

Report on the evaluation of the Research Unit in
Engineering Science (RUES) at the University of
Luxembourg

Based on a peer review as commissioned by the Ministry of Higher Education
and Research of Luxembourg

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COMPANY INFORMATION

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TABLE OF CONTENTS

1	INTRODUCTION	4
2	RESULTS OF THE EVALUATION	6
2.1	Overall assessment	6
2.2	Input	6
2.3	Output	8
2.4	Outcome and impact	10
2.5	Strategy for the future	11
3	SUMMARY AND RECOMMENDATIONS	12
3.1	Summary	12
3.2	Recommendations	12

I INTRODUCTION

The Ministry of Higher Education and Research (MESR) of Luxembourg mandated *Interface Policy Studies, Research, Consulting*, Switzerland, to organize and lead a research evaluation of the University of Luxembourg. Simultaneously, the Institutional Evaluation Programme (IEP) of the European University Association carried out an institutional evaluation of the University of Luxembourg. The results of the IEP evaluation are published in a separate report.

The research evaluation was conducted in 2016 and followed two earlier evaluations carried out in 2008 and 2012.

The University of Luxembourg has three Faculties with research units conducting research in different scientific disciplines. In addition, there are three interdisciplinary centres.¹ The evaluation focused on the research performance of the University research units and interdisciplinary centres. This report presents the evaluation of the Research Unit in Engineering Science (RUES).

The observations and recommendations presented in this report are based on a peer review by the following four experts working in the research unit's research fields:

- Jeffrey Packer, professor of civil engineering at the University of Toronto, Canada
- Stefanie Reese, professor and head of the Institute for Applied Mechanics at RWTH Aachen University, Germany
- Kurt Stockman, professor of electromechanics at Ghent University, Belgium
- Martin Vermeer, professor of geodesy at Aalto University, Finland

The peer review consisted of a self-assessment report written by the RUES and a hearing at the research unit that took place in September 2016. The evaluation assessed the period 2012 to 2015. The hearing, which was organized and moderated by Interface, consisted of a self-presentation by the research unit, a group discussion of the self-assessment report, and several individual and group interviews. These included interviews with representatives of the management team, professors, PhD candidates,² and further members of the research staff. Based on the experts' assessments, the report was finalized by Ueli Haefeli and Olivier Dolder of Interface. The report has been approved by the experts.

¹ The Interdisciplinary Centre for Contemporary and Digital History was established in 2016. It is not part of the evaluation, as the assessed period is 2012 to 2015.

² The University of Luxembourg calls its PhD students 'PhD candidates'.

The overall results of all unit evaluations are summarized in a synthesis.³ The synthesis report includes the findings of the interviews conducted with representatives of the management team at the University of Luxembourg.

The report is divided into two parts: The first part discusses the expert team's observations gathered during the evaluation process. The focus is on the input, the output, and the outcome/impact of the research unit:

- *Input* includes the preconditions for the research conducted, such as strategies, financial and human resources, infrastructure, organization, and quality assurance systems.
- *Output* includes the performance of the research unit, exemplified through research results and their dissemination.
- *Outcome and impact* refer to the medium- and long-term effects as well as the relevance of the output for science, society, economy, and politics.

The second part presents the expert team's recommendations for further development of existing strengths and overcoming observed weaknesses.

The evaluation team would like to thank everyone involved for preparing and implementing the hearing at the RUES, for making the documentation available, and for participating in interviews.

³ Rieder, Stefan et al. (2017): Evaluation of the University of Luxembourg, Interface Policy Studies, Research, Consulting, Lucerne.

2.1 OVERALL ASSESSMENT

The RUES is in serious trouble. There is only a little team spirit within the research unit, and there are two opposed groups with not much mutual understanding: a group of mostly research-oriented members and a group of mostly education- and service provision-focused members. The research unit's self-assessment report (the main source for this report) reflects the tensions within the research unit: The quality of the report is rather low, and it includes unclear data. The RUES missed the opportunity to make a team effort and to present its achievements. Therefore, the expert team is of the opinion, first, that the research unit needs a *comprehensive assessment* that focuses not only on research but also on teaching and on structure and process. Second, the expert team highly recommends restructuring the unit based on the results of the comprehensive assessment.

