ISRC)	Instituto Superior de Engenharia do Porto (ISEP/IPP)
Centro de Investigação em Sistemas Computacionais Embebidos e de Tempo-Real (CISTER)	Instituto Superior de Engenharia do Porto (ISEP/IPP)
Centro de Investigação em Sistemas Electromecatrónicos (CISE)	Universidade da Beira Interior (UBI)
Centro de Sistemas e Tecnologias (SYSTEC)	Faculdade de Engenharia da Universidade do Porto (FE/UP)
Centro de Tecnologias e Sistemas (CTS)	Instituto de Desenvolvimento de Novas Tecnologias (UNINOVA/FCTUNL/UNL)
Grupo de Investigação em Engenharia e Computação Inteligente para a Inovação e o Desenvolvimento (GECAD)	Instituto Superior de Engenharia do Porto (ISEP/IPP)
INESC TEC - INESC Tecnologia e Ciência (INESC TEC)	Inesc Tec - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência (INESC TEC)
Instituto de Engenharia de Sistemas e Computadores de Coimbra (INESC Coimbra)	Instituto de Engenharia de Sistemas e Computadores de Coimbra (INESC Coimbra)
Instituto de Sistemas e Robótica - ISR – COIMBRA (ISR-UC)	Instituto de Sistemas e Robótica (ISR)
Instituto de Telecomunicações (IT)	Instituto de Telecomunicações (IT)
Laboratório de Robótica e Sistemas de Engenharia (LARSyS)	Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID)
Unidade de Investigação em Microsistemas Eletromecânicos (CMEMS-UMinho)	Universidade do Minho (UM)

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Electrónica, Optoelectrónica e Telecomunicações (CEOT)

Coordinator: Rui Manuel Farinha das Neves Guerra

Integrated PhD Researchers: 12

Overall Quality Grade: GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 3
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 143 K€

Recommended Programmatic Support

PhD Fellowships: 3

Programmatic Funding: 235 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

CEOT is a small R&D Center as a collaborative result of several young scientists. The research strategy is towards an integrated and multidisciplinary approach to networks, electronics and sensing applications in biology. The research activities have a strong emphasis on the IoT, sensing for agronomic applications and optical and electrical measurement. The goal of the team is to merge IoT and optical/electrical sensing tools within an Agriculture 4.0 context.

The Center presents a high focus on the fundamental research: about 70% of research activities are related to basic research; while the industrial and technology transfer each accounts for about 15% of activities. There is a quick growth in publication productivity, from

The Panel suggests the team to broaden their national and international collaborations. We expect it can help improve the quality of the R&D activities as well as extend the international collaboration. We also suggest the Center to explore European projects and international programs, which may help attract potential collaborators that are interested in the Center unique application domain and provide complementary technical strength.

The Center, by nature, demonstrates a multidisciplinary character. Besides the faculty and researchers with computer science training background, a large portion of researchers and PhD students were trained on exact science (physics, chemistry and math) and biological science.

The Center shows a rapid growth in recent years. During the period of 2012-2014, it had only 1 PostDoc and 2 PhD students. The numbers increase to 12 senior researchers, 3 junior researchers, 8 PhD students and 3 MS students (in total 26) during the performance period of 2015-2017.

A well-balanced gender distribution across all the levels, from PhD students, to senior researchers was observed. Many team members present high passion in research study, despite of the high teaching load and unstable placement.

As a small Unit, the team presents clear and convincing objectives that align with the team's capability and the need from local community. The team also presents a need and willing to energize the PhD and PostDoc pipeline.

To continue the sustainability and improve the productivity of the Center, the Panel suggests to meet with the University head/Institute director and negotiate 1) reasonable teaching assignment and 2) credit for student supervision and research outcome.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work

of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The awarded Programmatic Funding is to be partially used for hiring 1 new Junior PhD Researcher, to strengthen the Advisory Board and to support the marketing of results.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Investigação em Digitalização e Robótica Inteligente (CeDRI)

Coordinator: Paulo Jorge Pinto Leitão

Integrated PhD Researchers: 18

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 4
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 328 K€

Recommended Programmatic Support

PhD Fellowships: 3

Programmatic Funding: 235 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

CEDRI exploits the inherent strengths of its team member and past projects and thus has a focus on applied research for industrial methods. A common, driving force is the use of multi-agent systems in many forms. The Unit has embraced modern methods such as deep learning in order to address problems posed by industrial partners.

While IBP cannot offer PhD degrees, the Polytechnic has actively sought partnerships with the University of Porto, Minho and (Brazilian institution) for the offering of PhDs; this is a strategic move. That the Unit has actively determined to have diversity in the PhD granting institutions of its doctoral students is evident in the current group of students. While that may require more effort in the short term, in the long term it diversifies risk and enables the group to pivot more quickly should the internal goals of one of the partners change, making it more difficult to collaborate. Building relationships with more than one institution gives them a stronger grounding for future growth as it provides more versatility to respond to changing conditions.

Another positive element is actively seeking to develop partnerships with Spanish institutions, several of which are physically closer to Braganca than Portuguese counterparts. The conference organized for 12 Spanish institutions is viewed as an excellent step towards the goal of increasing academic partnerships. This diversity is viewed as a positive element. The plan for having a similar conference for companies is also viewed as a positive. The inclusion of mathematicians who can provide a bridge between fundamental analytical research and application of such methods to the projects of CEDRI is also positive. The Panel was impressed by the desire of the Unit to actively engage with the local region and provide mechanisms for increasing the industrialization and digitalization of the community. In particular, the application of multi-agent systems and optimization methods to Agrofood was considered to be a wise choice. The creation of courses to assist Masters students with commercialization and encourage entrepreneurship looks promising. The Unit is encouraged to determine a strategy by which success of these courses can be measured. The Unit is also encouraged to begin tracking the placement of their PhD students. The current batch of PhD students are well-selected for the strengths of the Unit; the PhD students expressed their happiness with their projects and the strong corporate interaction and ties.

The Panel was pleased with the discussion of advantages and disadvantages of a small Unit. The Unit appears to be very pragmatic (and yet ambitious) in its approach. It is clear that the Unit is committed to excellent in applied research as focused on industrial automation. The Unit researchers are engaged in their professional communities through conference organization and presence on technical program communities. The corporate projects cover a wide gamut of industries and, perhaps more importantly, are drawn from companies from all over Europe. Thus, the Panel deemed that the Unit had an excellent international presence.

They have been successful at securing grants in both European and National programs, including Portugal2020. They also have secured contracts with companies. The bulk of their funding comes from European sources. FCT funds are a

modest portion of their budget which indicates they are effectively leveraging the FCT funding to strengthen the organization.

There are several concerns. The Unit does not appear to have plans for including other institutions/organizations into the Unit. Given the modest size of CEDRI, a plan for growth should be devised. There was also concern that the Unit was taking on projects that had too much diversity in the applications. Focusing on a few domains/application-areas would give the Unit added strength and credibility. All researchers reported wanting to remain where they are, in part because the organization is smaller, and thus is more nimble. As the team observed, because they are not beholden to a large sponsor or overarching organization, they can adapt to new interests. They already have international recognition and people who want to work with them. They are asked to submit proposals at the European level regularly. IEEE is asking for them to work on standardization efforts.

There appears to be a focus on keeping PhD graduates within the Center as permanent researchers. However, PhD graduates should also be encouraged to seek employment outside of the Unit and Bragança as this is a method to increase the visibility of CEDRI. Hiring integrated PhD researchers from outside of IPB/CEDRI will also increase the diversity of methods and thinking that the Unit can leverage. While Bragança has an incubation hub; it was not clear (beyond the Masters level courses) what were the plans for increasing commercialization and entrepreneurship; how will spin-offs be encouraged from CEDRI activity? The Unit might also benefit from an additional academic member (someone who engages in like-minded applied research) on their Advisory Board.

The Unit is also encouraged to develop a plan for leveraging funds to reward success in research and success with corporate projects. An incentive system could assist in propelling the Unit forward.