2.2 INPUT

Specific remarks

The research unit was founded in 2003 based on pre-existing departments for civil, electrical, and mechanical engineering at the former Institute of Science and Technology. These departments were mainly dedicated to education and the provision of services to industry. Now, the research unit is struggling due to its roots. The strategy of the University of Luxembourg is scientific excellence in teaching and research. The RUES is committed to high standards in teaching and does have some scholars performing excellent research. However, the research unit developed from an institution comparable to a university of applied sciences. Hence, the RUES primarily offers a very large number of courses and provides services for industry. There are even professors who predominantly teach and do little research. Today, there are thus two groups of people within the research unit that are committed to different cultures, and they do not have much mutual understanding or appreciation of each other.

Research strategy

The research unit had no overall comprehensive research strategy in the evaluation period. According to the experts, the missing strategy is a consequence of the research unit's fundamental problems. As a result, with no (research) strategy and university policies in place, the research unit will not be able to improve its very modest total research output.

Human and financial resources, infrastructure, and equipment

In general, the RUES has a solid financial base, especially considering the internal annual budget allocation of EUR 40,000 to each professor. The number of administrative staff is very low in the experts' view. Four full time equivalent (FTE) in 2014 and 2015 for administrative support (secretarial, accounting, research facilitation) is not sufficient for a research unit with more than 20 professors. However, the problems regard-

ing teaching load and moderate scientific output (see section 2.3 below) are hardly due to the research unit's human resources situation.

Regarding infrastructure and equipment, it was unclear to the experts as to what the implications of the move to Campus Belval would be for the unit. The experts were very surprised that the RUES did not plan for them to tour their laboratories. Only after the evaluation team insisted were the experts able to visit the research unit's laboratories. Then, only the structural engineering laboratory, materials laboratory, and an unmanned aerial vehicle (UAV) laboratory were presented. These laboratories appeared well used and active but relatively modest compared with leading research-intensive universities.

Organization

During the evaluation period, the RUES had no subunits. A council of all professors in the research unit took all decisions within the unit. The role of the head of the research unit, as the experts understood it and even in the opinion of the current head, was and is not clear. The role of the head is rather a sort of coordinator, at present. In the view of the experts, the position of head warrants a clear job description and mandate.

Since the beginning of 2016, the research unit has structured itself into five subunits. In the experts' view, this structure could function, if the research unit itself had no troubles. However, in the current situation the experts are convinced that the creation of subunits will not resolve the fundamental problems that the research unit has.

External research collaborations and service provision

The research unit has many contacts with industry, which is a very positive situation in the opinion of the expert group. However, these contacts do not normally result in research contracts and projects financed by industry. The RUES principally provides services to industry. Unfortunately, here the evaluation cannot assess this form of collaboration due to a lack of data and the ambivalent statements of different interviewees. In addition, collaboration with and competition with the Luxembourg Institute of Science and Technology (LIST) also did not become clear to the experts.

Hence, the research unit does not exploit the potential for fruitful and stimulating collaboration with industry. Luxembourg offers possibilities for good collaboration: There are several industrial companies in the country, and the Luxembourg National Research Fund (FNR) offers PhD and postdoctoral grants for research projects carried out in collaboration with a company in Luxembourg (AFR-PPP⁴).

Quality assurance system

The experts could not identify a quality assurance system within the research unit. In addition, the experts identified a lack of accountability; the research unit members do not have to account for their research activities and productivity on a routine basis. This lack of a goal-oriented and merit-based system is likely a prime reason for the very modest scientific performance of the unit (see section 2.3 below). A reward struc-

⁴ See <www.fnr.lu>.

ture, with appropriate incentives, needs to be in place, and the University's academic plan needs to reflect its commitment to excellence in teaching and research.