The PhD students are engaged with their work, open, and eager to share their pride in the organization. All those spoken with indicate that they want to remain where they are. They have easy access to their advisors, with one formal meeting per week but tending to interact on a daily basis. For their co-advisors, they either go to the other site or video conference on a regular basis. They believed they are getting good advising. Also important to note, especially given the range of industry contract work, is that none of the students reported facing problems with intellectual property or non-disclosure agreements on their publishing on industry collaborative projects.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The Panel was very impressed by this Unit -- the level of the corporate projects, the local societal impact, etc. The main concern had to do with plans for the future and growth. This Unit was one of the few where the Polytechnic leadership has been very forward thinking in its support of the Unit. The Panel recommends that the Polytechnic leadership consider lowering the teaching loads of the CEDRI faculty and staff.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Investigação em Estudos Interdisciplinares (ISRC)

Coordinator: José António Tenreiro Machado

Integrated PhD Researchers: 15

Overall Quality Grade: WEAK

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 2
- (B) Merit of the team of Integrated Researchers: 3
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 2

Justification, Comments and Recommendations

The proposal is to increase the activities of a relatively new Interdisciplinary Research Studies Center. The IRSC is a group of researchers at one institute who are seeking to build out a research program that is heavily intellectually invested in the creation of a PhD program at the site. Part of the goal of the IRSC is to create opportunities for PhD students to receive their degrees from the Institute Superior rather than have to be co-advised by professors from a University.

While the Research Group exhibited clear strengths, those strengths are not necessarily well aligned with the articulated goals of the proposal.

The proposal is to build a R&D Unit that addresses an R&D gap. However, the activities of the R&D Unit are not well developed and do not have a coherent theme that answers the question of “how to address the R&D gap”.

There is a gap in the quality and relevance of the researchers work. There is limited evidence of research quality, including publications in top tier conferences or journals.

The Engineering Education thread is in early stages with researchers still establishing a thorough understanding of the field and ability to articulate research questions that will advance the field. There was evidence during the review that junior researchers across institutions were clearly motivated and had been working together and co-authoring as they build a research agenda. This was one of the stronger elements of the Unit. The more senior researchers were not actively collaborating with one another. The research quality across the Center is uneven.

The Center Coordinator has made pioneering contributions in the area of fractional calculus and the majority of the proposed researcher themes are centered around this concept. It was not clear that this particular research expertise would inform the Research Themes productively.

Worth noting is the intellectual curiosity and engagement among the junior researchers interested in Engineering Education. The researchers are actively engaged with international projects in this area, and they are clearly working to become situated in the field.

This is a new Center just getting started, and the four articulated Thematic Lines are a starting point, not an ending point. Some of the Thematic Lines do seem to articulate research topics that are not currently being addressed widely in Portugal by ECE Units, namely Engineering Education and Social Change and Development. It was not reviewed by this Panel whether other disciplinary areas in Portugal are working on Social Change and Development. Other research themes of Models and Methods (MM) and Smart and Integrated Optimization Networks (SION) are being addressed by other Centers. While there is not an institutional issue with multiple Centers addressing similar research topics, of most concern to the Panel was the leadership repeated assertion that there are no other interdisciplinary R&D Centers in the country. This is clearly not the case and the lack of awareness of other Centers conducting interdisciplinary work is of concern. If the members of the ISRC believe their work is of a different kind of interdisciplinarity, or involves different disciplines or addresses novel research questions, we encourage a future application to emphasize those distinctions.

The Panel sees strong possibility for future impact and internationalization, especially in the topic of Engineering Education which is reaching some maturity in other countries and could be effectively launched as a research thread in

Portugal. However, the Panel recommends that the individuals interested in this area spend more time assessing the field and generating a comprehensive understanding of the state of current research before launching a broad research agenda.

The Center lacks an integrated sense of strategy. An overall assessment is that the Center seems to have been conceptualized as a largely top-down initiative. Given the level of engagement among the junior researchers, it is clear there are strong human resources present in the Center that could help direct the research agenda. It may be fruitful to consider an alternative management structure that capitalizes on the intellectual engagement of the junior researchers.

The gender balance in the Center and the several women in advisory leadership positions is to be commended.

There are some deficiencies in the proposal, including a missing cv from one of the Management Council members which makes evaluating the capacity of that person to provide effective direction difficult. They were also not present at the evaluation, and so the Panel was unable to gather the missing information in person.

In the matter of supervising PhD students, since the Institute is affiliated with the Polytechnic, students must have a co-advisor at the university (until the new law takes effect). The leadership clearly saw this as a crippling disadvantage, however co-advising can be an advantage for students and researchers when managed well. The lack of interest in meaningfully collaborating with other institutions was of some concern since as interdisciplinary work grows, it is likely to involve disciplines outside of the Polytechnic.

The institute leadership is encouraged to read the recommendations above very carefully. While there were individuals whose research merits were considered to be good, the overall program for the Unit was not focused at all. There were serious concerns surrounding claims made about interdisciplinarity -- many of the evaluated Units had interdisciplinary research driving the Unit program. The Unit leadership did not appear to have clear plans and strategies to forward their goals.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Investigação em Sistemas Computacionais Embebidos e de Tempo-Real (CISTER)

Coordinator: Eduardo Manuel de Médicis Tovar

Integrated PhD Researchers: 16

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 3
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 273 K€

Recommended Programmatic Support

PhD Fellowships: 1

Programmatic Funding: 235 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

This is a small/medium-size Center, which intentionally narrows into a small but important area. As such, the research focuses on real-time and embedded computing systems. In the past two decades, the group has built an impressive program with high research productivity and an excellent set of integrations and collaborations.

The group performed innovative cutting-edge fundamental research. In the past performance period, the researchers in the group led more than 13 fundamental research projects, most funded by FCT and some by the European Commission. The Center was involved in 14 internationally-driven projects involving more than 200 international partners, both from academia and industry. The team has a good publication record in terms of both quantity and quality. In the past performance period, they produced 300+ papers. Out of those, around 60% have external collaborations with academia and 10% is with industry. Fifteen papers were published on IEEE RTSS, ECRTS and RTAS, the three most important conference venues in real-time embedded system society. The patent number is low compared to the publication productivity. Only a few on hardware and zero on software level. The team presents a fair good balance between the basic research and applied science. Measured by TRL, the fundamental study with relative low TRL accounts for ~35% of efforts, research and development is ~50%, and the remaining 10% efforts are related to the technical transfer in the high TRL.

The team doesn't lean on IEEE/ACM fellows/members. Prof. Eduardo Tovar serves as ACM SIGBED vice chair. Various the Center researchers were elected to leading roles in relevant IEEE Societies or ACM Special Interest Groups and endorsed with leading roles in various key scientific events of the RTES area (General chairs, TPC chairs, TPC members). The Center organized a number of international conferences and workshop, including IEEE RTSS 2016 and CPSWeek 2018. The full time researchers come from more than 20 countries. From the 18 PhD students graduated in the past performance period, 12 were foreigners coming from 9 different countries.

The placement of PhD graduates is impressive with about 19% staying at CISTER, 31% to industry and 50% to academia as faculty or independent researchers, in Portugal or outside of Portugal. The gender balance need further improve: there were 2 female students among about 20 PhD students in the meeting.

In 2013, the Center initialized the CiWork series, which is a 1-day yearly workshop that brings together researchers from CISTER and representatives of major Portuguese companies. In 2016, CISTER started a new initiative, called CiTech, to serve as a formal platform to solidify the national industrial ecosystem working on RTES and to boost the impact of collaborative national R&D in the international panorama.

The Panel strongly recommends the Center to improve the diversity and considers it important for further enhancing the Center broader impact. New means shall be considered, including exploring various recruiting resources and introducing women leadership examples to the team.

Research wise, the Center plan to align its activity with international R&I agendas and societal challenges, in particular in research directions with build upon the Center internationally recognized topics.

The team presents a need and willing to re-energize the PhD pipeline. There is no plan to grow up too big. Instead, strategic hiring of internationally recognized researchers is the alternative option.

The team can further aggravate the technology transfer by considering the nature of their research and close collaboration with industry. The CiTech and CiWork are a start.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the R&D Units. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the R&D Units negotiate with parent universities and Polytechnic Institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other Institute endeavors such as technology transfer.

We suggest to partially use the awarded Programmatic Funding to strengthen the Advisory Board and to support the marketing of results.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Investigação em Sistemas Electromecatrónicos (CISE)

Coordinator: António João Marques Cardoso

Integrated PhD Researchers: 17

Overall Quality Grade: VERY GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
- (B) Merit of the team of Integrated Researchers: 4
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 3

Base Funding for (2020-2023): 236 K€

Recommended Programmatic Support

PhD Fellowships: 2

Programmatic Funding: 190 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

Researchers in CISE have a broad range of expertise, including electric machines, fault diagnosis, fault tolerance, energy efficiency and power electronics. CISE objectives are defined in terms of work packages, of which they have seven mostly related to renewable energy and power systems. Their projects are practical, with notable societal and environmental impact, and could be immediately marketed. Their publication record is good, with more than two publications in journals per integrated researcher per year. Another notable feature of CISE is their significant contribution to the area of disseminating technical information. For instance, CISE has organized the 10th edition of the IEEE International Symposium on Diagnostics for Electrical Machines which was held the first time in Portugal. Moreover, there are a significant number of publications co-authored with foreign researchers and by members of different sites of the lab. An ERC Consolidator grant is under evaluation.

The researchers are known in their fields of expertise. Their participation in international committees (such as IEEE Europe) to lobby for their research agenda has been extremely effective which is very clearly illustrated in the memorandum on the use of DC at home. Apparently, some interest in this approach has also been expressed by the Director General of Energy of the EU.

Their participation in European projects is relatively good especially for a starting R&D Unit; they are involved with a COST action and a European Network project. The work on collective publications and international conference organisation shows an international recognition of the R&D Unit.

CISE consists of research teams organized around projects, rather than research groups. They have good representation from other institutions in Portugal and other countries, especially Algeria. Their international collaborations have enabled them to attract postdocs and Ph.D. students. A significant number of their publications are generated based on their international collaborations.

CISE started its activities very recently, in 2015. It is a small centre, with emphasis in engineering and development. They are building a reputation as a good centre in fault diagnosis and renewable energies. The R&D Unit experienced significant growth since 2013 till now, doubling the number of its members.

The R&D Unit is distributed in four places, three in Portugal (Politécnico de Guarda, University of Beira Interior, University of Algarve) and Biskra University in Algeria. A significant number of polytechnic institutes are somehow involved in this initiative. The difficulties of a territorially distributed institution, in less attractive areas of the country, are addressed by a common governing body. This body includes members from all sites and establishes the overall strategy of CISE, e.g. new PhDs, distribution of scientific visitors, or distribution of fellowships. The different sites are specialised in different subareas: LSE, Electromechatronic Systems; GIRS, Thermal photovoltaic panels and renewable energy; LSEE, Electric Energy Systems; LESM, Electromechatronic Systems modelling.

The Unit strong social commitment to the region (e.g. with the participation in ENERAREA and in technology fairs) is commendable.

CISE team members appear dynamic, energetic and highly motivated to grow their research activities and attract more PhD. students. The four Ph.D. students who met with the committee were very positive about their educational experience in CISE.

The overall strategy of the R&D Unit concentrates efforts in growing the amount of human resources. The future lines of research are wide-ranging and related to the diversity of the R&D Unit. There are some very innovative lines of work such as the DC at home research program.

We encourage the R&D Unit to explore the Marie Curie ITN mechanism as a path to improve the current difficulties in getting new PhD students. More effort should be made in securing funding from the EU in the H2020 program. Some actions should be taken to guarantee a quality research environment. First, funds have to be secured by CISE to provide an improved attendance to international conferences since the universities have limited funds. Also, FCT should try and provide funds attached to fellowships to facilitate access to conferences that now is rather limited.

A negotiation has to be made with the University of Bikra to have longer stays of their students at CISE Portugal. Also, we encourage CISE to make Beira and Bikra Universities agree on a double PhD degree program that might facilitate the stay of postdoctoral students coming from Algeria in CISE Portugal. We suggest making VPN connections available to CISE Bikra members so they can access the bibliographic data bases accessible from CISE Portugal.

One of the difficulties in getting PhD students from abroad is the need to homologate their degrees in Portugal before signing a contract or being granted a scholarship. We suggest FCT alleviate this situation by allowing pre and post docs to sign contracts immediately after the application for homologation is made, without waiting for the resolution of the administrative process. Also, if extra funds are secured by CISE, we suggest expanding the advisory board to include more varied profiles among members.

To enhance its value and contribution, CISE may consider marketing some of its existing projects. Moreover, they have opportunities to expand the scope of some of their existing projects, which could generate additional resources.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic Institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

We suggest to partially use the awarded Programmatic Funding to strengthen the Advisory Board and to support the marketing of results.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Sistemas e Tecnologias (SYSTEC)

Coordinator: Fernando Manuel Ferreira Lobo Pereira

Integrated PhD Researchers: 33

Overall Quality Grade: VERY GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 480 K€

Recommended Programmatic Support

PhD Fellowships: 2

Programmatic Funding: 185 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

SYSTEC is a small, but lean Unit. There is a significant focus on control, dynamical systems and the use of control theoretic methods. Having said this, they have an impressive program on the development of AUV building with meaningful field tests and an excellent set of interactions and collaborations. In particular, the interaction with international groups on ocean sampling, modeling and environmental monitoring is world class (MBARI, NWUC, La Spezia, etc.). The integration of theoretical research into these real world deployments is strongly evident. Despite being a more academic Unit, there is also a measurable impact via the generation of spin-off companies. The placement of PhD graduates is also impressive with about a 30% faculty placement as well as industry and other research labs.

There is active engagement across the members with weekly meetings for thematic lines, three annual events, summer schools and other consortia meetings. This Unit is able to achieve consequences that are comparable of a much larger Unit. The first three contributions in the proposal have good synergy with respect to the networked underwater robotics and attendant fields (e.g. optimal control, actuation, robotic systems, etc.).

There is strong international and national collaboration: with IST (PT), Portuguese Air force, NTNU (Norway), EPFL (Switzerland), KTH (Sweden), EUT (Netherlands), ANU (Australia), CMU (PA, USA), UIUC (IL, USA), NPS (CA, USA), UC (CO, USA). There is clear corporate interaction via the EU projects.

There appears to be measurable diversity in the integrated researchers _ a wide variety of origins of the PhD students and postdoctoral researchers. Whereas the gender diversity is modest (21%), the Unit appears to be aware of the issues and there are women in some leadership roles. The Unit is encouraged to actively engage in increasing diversity. It is anticipated, that given their success with achieving EU and Portuguese projects in eras of scarce funding, they will be able to achieve success in increasing diversity under similar challenges of scarcity with respect to the pool of candidates.

PhD students and postdocs uniformly point to the collaborative opportunities available at ISR. The corporate interaction is also widely praised.

There are concerns:

The current Advisory Board does not seem to be providing meaningful advisement and engagement with university leadership to advocate for the Unit. While there are some good journal publication venues, the Unit is encouraged to aim higher – the group accomplishments are not properly reflected in the publication venues. Striving for more competitive and prestigious venues will increase the international recognition of the group.

For a Unit trying to achieve research success, the teaching load is high. The impressive track record with EU and FCT projects should be rewarded by the university/polytechnics.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

SYSTEC is a R&D Unit on the rise with good metrics. With concerted effort and good planning, the Panel believes that in future evaluations, the Center has the potential to gain good ground. The quality of venues, increased international interaction, all will lead to improved scores.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Centro de Tecnologias e Sistemas (CTS)

Coordinator: Luis Manuel Camarinha Matos

Integrated PhD Researchers: 39

Overall Quality Grade: VERY GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 578 K€

Recommended Programmatic Support

PhD Fellowships: 3

Programmatic Funding: 295 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

The Center for technology and Systems (CTS) is active in interdisciplinary research with a strong focus on Cyber-Physical Systems with subareas drawn from sensors, signal processing, communication networks, and computing. The area of CPS has become one of the very active areas during the past five years with broad applications in robotics, healthcare, energy and signal processing systems. The leadership of CTS has made a conscientious choice to operate at TRL4-TRL 6 so that they can be competitive in winning projects from the European Union and other entities. The broad scope of research activities in CTS has created a rich and intellectually stimulating technical environment, but it also induced additional challenges to developing and managing projects. From our communication with PhD students, it was confirmed that several have two research advisors from different disciplines, which is a very positive indicator for CTS. It also highlights the collegial spirit of CTS members and reflects the enthusiasm of the team Coordinator Dr. Luis Manuel Camarinha Matos Carlos. Almost everyone we talked to (doctoral students, junior and senior researchers) mentioned that CTS maintains a friendly and welcoming environment.