2.3 OUTPUT

In the expert team's view, the research unit's total number of publications – and especially the research unit's number of publications in international peer-reviewed journals – is too low for a university aspiring to be excellent and internationally recognized. Many of the scholars have an insufficient track record regarding publications. Nevertheless, some of the researchers have a high number of excellent publications. These scholars have good h-index values (according to Scopus) and are well-known in the international scientific community.⁵ The expert group would like to point out that it sees a risk for the research unit in that the high-performing scholars might leave this unit for other units within the University. Hence, there are efforts needed to retain these staff members.

The experts learned that the modest output performance of the research unit could be explained by its history. The research unit's precursor institution was primarily dedicated to education. Even today, several professors predominantly teach. The RUES still offers, in addition to the academic bachelor's degree programme, a professional bachelor's degree programme (as a university of applied sciences would do in other countries) and has even established multiple master's degree programmes in recent years. This large number of degree programmes creates a heavy teaching load and holds some of the motivated scholars back from increasing their research output and publishing more. In the experts' view, the teaching offerings are too broad, and consequently the aggregate teaching loads are too heavy.

Comparing the different research fields in which RUES is active, the experts observed that in all fields, some professors are performing well, whereas only some fields have people with poor scholarly output. Nevertheless, the expert team is of the opinion that, with some effort, the research unit could increase its publication output, since some of the current members could develop a publishing culture that goes beyond conference articles. The lack of a disciplined and rigorous approach to publishing by some RUES professors is evident in their incomplete and irregular approach to citing their own publications in the self-assessment report.

Based on personal interviews, the expert team noted that there appeared to be a very good cohort of PhD candidates and postdocs. Members of this group were positive regarding their experience, had clear research targets, and came from diverse international backgrounds.

In line with the publication situation, the number and amount of acquired third-party funds – from funding agencies as well as from industry – is too low. The experts see

⁵ The experts are aware that the h-index has to be interpreted carefully and that in different fields different levels of the h-index can be achieved.

also here a bias towards a small group of high-performing scholars. In general, the experts could not identify a culture within the research unit of regularly writing proposals to acquire third-party funds.

The research unit submitted several patents during the period under evaluation. Two international patents were granted, one by the European Patent Office and one by the United States Patent and Trademark Office. According to the expert team, this is very positive for a group of the size of the RUES. The research unit did not create any spin-off companies within the same period that could further commercialize the unit's research by using the obtained patents.

The professorial staff won relatively few significant international honours or awards during the period under review. Recognition of that kind is a key driver for academics and very important for a university's international stature and ranking. Some members of the RUES are of this calibre, so nominations for prizes and accolades should be regularly pursued. High public visibility of some researchers at the University of Luxembourg will serve as a magnet for attracting further good staff and good students.

For the purpose of a further description of the RUES research output, the experts chose the research unit's classification of research domains:

- *Geodesy and Geophysics*: This subunit provides excellent research, with a fair number of publications in peer-reviewed journals, e.g. one article in 2012 in *PNAS*, the Proceedings of the U.S. National Academy of Sciences. It is also a part of a Horizon 2020 project. Further, graduate (PhD) studies appear well organized and well integrated into the research.
- *Computational Engineering (ICE)*: This subunit provides excellent research. Prof. Bordas has obtained a Starting Independent Research Grant funded by the European Research Council (ERC). The topic is "Towards real time multiscale simulation of cutting in nonlinear materials with applications to surgical simulation and computer guided surgery". This is one of the first attempts to combine multiscale methods, which are usually computationally very elaborate, with model order reduction. The goal is to make multiscale simulations computationally more feasible, in particular for highly complex biomechanical systems. If the group succeeds, this would have a large impact on multiscale modelling in general, also in the context of other materials and applications. The group shows excellent publication output.

Further, there is a very interesting project funded within the FP7⁶ framework for Industry-Academia Partnerships and Pathways. The partners come from Germany, Latvia, and Luxembourg. The goal is the development of advanced multi-physics simulation technology as a versatile interface for coupling the discrete particle method to field problems. The tool will reach applicability under industrial standards.

⁶ 7th Framework Programme for Research and Technological Development of the European Union.