The Unit has had active rotation of its leadership over the years and the Panel believes that this healthy change-over has led to increased agility on the part of the institute. The leadership engages in regular brainstorming and preparing road-maps for the institute; this is excellent. While junior researchers do take part in brainstorming; it was unclear if these researchers are engaged in decision making at higher levels with respect to institute priorities. It was also unclear if junior researchers have a seat on key boards of the Unit.

The leadership was able to clearly articulate their strengths in manufacturing and factories of the future. However, given the emphasis on cyber physical systems, there was concern that insufficient attention was being paid to having core expertise in cyber security.

CTS has attracted several projects and supported research in a diversity of areas of interest to partners in Portugal. Many projects were primarily a problem in one of the fields listed above. The underlying methodology is one based applied engineering approach. The projects addressed practical challenges of interest to a partner and the outcomes were useful. The Panel feels that focusing 90% of the work on TRL4-TRL 6 efforts may be injurious to being able to develop long-term basic research initiatives. The Center Coordinator outlined the broad areas the team be focusing on over the next 4 years. Emphasis will be placed on human in the loop system as well as on exploiting emerging trends in machine learning and artificial intelligence. In the absence of strong basic research efforts, it may be difficult to respond to emerging trends as the concern the Panel has whether the team will be always on a catch up model. The Panel recommends that the Center consider devoting more efforts on improving their research efforts at TRL1-TRL 3, which may be useful to quickly move into emerging areas as well as discover new science. The Panel was informed that significant time is spent on generating proposals, which in turn means less time is available for doing research. Conversations with doctoral students, junior and senior engineers revealed that not having full-time lab technicians and project managers has significantly cut into their ability to devote more time to work on their research activities.

The Center has a method to evaluate the performance of the researchers based on their publications in top journals and conferences. It may be important to annually revisit which are the top venues as the Center moves forward. As all the employees are hired through the university system, it appears that methods for incentivizing or de-incentivizing are hard to implement. In order to be agile and maintain high quality, the Center is encouraged to put in place to provide incentives to top performers.

The emphasis on education and training was deemed to be excellent by the Panel. There is significant outreach to high schools to encourage interest in STEM fields; there is the forum for Masters students which has a 50% acceptance rate (very competitive for such an event); and the ethics training for PhD students. Furthermore, it was very evident that the institute works hard to ensure the success of their junior researchers through active training and mentorship. This training includes research management, how to write proposals, professional research, how to develop international networks, the supervision of graduate students, etc.

The Unit is encouraged to explore different avenues via project funding to support technicians and project managers. The Panel believed that there might be options with existing project funding lines to achieve this staffing goal.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The Center is encouraged to expand its activities at TRL1-3 levels. It is also encouraged to hire lab managers, project managers and lab technicians so that researchers have the needed support for pursuing their efforts.

Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering**

R&D Unit: Grupo de Investigação em Engenharia e Computação Inteligente para a Inovação e o Desenvolvimento (GECAD)

Coordinator: Maria Goreti Carvalho Marreiros

Integrated PhD Researchers: 12

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 4
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 218 K€

Recommended Programmatic Support

PhD Fellowships: 1

Programmatic Funding: 210 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

The group has developed an excellent reputation in the area of Energy, particularly in Smart Grid Applications and intelligent Building management. The mixture of reality, emulation and a real-time environment in a dedicated Building is a very flexible experimental facility. For instance, the use of multiagent technology was clearly illustrated on this facility. The centre was very wise in building this infrastructure as this has proved to be an asset to facilitate GECAD's participation in EU project consortia. In that respect, it is worth noticing that the success of GECAD project applications is extremely good. The ratio of funding per researcher with a PhD is excellent. It is commendable that the R&D Unit took action into downshifting its size to guarantee that all members have a very good publication and fund raising profiles. The completion of around 4 PhDs per Year is adequate for the size of the centre.

The researchers of the centre publish a significant number of papers in prestigious journals. The ratio of publication per researcher is good. There is a combination of fundamental research and applied research, with a clear emphasis on the latter. The centre has successfully organised several international events.

GECAD has focused on advancement of the state of the art of Intelligent Systems that can deal with complex real-world problems through partnership with international institutions. It is relatively small that has 12 integrated researchers with Ph.D. In 2013-2017, GECAD raised more than EUR 6 million of funding for its projects, with a very small share from FCT Funding. Thus, its dependence on FCT is modest.

The team benefited from international collaboration, that is a strength. As the team focuses on the research of TRLO-2, it is important that the team focuses on the quality of the publications.

GECAD organization in 2018-2022 is based on Project Lines and four transversal areas, which is about the same as the previous years. As GECAD is the process to grow in terms of size, it is recommended to organize GECAD into smaller project lines/areas to leverage the resources available within GECAD.

As mentioned above, the decision of downsizing the centre to integrate only researchers with a good research and development profile is a measure that seems to be adequate to create a smaller but more focused group of research. The success of GECAD in recent EU project calls shows that this change did not affect the competitiveness of the centre. The group has a strong multidisciplinary profile and this is highly appreciated by all members, especially PhD students and early career researchers.

The strategic alliance with the University of Salamanca seems to be a practical arrangement for the students and for the internationalisation of the group. GECAD, despite the difficulties, attracted a reasonable number of foreign students. The collaboration with industry is intense via projects funded with public money. Some further involvement of companies is desirable to support PhD students.

GECAD proposes to strengthen the Advanced Training of PhD students. This is the right strategy. But the expected funding for PhD, PostDoc or other fellowships is only 120K euro, that does not seem to represent a growth.

In 2018-2022, Artificial Intelligence will continue to attract post-docs and researchers. GECAD currently has the expertise in Artificial Intelligence, Ambient Intelligence, Affective Computing, Decision Support, Smart Grids, Energy Efficiency and Sustainability, Demand Response, Cyber-Physical Systems, and Internet-of-Things, which may not well understood by new researchers. Some of them are Artificial Intelligence competence, and others are Artificial Intelligence applications. It is recommended to organize the expertise in a better way.

The Centre has clear plans to align its research agenda with international trends. In particular, the addition of the ethical, legal and social dimensions to the developments is a sensible move. Also, the concentration on quality and a more selective group of international contacts will probably increase the international reputation of the centre. The plans on promoting the centre among students and the outreach to society are very reasonable.

The researchers, although using AI technology in the context of energy management, should try and submit papers to top AI conferences, especially to these conferences application tracks.

FCT should simplify the contracting procedures of foreign potential PhD students, for instance by allowing the contract to be signed right after the submission of the application for degree homologation.

The preparation and management of project proposals is very demanding and, in some cases, requires the involvement of PhD students. Efforts should be made to increase the personnel of support.

Some simplification of bureaucratic processes should be achieved, in particular in the acquisition of equipment.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

We recommend the awarded Programmatic Funding to be used to better align the research with current AI developments.

Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering**

R&D Unit: INESC TEC - INESC Tecnologia e Ciência (INESC TEC)

Coordinator: José Manuel de Araújo Baptista Mendonça

Integrated PhD Researchers: 286

Overall Quality Grade: VERY GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 3
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 3

Base Funding for (2020-2023): 4290 K€

Recommended Programmatic Support

PhD Fellowships: 14

Programmatic Funding: 1070 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations

The Integrated Researchers in the R&D Unit are conducting research that combines an innovation push and a market pull dynamic. Overall, the Institute is significantly focused on applied research and technology transfer. There is a large amount of interaction on projects with corporations. The Institute research focus is in varied areas: applied physics (optical sensors, microfabrication) to electrical engineering (power, telecommunications, electronics, robotics), computer science (artificial intelligence, computer graphics, high assurance software), industrial engineering (logistics, asset management, simulation) and innovation. The research efforts are nicely divided in the following four thematic lines: Energy, Networked Intelligent Systems, Industry and Innovation and computer science. The emphasis on innovation and technology transfer is very evident as are the successes of these efforts.

They have worked, consistently over the years, across multiple organizations and geographies, and they have pioneered a new model of scientific innovation in Portugal that acts as a counterpoint to a traditional Principal Investigator research model. The managed science model was developed in order to help build interdisciplinary efforts and ease the transition from basic science to commercialization.

During the review period, the organization has been extremely successful at amplifying the effect of FCT resources, leveraging 1MEuro of FCT funds into a total of 6M in additional national and international competitive funding as well as consulting services income. FCT funds are catalytic for the Institute.

The scientific production of the group demonstrates steady production of quality research, and members are active in IEEE and ACM with 2 IEEE Fellows, 13 IEEE Senior Members and 1 ACM Senior member. The researchers have published their work in prestigious journals such as the Proceedings of the National Academy of Sciences, ACM computing Surveys and several IEEE Transactions. Team members have won awards, given invited talks and organized many national and international conferences and workshops. The Institute researchers are publishing in some very strong venues; while other venues could be improved. The Institute has the potential to improve its impact and increase its international visibility by being more selective in its publication venues overall.

The Institute is extremely effective at internationalization, with international PhD students, large numbers of co-authored articles and leadership roles in international conferences. The Institute is actively collaborating with many international partners in Europe as well as outside. While noted below, the Panel highlights the programs with Brazil, India and beyond.

The group works in a model of end-to-end innovation, starting with basic research and continuing through commercialization activities. For at least some of the researchers, consulting work for corporations helps to identify potential research questions for more fundamental scientific work, but is not completely clear how the market pull element of their model works across the Integrated Researchers comprehensively.

There are a large number of centers of varying sizes, which can make it difficult for each center to receive appropriate attention since smaller organizations/groups can sometimes be overshadowed by larger, more-established organizations that have had more time to build a research reputation. It would be useful if future strategy incorporated specific actions and metrics that would act as enablers for smaller Units working to become established in their fields.

The goals of the Brazil/India collaboration are to provide connections to potential PhD students and this goal seems to be effectively realized.

This Institute appears to have one of the lowest percentage of women, especially at all levels of leadership. The scientific advisory board of the institute specifically raised this concern in 2017. In more than a year, there appears to be no efforts to ameliorate this deficit. There are no women on the Scientific Advisory Board – a deficit that can be easily corrected since the Scientific Advisory Board is being continually expanded, as reported during the site visit. Currently, Scientific Advisory Board members do not have specific term lengths, and rotating Board members is another way to increase diversity.

Given the goals of the Institute it is somewhat surprising that a person dedicated to patents and licensing was hired only four years ago. However, the decision to hire such an individual is commended as it is clearly of high value and advances the goals of the institute.

There is an impressive number of spin-offs, largely due to the efforts the postdoctoral researchers. Within the constraints of the various funding lines, INESC-TEC is able to offer modest initial funding, incubation incentives for which INESC-TEC receives equity, connections to angels, some mentoring, etc. There is the possibility that more aggressive licensing arrangements could increase revenue generation for the organization. They are endeavoring to develop a payment model to incentivize consulting.

The Institute is taking full advantage of joint programs between Portugal and MIT, CMU and UT Austin with Institute members having leadership roles in those programs.

The Institute has an annual evaluation process that considers scientific productivity among members. This was a new model that was created in response to the Advisory Committee report. Indicators from that evaluation process define who gets funding. Publications are the most important metric in the process, but other factors can be considered as well. There is a process for shifting resources across the Institute when necessary. There is an incubation process which has been used successfully in the past and which serves as a tool for helping encourage people to shift research areas. In addition, the Institute has a mechanism whereby R&D Centers can identify emerging areas of research and the Board discusses those topics and decides whether or not to allocate funding. This combination of a bottom-up and top-down process for keeping research agile allows for direct input from researchers that can effectively reflect changes in the scientific fields while also providing for strategic coherency from the Board involvement.

PhD students have easy access to advisors and co-advisors. They are supported to explore potential careers in either academia or industry. Some students have expressed interest in pursuing an entrepreneurial path and they are able to take advantage of resources at their respective institutions or work with the extended INESC-TEC network to learn relevant skills. Students could more actively be encouraged to take classes in business or entrepreneurship if commercializing their research is a goal the Institute wants to pursue.

The postdoctoral researchers, similar to the PhD students, see career possibilities in both academia and industry. They are encouraged to see their research as tied to society, and many expressed interest in having ties to both research and commercialization in their careers. Both PhD students and postdoctoral researchers see the transparency in how groups meet and exchange ideas.

The interaction between thematic lines is very good. This interaction was highlighted and emphasized in all meetings (PhD students, post-doctoral researchers and senior researchers). The meetings every two weeks with investigators are commended; the mix of leadership with one scientific (PhD) leader and one manager is also very good to ensure that project goals are met.

In terms of future strategy, the Institute is investigating the possibility of changing the scientific management model, in order to develop a governance model that would direct processes for creating and recreating the clusters. At the moment, it does not appear that the Institute strategy for the future has any emphasis on scientific contributions. One concern is that there are four Research Clusters which are combined with six Cluster Research Lines around which future

strategy is being constructed. The relationship between Research Clusters and the TEC Cluster Research Lines introduces a level of complexity to the overall strategy that may inhibit focused growth activities.

There are a large number of R&D Centers of varying sizes, which can make it difficult for each Center to receive appropriate attention since smaller organizations/groups can sometimes be overshadowed by larger, more-established organizations that have had more time to build a research reputation. It would be useful if future strategy incorporated specific actions and metrics that would act as enablers for smaller Units working to become established in their fields.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

INESC-TEC is a strong R&D Unit with a storied history. Technology transfer and spinoff construction is impressive. At the moment, it does not appear that the Institute strategy for the future has any emphasis on scientific contributions. One concern is that there are four Research Clusters which are combined with six Cluster Research Lines around which future strategy is being constructed. The relationship between Research Clusters and the TEC Cluster Research Lines introduces a level of complexity to the overall strategy that may inhibit focused growth activities.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Instituto de Engenharia de Sistemas e Computadores de Coimbra (INESC Coimbra)

Coordinator: Carlos Alberto Henggeler Carvalho Antunes

Integrated PhD Researchers: 55

Overall Quality Grade: GOOD

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 3
- (B) Merit of the team of Integrated Researchers: 3
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 3

Base Funding for (2020-2023): 645 K€

Recommended Programmatic Support

PhD Fellowships: 2

Programmatic Funding: 210 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

INESC Coimbra is active in interdisciplinary research in broad technical areas, including electrical, civil, informatics, geographic, mechanical fields. This breadth of scope has created a rich and intellectually stimulating technical environment, but it also induced additional challenges to developing and managing projects. From our communication with PhD students, it was confirmed that several students have two research advisors from different disciplines, which is a very positive indicator for INESC Coimbra. It also highlights the collegial spirit of INESC Coimbra members and reflects the enthusiasm of the team leader Dr. Carlos Alberto Henggeler Carvalho Antunes.

INESC Coimbra attracted several projects and supported research in a diversity of areas of interest to partners in Portugal. Many projects were primarily a problem in one of the fields listed above coupled with an optimization or a modeling approach.

One of the underlying themes is energy efficiency. The projects addressed practical challenges of interest to a partner and the outcomes were applied and useful. In the area of designing and evaluating energy efficiency measures, INESC Coimbra is a dominant player in Portugal supported by international collaborations in Brazil and USA. Both basic and applied research efforts undertaken by INESC Coimbra researchers have impacted the residential, commerce & services and industry & agriculture sectors,

Likewise, in the area of automating radiotherapy treatment planning, a robust solution based on pattern search optimization algorithms, meta-heuristics and fuzzy logic has been developed. This effort will ensure the widespread adoption of the treatment planning protocol which will protect the healthy organs as much as possible, while selectively destroying the cancerous cells. This effort is well aligned with the broad goals of "European Society for Radiotherapy & Oncology Vision 2020". Moreover, this focus area has broad and deep international collaborations with many countries in Europe and North America.

In the area of geospatial data analysis, the approach of ingesting crowd sourced data for generating products related to land use is a timely. This effort has applications in Global Monitoring for Environment and Security Urban Atlas, the Corine Land Cover pan-European land cover product and the GlobeLand30. The incorporation of volunteer-generated data will enable the integration of information generated by satellites and humans for land use updates, verification of generated land use maps and future development of machine learning-based approaches. Collaborations with researchers drawn from International Institute for Applied System Analysis, Polytechnic of Milan, Univ. Heidelberg and National Technical Univ. Athens are strong.

In the area of network routing, the research team has developed solutions to problems suggested by a company (Altice Labs). These problems are related to finding paths visiting specified nodes, and network-wide optimization. The solutions are expected to solve existing problems in network management platforms for telecommunications transport networks. The Panel notes that international collaborations in this area are weak, may be because the solutions are tailored for one specific company.

Finally, the last area of research highlighted in the applications is on .developing methods for managing the energy efficiency in electric vehicles. The goal of this focus area is to "optimize the energy and power sharing between two sources with different characteristics: high specific energy (battery) and high specific power (super capacitors)". The solution is based on classical rule-based heuristics, featured in a highly cited paper.

The Panel appreciated that corporate projects were selected as a function of the potential for scientific output at the end of the project. The Panel was impressed by the success rate for FCT proposals. The use of seed funding to initiate exploratory research that forms the basis of these proposals was deemed to be a very positive aspect of the institute.

A challenge with the large amount of diverse research topics and projects coupled with having so many part-time PhD students is that PhD students and post-doctoral researchers do not appear to have a community with which to interact. In fact there are seven research thrusts stated; there was the suggestion that half of the integrated researchers were devoted to a single thrust,

A concern is that the Institute does not appear to have methods by which it can incentivize success in research projects and/or success in corporate projects. The Institute is encouraged to develop a reward structure that will enable it to forward its goals. The Institute also does not appear to consider its lack of gender diversity to be a problem that can be improved.

Amongst the various sub-units of the Institute, there does not appear to be interaction or collaboration. It should be underscored that this conclusion is drawn from the fact that no material was provided on this aspect and discussion on this point did not lead to concrete examples of interaction. It was unclear if the Institute had a plan for investigating modern research areas. It is clear that the institute has a history in certain approaches and they are leveraging this expertise in their projects.

The INESC Coimbra leader is an energetic, enthusiastic and friendly leader. His leadership style appears friendly and team oriented. This has created a collegial environment in the Center.

The senior researchers are active, knowledgeable and eager to work. Nevertheless, the recent economic challenges have impacted the resources available to the University and INESC Coimbra leadership. Thus, the senior researchers were not effectively rewarded, via salary raises or promotions, for several years. This lack of recognition has resulted in a subtle sense of being insufficiently appreciated. However, it should be noted that all institutes across Portugal have faced similar challenges due to the past economic situation.

The Ph.D. students are energetic and highly motivated. On the average, they are able to complete their degree requirements and graduate in 4 years. INESC Coimbra has about 40 PhD students, with roughly 25% of them full time. The remaining students are currently employed as lecturers in nearby Polytechnic Institutes and appear to be not very active. Further erosion of PhD student enrollment will be detrimental to the well-being of this Institute. The Institute is able to graduate about 10 doctoral students per year. If INESC Coimbra is to produce more graduates, additional resources need to be provided. Moreover, reallocation of some of existing resources, if allowed, would be recommended.

INESC Coimbra has proposed several interesting projects for the next 5 years. Most of them are continuing along the same lines of current areas. It is recommended that the Center reevaluates its existing strength and consider redirecting some of its efforts into emerging areas or concentrating more on the most rewarding ones. For instance, it appears that energy related projects (e.g., energy efficiency, smart grid, electric power transmission, energy storage, renewable energy, etc.) have been very successful in attracting more resources and also enhancing international collaborations, which significantly increased INESC Coimbra visibility. Thus, focusing on this topic, and similar ones, could be an effective approach to enhancing the Center standing in Portugal and abroad.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The serious issue facing this Institute is the drop in PhD production. If this is not addressed quickly, the well-being of the Institute will be seriously impacted.

Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering**

R&D Unit: Instituto de Sistemas e Robótica - ISR – COIMBRA (ISR-UC)

Coordinator: Aníbal Traça de Almeida

Integrated PhD Researchers: 42

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 719 K€

Recommended Programmatic Support

PhD Fellowships: 4

Programmatic Funding: 325 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

The Institute of Systems and Robotics - University of Coimbra (ISR-UC) is a private, non-profit research institution. ISR was founded in 1992 to carry out leading edge research in several important areas of science and technology, with a special emphasis in systems and robotics. ISR-UC is organized into 7 groups, and consists of over 110 researchers. There appears to be about 2 journal papers per senior researcher per year, a good production rate. The diversity of the funding portfolio is to be commended. The institute noted that while FCT funding would be strongly advantageous, they have a lean operation that is not fully dependent on programmatic funding. ISR-UC has been effective in garnering funds from FCT grant competitions and other national and international sources.

ISR-UC delivered a number of high-quality research results. The Video-based Computer-aided Orthopedic Surgery from the Medical System and Robotics group leads to a spin-off company. e-Tattoos is invention for printing of ultrathin (5_μm) electronic circuits transferable over the human body for bio-monitoring. The research results are published in top-ranked journals such as PAMI and Advanced Materials as well as top computer vision conferences such as ICCV, and ECCV. ISR-UC actively participated in, as well as organized important international conferences (e.g. IROS), served in Editorial Board of leading journals, and received international awards. The Panel is also impressed by the garnering of a highly rated EU FET grant.

Some of the new research activities are considered to be quite impressive as noted above, in addition, the Panel highlights the new work in stretchable electronics with good equipment and very promising results. There is a meaningful concentration of projects related to health and well-being for which new navigation, control, machine learning, etc. methods are needed. The institute has found good synergy between classical control and robotics and medical systems (surgery, wheelchairs, brain computer interfaces, endoscopy).

ISR-UC provides a conducive environment to students. The current ratio of PhD students vs integrated researchers with PhD is low. Students and supervisors enjoy plentiful interaction. In general, post-docs are happy taking up lab administrative duties. There is also excellent mobility of the PhD graduates of the institute.

It is noted that ISR-UC is organized in 7 groups, which is not clearly justified. The synergies between the groups are not clearly articulated. On the other hand, ISR-UC suffers from lack of space, technical or administrative support staff, which limits its ability to manage large projects or to respond to call for proposals. It is suggested by the Institute leadership that the diversity of projects and topics was driven in part by the expertise needed to cover teaching obligations.

The 2019-2022 technical plan is reasonable. However, it lacks clear definition of success criterion for the activities. It is unclear why the predicted funding income for 2018-2022 is only half of that for 2013-2017.