- *Civil Engineering and Environment (ICEE)*: Scholarly research is being conducted on: steel, concrete, steel-concrete and steel-glass composite structures; water, waste-water, and energy systems; soils and foundations; and transportation. The subjects are topical and are leading to some good publications. The experts appreciate that the unit could acquire two FP7 projects, one ERASMUS project, and one INTERREG B project. The Arcelor Mittal Chair of Steel and Façade Engineering, established in 2010 and renewed in 2015 for another three years, is a major achievement. This ICEE discipline has good PhD candidates winning competitive awards, which is very encouraging from the viewpoint of both quality and willingness to compete. Participation by some professors in this group in European code committees is very commendable and will serve to enhance their stature. Appendix A.3 of the self-assessment report reveals an over-emphasis on conference presentations and insufficient attention to publishing in high-quality, well-refereed, English-language journals.
- *Electrical Engineering (IEE)*: This unit in part provides excellent research. However, these activities are all associated with the Interdisciplinary Centre for Security, Reliability and Trust (SnT). The self-assessment report mentions no important research projects related to IEE. Within the SnT, RUES researchers have been involved in 20 granted projects. Within the SnT, RUES researchers are active in the field of control of autonomous vehicles, robotics, adaptive control, and distributed control. Other topics within IEE are antenna systems, power quality, and advanced semiconductor devices. The research has resulted in good publications, although the majority are conference publications. Within the SnT, five best paper awards have been achieved. During the hearing, the Unmanned Aerial Vehicles Lab was visited; it had the required infrastructure to perform high-end research in this discipline. Collaboration with the Luxembourg Army and the LuxSpace company were mentioned.
- *Mechanical Engineering (IME)*: This unit conducts applied research. The experts appreciate that the unit could acquire two INTERREG Greater Region projects, with a focus on teaching and research on robotics. IME is also participating in the Laser Technology Competence Centre, co-funded by the European Regional Development Fund (ERDF), that was started in 2012. Four related projects are running, with several PhD projects on laser joining technology. Other research activities of IME have generated publications related to autofrettage in aluminium, automated assembly systems with vision-assisted robots, advanced control systems for robots, design-by-analogy methods, heat recovery systems, and energy performance assessment techniques for building elements. In 2013, a member won a European Patent Office Innovation Contest award.

2.4 OUTCOME AND IMPACT

The research unit has some strong scholars and has therefore had some impact on the international scientific community. For example, some professors have won international honours or awards (see section 2.3 above).

With its professional bachelor's degree programme, the research unit is responsible for the education of a large number of engineering professionals in Luxembourg. Therefore, the experts are of the opinion that the unit has a considerable impact on Luxembourg industry as well as on Luxembourg society.

2.5 STRATEGY FOR THE FUTURE

The research unit has no cohesive strategy for the future. The expert team is of the opinion that a strategy is necessary but also that the RUES, with its current tensions between the more research-oriented and the more teaching-oriented members, will not be able to elaborate such a strategy. Nevertheless, the experts stress the potential of the unit: The current composition of the research unit would allow the conducting of multidisciplinary research. In the experts' view, the research unit needs a small number of research goals linked to the University's strategy (e.g. contribution to the digitalization axis) and to the societal needs of Luxembourg (e.g. intelligent buildings).

3.1 SUMMARY

The RUES is in serious trouble. The research unit is composed of academically oriented people having excellent publication track records on the one side and mostly education- and service provision-oriented people on the other. The two groups do not have much mutual understanding or appreciation of each other. Moreover, there is only a small amount of team spirit within the RUES. The division into two opposing groups can be explained by the history of the research unit. It was founded in 2003 based on pre-existing departments mainly dedicated to education and the provision of services to industry. Still today, the RUES primarily provides services for industry and offers a very large number of courses at the bachelor's and master's level; some of the professors are almost only engaged in teaching. In the opinion of the experts, the research output of the RUES is not satisfactory; the total number of publications and the number of publications in international peer-reviewed journals are too low. At an individual level, many of the scholars have an insufficient publications track record. The number and amount of acquired third party funds is also inadequate. Despite these overall shortcomings, some of the researchers demonstrate a high number of excellent publications, and the research unit has received two international patents, which is very positive for a unit of this size. However, to solve the RUES' fundamental problems and to reduce the risk of high-performing scholars leaving the unit, the experts see a restructuring of the unit as necessary.