The new funding would help with the overhead and the possible expansion of the lab space. However, it is not well articulated how ISR-UC will use the FCT fund to sharpen its edges.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The Panel fully supports the program under the recommended levels. We hope the current funding levels will allow sufficient growth and enhancement of the program.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Instituto de Telecomunicações (IT)

Coordinator: Carlos Eduardo do Rego da Costa Salema

Integrated PhD Researchers: 263

Overall Quality Grade: VERY GOOD

Evaluation Criteria Ratings

(A) Quality, merit, relevance and internationalization of the

R&D activities of the Integrated Researchers in the R&D Unit Application: 5

(B) Merit of the team of Integrated Researchers: 3

(C) Appropriateness of objectives, strategy, plan of activities and organization: 3

Base Funding for (2020-2023): 3663 K€

Recommended Programmatic Support

PhD Fellowships: 17

Programmatic Funding: 1070 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations

The Institute of Telecommunications (IT) is one of the oldest and largest institutes in Portugal. IT main objectives include creation and dissemination of new knowledge and supporting advanced training. It is comprised of six academic institutions, one of which is a Polytechnic, as well as two companies. This Unit is one of the most academic/research oriented Units. Thus, it is expected to have a strong emphasis on fundamental research. There has been significant growth in the number of PhDs produced over the recent years. IT has high productivity, significant technical contributions and considerable impact in research areas served by the Unit as evidenced by the respectable number of quality conference and journal papers published, patents granted, the broad scope of projects developed, the financial support received, the talented researchers attracted to the institute from Portugal and abroad, and the high visibility of IT researchers in international professional societies. Overall, IT researchers generate respectable volume in all these areas. The IT performance index used to evaluate researchers incentivizes such activities. Interestingly, while the leadership of the Institute believed that there was a strong emphasis on basic research, students perceived that the work of the institute was 50% basic and 50% applied.

The Panel was very favorably impressed with the research quality of the various laboratories and groups. The wireless group has had significant impact and developed facilities from scratch 25 years ago, including the construction of several anechoic chambers. The work on microwave devices and circuits, antennas, pattern recognition, inverse problems, network research and multimedia has internationally recognized researchers and many of the awards of the Unit stem from this research group.

IT is also effective in the advancing-training aspect of its mission. Almost half of its doctoral graduates are employed by Portuguese or international academic institutions. The majority of the other graduates are employed by industry. Moreover, IT offers 3000+ introductory courses and lab demonstrations to secondary-school students, organize conferences and tech days, and experts advising government agencies. IT has been relatively successful in IP generation and in marketing its portfolio to industry. IT has also made contributions to the economy in the regions through spin-off companies.

The internationalism of the graduate student and postdoctoral population is excellent. Also very impressive is the placement of the PhD graduates across the world. The presence of IT PhD graduates in international academia is praiseworthy. The Panel was impressed to see that a limited number of graduates stay at IT. This mixing of individuals and the bringing in of new talent is very good.

Both the Advisory Board, as well as other researchers, suggest the need for greater interaction across the various sites wherein similar research is being conducted. The Institute is to be commended for strategically placing research groups across the different locations to enable synergy and complementarity in research approaches; however, greater integration is needed.

The Unit appears to emphasize the computation of the performance index (PI) in how it evaluates its members; however, by the Institute own admission, there are a large number of underperforming researchers and the PI has been in place for nine years without any action being taken based on the assessments. In fact, the tail of this distribution is very long. There is no plan to encourage greater productivity or to reduce the number of under-performing researchers. It is not clear that the performance index has any impact on performance. This policy is nine years old; it may be useful to update the policy to both include tech-transfer as well as corporate interaction as positive measures. Additionally, it would be useful to reconsider the journals and conferences that are considered to be high quality. Being indexed is insufficient to determine the quality of the venues. The consideration of international collaboration as desirable is also good. It appears to be a recent transformation to consider societal impact of the research.

The Unit has received impressive awards and has a meaningful number of IEEE Fellows. The Unit is very active in IEEE activities through editors-in-chief, associate editorships and conference organization and other scientific boards. However, given the size of the organization, the number of IEEE and other association fellows seems modest. The Panel was pleased to hear that the institute covers IEEE membership. There is also concern that paper production is concentrated in the efforts of a few researchers.

IT receives about 50% of its funding from FCT, which is a reflection on and a results of its strong emphasis on fundamental research. However, this suggest that the Institute has a very large dependence on FCT programmatic funding – a uniquely large dependence, in fact. It was unclear how the Programmatic Funding was being used to stimulate new initiatives. One use was for seed funding for junior researchers; however, the competition is every two or three years and it appears that few are awarded. Thus, the impact on an organization of the size of IT could be modest. The Panel was supportive of the Institute effort to improve its success rate with EU and corporate funding through the hiring of consultants. The Institute is encouraged to hire someone who can develop and manage a commercialization strategy. Another potential avenue to explore is the construction of an Industrial Advisory Board.

The Institute is also to be commended for enabling junior and senior researchers to have a stake in the governance of IT. However, there does appear to be a significant hierarchy. Researchers noted that the hierarchy did not affect research choices, but it does appear to have affected the ability of the Institute to develop robust, actionable, and strategic plans for moving forward. The plan for future research expansion was questioned in terms of its novelty and how forward thinking the topics are; in some cases, new areas for research are several years into expansion and well developed in other countries. The junior researchers are capable and dynamic intellectual leaders, and they would likely be able to provide extremely useful research strategy input for the Institute.

The leadership structure of the Institute seems to have been static for some time and this may have affected IT ability to be agile both in terms of how individual researchers work and as an overall institution. Generally speaking, research institutes benefit from regular turnover of the leadership, and in this specific instance a lack of turnover across senior leadership seems to have entrenched an internal culture that is not allowing the excellent scientific work of research groups to drive the organization forward. The Institute is encouraged to consider a more dynamic model, including regular rotation amongst the Board of Directors. None of the Institute leadership are women.

The size of the Advisory Board seems modest (three colleagues) given the size of IT. The current board has one woman and two men; this composition is considered good. For an institution of this size and that spans multiple sites, a larger advisory board would provide a more comprehensive perspective on the field and may also enable the organization to benefit from the insight of a more diverse set of experts.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The IT has a storied history and has made significant impact on Portuguese information technology. The hope of the Panel is that the institute be able to be equally successful in the future; however, the vision and strategy for the future should be improved. We suggest to partially use the resources awarded to strengthen the Advisory Board and to support the marketing of results. There were strong concerns about the vision for the future and whether the Unit is examining problems that are cutting-edge. It is strongly recommended that the leadership (director/board) have regular change-over to assist in looking forward.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering

R&D Unit: Laboratório de Robótica e Sistemas de Engenharia (LARSys)

Coordinator: Jose Alberto Rosado Santos Victor

Integrated PhD Researchers: 126

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 2180 K€

Recommended Programmatic Support

PhD Fellowships: 12

Programmatic Funding: 955 K€, including for 3 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations

This Laboratory is a large organisation with many faculty, numerous pre and post docs, research projects and international collaborations. The Laboratory is especially strong in securing funding coming from the EU. The internationalisation of the activities and the visibility of the lab as a referent in robotics in Portugal are beyond doubt.

The publication record and quality of the publications is very high. There are more than two journal publications per faculty member per year, which is very good by international standards. Publications include several papers at the major robotic conferences, ICRA and IROS. Some best paper awards have been obtained during the period. It should be noted that the research lines have a long trajectory with diverse approaches to the problems, and not everybody follows new trends like deep learning, which can be considered a strength. The effort in mentoring new researchers is impressive with a very large cohort of PhD students and post-docs. Several patents have been filed and there is a substantial level of collaboration with the local industry.

The Laboratory demonstrates excellent capability in developing and growing infrastructures (e.g., the cognitive robots in Interaction program) and leveraging opportunities with high impact (e.g., EC first marine seismic survey worldwide using cooperative robots).

The Laboratory demonstrated close collaboration with industry that has generated relationships that benefit PhD students.

Given the research topics of the Laboratory, the Panel recommends an increased effort to publish in premier conferences within groups' themes/areas. Publication quality remains more important than quantity. Also, consider strengthening the scientific questions beyond the engineering work. Sometimes there is important science that is hidden behind the machines and tools being developed and that should be presented as such.

The structure of the laboratory is complex, integrating ten research groups around five thematic lines. The integration of the work along the thematic lines is a challenge and the Panel appreciated the efforts made to articulate mechanisms to facilitate that. For instance, there are mechanisms to share across the different groups resources that are not associated with projects, and the advisory boards are asked to assess the level of integration of each R&D Unit with the different thematic lines. The annual conference organised for the whole lab seems like a very good mechanism to address the complexity and to make the ideas flow across the organisation.

The matrix structure between the R&D Units and the thematic lines is effective in connecting multi-disciplinary research to address real-world problems.

The international interaction of the Institute includes participation in EU FP7 projects as Work Package Leaders; this has raised international visibility of the Unit. The Urban sub-unit participated in the Sharing Cities project that partnered

with European cities to build smart cities, which is a new way of engaging with society. The Life program closely collaborated with the medical school and clinicians to assist early detection of disease and diagnosis as well as develop novel interactive methods of rehabilitation. Moreover, this Unit has ventured into a new initiative on grazing livestock production research that creates innovative services to traditional agriculture. The Oceans program brought outside collaboration from the private sector and partners on R&D projects, many of them leading institutions in the fields of research. The AIR program has benefited from high levels of international and interdisciplinary activities.

The Panel recommends that the Laboratory finds methods to describe the social and economic impact. Not all measures are quantitative, and in particular, social impact must often be evaluated qualitatively. If social impact is to remain a goal, appropriate metrics to measure and evaluate the impact must be developed. This is also relevant to the researchers working in the design, HCI, and policy fields. It is important to note that scholarship in these areas needs to be evaluated according to metrics appropriate to their fields which often results in fewer overall publications because of the nature of the research and requirements for dissemination. One of the significant strengths of LARSyS is its successful interdisciplinary work, and in order to continue its leadership in several of its research areas, more tightly integrating and rewarding the participation of non-traditional engineering colleagues such as those at M-ITI is essential. Small initiatives such as a collaboratory on site at IST for the design and HCI researchers, for example, could have a significant impact on the ability of such researchers – and their work – to contribute to LARSyS intellectual leadership in several of its research themes.

Also, other measures should be monitored, like the number of joint papers across the different research groups. It is commendable that some PhD theses are co-advised by members of different research groups, and further efforts in this line should be made. Also, some effort should be made to try and simplify the bureaucratic burden that affects students in getting reimbursements or gaining access to papers and materials from non-registered providers.

The Panel also recommends that the Research Unit encourages and facilitates students internships in overseas academic and industry organizations, and that it increase the admission/support of international students to improve diversity and enrich the program. There was palpable enthusiasm from PhD students to engage with industry during the summer. Unfortunately, these opportunities were not possible due to restrictions on students receiving a stipend/salary for this type of training experience. The Panel recommends LARSyS explore creative solutions to the structural limitations for internships. Also, the Panel recommends that students be allowed to charge membership fees to professional societies to allow networking and development.

The Laboratory proposes three objectives for 2019-2022, which largely focus on enhancing the existing activities and outreach. The Panel recommends that the Laboratory looks into how to optimize the FCT investments to grow the strategic areas, to strengthen the integration within the thematic lines, and to prioritize the activities in response to technological, economical and societal changes. The Panel recommends that the Laboratory be more explicit in the directions to advance in the future and provide more guidance and vision that is forward-looking. Also, the alignment and support from university level should be clarified. A dynamic system that can be adaptive to new opportunities would benefit the organization. This effort can be tied to PhD recruitment and infrastructure preparation, etc.

Some researchers have made very significant contributions that facilitated their subsequent joint work with NASA, and recently created companies in Portugal, with plans to get ESA support.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

LARSyS is a strong R&D Unit with excellent international visibility, strong publication venues and participation in professional society activities. The Unit is encouraged to further improve publication venues in all sub-groups (the sub-groups have varying quality) and be proactive about rewarding excellence in research and technology transfer. A more focused vision for the future, clearly articulated to sub-units is desirable.

Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Electrical and Computer Engineering**

R&D Unit: Unidade de Investigação em Microssistemas Eletromecânicos (CMEMS-UMinho)

Coordinator: José Higinio Gomes Correia

Integrated PhD Researchers: 29

Overall Quality Grade: EXCELLENT

Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 4
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 513 K€

Recommended Programmatic Support

PhD Fellowships: 3

Programmatic Funding: 285 K€, including for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations

This Unit (CMEMS - Research Centre in Real-Time and Embedded Computing Systems) had a well-reasoned plan to continue/support participation of its members in professional associations and international organizations including ACM, IEEE, ISO, and WHO. Also, many of the researchers are playing (or have played in the past) leadership roles in conferences (Chair/Co-Chairs) and journals as Associate Editors and Reviewers. International research collaborations have been evident, as over half (50%) of the published papers included collaboration with international researchers. Of note, at this site was two papers in Nature (551-2017 and 494-2013) related to neural electrodes and brain stimulation were published by its integrated researchers. In addition, we noted a significant amount of financial support from industrial projects from international companies.

Also, there was a structure in place to share (albeit limited) resources to send both doctoral students and post docs to conferences, targeted to increase international visibility and networking of students and postdocs within targeted professional communities.

There was clear evidence supporting that the integrated researchers (and graduates of the PhD program) have been hired by international companies, including Bosch, ARM, NVIDIA, TU Braunschweig and Carnegie Mellon.

This Unit has strength in two important areas: (1) Quality of their scientific/engineering research and (2) Infrastructure to carry out technology transfer.

In (1) the quality of their research activities included state-of-the-art studies on smart bio-materials applied to orthopedic (bone) to support regenerative medicine, as well as the creation of "lab on a chip" technology for diagnosis/screening of blood born pathogens and viruses. In addition, there were two ongoing projects related to dental implants/biomaterials being carried out in collaboration with the dental and medical and collaborators in the department of biomedical engineering located on the Braga campus. Of particular weight was the presence at the meeting of an M.D./clinician collaborator, working on refinements of the "video camera" for intestinal disorders.

There was very strong collaboration evident between/among doctoral students and MS students, postdocs and pre-docs, as well as regular laboratory meetings (weekly) occurring to support mentoring.

This was a "two-sited" Center, with the Medical School and the University being in part located on Braga (20-30 minutes travel by car). However, this was not a problem for either doctoral students, or other integrated research members. We also met with the Director of the INL (International Iberian Nanotechnology Laboratory) facility, who commented that many integrated researchers have made use of the fabrication facilities, including a clean room for nano-materials and micro-electronics, and microscopy. This facility is currently operating at 55% of its full capacity, and will provide "head room" for future growth of the CMEMS program, providing desk areas for students and integrated researchers to carry out basic science and development projects.

The second strength of this group is its strong commercial partnerships with industry, including Borsch and others. Borsch has entered into a long-term partnership with CMEMS and has provided extensive research facilities to the University (effectively prepaying licensing IP). There is an on-going partnership between Bosch and University of Minho (within the framework of the projects HMIExcel and InnovCar) that has resulted in funded projects, supporting integrated researchers and PhD students.

The strong partnership built with the International Iberian Nanotechnology Laboratory (INL), an international key player in the field of micro/nanofabrication, located in the city of Braga, has also enabled their Integrated Researchers to target EU grants who also make use of the INL shared facilities.

The Center has a reasoned and realistic plan to enhance their program through funded research projects in collaboration with industry, EU and FCT support. They have PhD students working with the group of Prof. Edward Boyden (MIT Media Lab., Cambridge, USA), that have resulted in published papers and with enhance their external visibility. Leadership is strong and effective, with well-defined objectives that will offer opportunities for high level publications, student internships, and funding support through industrial projects. There is an infrastructure in place to provide/assure fair governance of the resources over the next FCT funding period.

Overall, this is a well-balanced program that we are confident will progress both in quality of research (which is currently excellent) and academic program.

The Panel recommends that one representative from each group (junior, assistant, principal and coordinating) researchers be added to the various boards that manage the research centers and institutes. Such an action will empower each group, improve morale and be instrumental in connecting the senior leaders with emerging trends and on-the-ground realities. The Panel recommends that researchers from these groups be exempted from doing the work of lab technicians and be allowed to focus on their research endeavors. It is also suggested that the institutes and centers negotiate with parent universities and polytechnic institutes to reduce the teaching loads for researchers who are performing significantly above average with respect to research and other institute endeavors such as technology transfer.

The Panel fully supports the program and is enthusiastic about its future to have high impact, strengthened by collaboration with international collaborators. We hope the current funding levels will allow sufficient growth and enhancement of the program.