3.2 RECOMMENDATIONS

Based on the observations stated above, the expert team formulates the following recommendations for the research unit, the University, and the MESR.

Recommendation 1: Assess and restructure the research unit

To solve the RUES' massive problems, the expert team highly recommends conducting a comprehensive assessment of the research unit as well as reorganizing the unit. The assessment needs to focus on research and teaching as well as on structures and processes. The reorganization should be based on the results of the assessment. In this context, the expert team draws particular attention to the following points: (1) The RUES should become more homogeneous and focus on engineering; (2) The RUES will need a critical mass and should therefore not be divided into too many subunits; (3) Research and teaching should be closely linked, since there are mutual benefits and synergies between the activities; (4) The position of research unit head warrants a clear job description and mandate; (5) Administrative procedures need to be put in place for professorial staff of the RUES, and perhaps more broadly across the University of Luxembourg, to ensure regular reporting of and accountability for their activities.

Recommendation 2: Formulate a research strategy and align projects with the strategy

The research unit lacks a research strategy. The experts recommend that the RUES formulate a research strategy, including two to three multidisciplinary research goals linked to the University's strategy (e.g. contribution to the digitalization axis) and to the societal needs of Luxembourg (e.g. intelligent buildings; community resilience to unforeseen incidents and impacts; critical infrastructure protection). In addition, the RUES should align concrete research projects with this strategy. The experts encourage the RUES to re-submit the PRIDE proposal⁷ as well as to submit new projects based on new topics to the FNR and other funding agencies. Finally, future recruitments should also match the new research strategy.

Recommendation 3: Reconsider teaching activities

The RUES offers a professional bachelor's degree programme in addition to the academic bachelor's degree programme and in recent years has established multiple master's degree programmes. This large number of education programmes creates a demanding teaching load. The expert group recommends that RUES optimize its curriculum design in order to strengthen its research activities. The number of programmes and courses as well as individual teaching loads have to be reduced. No scholar should teach more hours than required by the Faculty.

Recommendation 4: Establish a functional reporting system and increase administrative staff

The expert team is of the opinion that the RUES needs a functional reporting system and more administrative staff. On a routine basis, scholars should report on teaching and research activities as well as productivity. Possible output metrics (for each scholar) are: the number and sort of publications, the number and amount of acquired third-party funds, the number and type of research students and fellows, the quantity of PhD degrees awarded, and the number of courses taught (with student enrolment numbers and student evaluations of teaching). The reporting system would be the basis for a goal-oriented and merit-based reward structure, providing appropriate incentives for scholars to become excellent in both teaching and research. The current budget of EUR 40,000 that each professor has at his or her disposal per year should in future be allocated based on merit. To sum up, the reporting system should be a management tool for the head of the research unit and should motivate the staff to carry out excellent research and teaching.

Recommendation 5: Clarify the relation with the LIST

The RUES provides a large number of services to industry. At the same time, the LIST, a mission-driven research and technology organization, also provides service to industry and society. The experts recommend that the RUES clarify its relationship with the LIST in order to identify synergies in service provision and to implement potential research collaborations.

⁷ PRIDE is the programme of the Luxembourg National Research Fund (FNR) for funding doctoral research in Luxembourg. Under this programme, a block of PhD grants is awarded to a consortium of excellent researchers grouped around a coherent research and training programme (see <www.fnr.lu>).

Recommendation 6: Clarify relationship between the RUES and the SnT

The expert team recommends that RUES clarify its relationship with the SnT at the University of Luxembourg. Today, excellent activities of RUES members in the domain of electrical engineering are mainly associated with the SnT. The experts are of the opinion that a system of association of research activities and scholars should be developed that supports both the SnT and the RUES.