

**Evaluation of the Acoustic Research Institute (ARI)
of the Austrian Academy of Sciences
February 2013**

Report of the Evaluation Board:

- Prof. Jean-Paul Haton, Université de Lorraine, Nancy, France and Institut Universitaire de France, President
- Prof. Corneliu Burileanu, Vice-President, University "Politehnica" of Bucharest, Romania
- Prof. Christian Jutten, Université Joseph Fourier, Grenoble, France and Institut Universitaire de France

A. Scientific performance and significance of the institute and research fields (please use the scoring system provided for the institute in general and for the research fields in particular)

How does the research institute compare with similar institutes in Austria and internationally?

The ARI is a rather small structure, with 21 persons, 12 of them being fully (and 1 at 50%) funded by OeAW. The ARI is constituted of 4 research groups, with a wide spectrum focused on acoustics and its applications, from mathematical theory, psychoacoustics and audiology, physical models, to linguistics and phonetics. This wide spectrum is probably unique for this size of lab. These research activities are complemented by an important development of freeware packages of high quality. The ARI has also designed and implemented a very complete and efficient experimental laboratory.

One key strength of ARI is the existence of a strong mathematics and signal processing team, which targets more theoretical aspects in acoustics and provides a good mathematical background to the other teams. The co-operation between the four groups of the institute is an important plus which is not common in other similar institutes. It is also worth noticing that there exists neither Phonetic Institute nor Acoustic Department within Austrian Universities.

Score: 2

What is the board's opinion of the research institute relative to national and international performance levels (scientific significance, innovative power, quality level, impact of publications)?

The four teams have different sizes. They correspond to different domains with their own research standards. The average activity – in term of publications and contract or research projects -is good, but with a high variability according to the research teams.

Two teams are very small:

- Acoustic Phonetics is based on 2 full-time persons (only one with a permanent position) and three part-time students; half of the publications are communications in national conferences, due to the fact that the studies are oriented towards German language and phonetics.

The number of publications in journal is medium: 5 journals, 3 chapters (int.), 12 international and 10 national communications in the last 6 years. Only 1 MSc thesis and the habilitation of the team head, during the period.

Score: 2.5

- Physical and computational acoustics is based on 3 full-time people, one professor (in München and Graz) and 2 researchers, but without any students. This team has a lot of small applied service contracts with companies.

The number of publications (over the last 6 years) is 8 in journals, and 16 communications in international conferences, 8 national communications and a few research reports. Only 1 MSC thesis and no PhD thesis during the period.

Score: 2.5

The two other teams are larger and are achieving more typical research activities, in term of studies, contracts and publications.

- « Psychoacoustics and experimental audiology » has developed a worldwide expertise in cochlear implants. The team is based on 2 full-time researchers and one research engineer, with 2 PhD students.

The number of publications is 15 in journals and 10 in international conferences. During the period, 6 MSc theses and 1 PhD thesis (presented at Université de Provence, Marseille) have been defended.

ARI issued and sold an internationally recognized patent.

Score: 1.5

- « Mathematics and signal processing for acoustics » is the largest team, with 7 full-time researchers, 1 engineer, but only 1 PhD student. The activity is mainly focused on theoretical framework for acoustics, practically time-frequency time-scale representations based on frame multipliers. This team is headed by P. Balazs, who is a brilliant researcher, awarded by a START Austrian research funding (FLAME project), very selective. Other members are high level scientists, coming from different foreign countries. Clearly, this team is very attractive.

This team published 21 papers in journals and 21 in international conferences, including the best international journals of the field, such as JASA (Journal of the Acoustical Society of America: this journal is the best in the acoustic field, very selective, even though its impact factor is not very high).

One can wonder why there is not more publication in Signal Processing journals and conferences. Moreover, some publications in low impact journals can be avoided.

The way for computing the number of international journal per year and per researcher should be clarified, especially due to the fact the number of researchers has grown very fast during the last few years.

Only 1 PhD student and the habilitation of the head of the lab have been defended during the period.

It is clear that this team is the motor of ARI, both through the number of people, the activities, and the leading persons.

Score: 1

The institute manages to obtain third-party funding from very competitive calls, such as Hanse-Wissenschaftskolleg – HWK, City of Paris grant; FWF Lise Meitner grant, FWF DACH grant.

- What is the board's opinion of the overall scientific quality of the institute?*

The average quality is excellent, but as explained previously, with some differences between the groups.

Score: 2

- Which scientific activities can be described as outstanding in all regards?*

-The activities of the two teams « Mathematics and signal processing for acoustics » and « Psychoacoustics and experimental audiology » are outstanding, with an international recognition.

Two other outstanding points of ARI are:

- the experimental room,
- the development and distribution of different software packages and of the HRTF database.
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Score: 1

- The existence of the team «Acoustic Phonetics» (AP) within ARI is original and fruitful. On one hand, AP uses the software tools developed by the signal processing experts, implemented in the STx and Matlab excellent and very complete packages (spectrograms, pitch contours determination, formant tracking, etc.). On the other hand, AP brings to engineers and automatic speech researchers the linguistic knowledge on natural language that sometimes misses in many other groups totally based on a statistical approach of the problems. These contributions clearly appear in the fields of speech synthesis, forensic applications, and speaker verification.

Besides, the research of this group on Austrian German language and dialects is really original and important for Austria.

Score: 2

-The activities of P&CA are applied research closer to company R&D than to typical academic research. Applied research is acceptable for this group because it is really innovative. It could certainly lead to patents, in addition to publications. This problem relies upon the policy of ARI in particular, and of the Austrian Academy in general, concerning patents.

Score: 2

How appropriate is the personnel structure regarding the research goals?

Except for the team « Mathematics and signal processing for acoustics », the team size is rather limited, in terms of senior researchers as well as of PhD students.

Probably, one explanation for the small number of PhD students is the limited amount of relationships with universities. Most members are full time researchers and, consequently, have only limited academic activities. In addition, the policy of ARI is to favour post-doc positions rather than PhD positions. This choice is quite reasonable, in particular if post-doc persons stay for sufficient durations (at least two years).

In addition to scientists, there are 3 people (2,25 full-time) for administration, secretary and finance, and a team of 2 full-time engineers for the experimental room and for software development. This latter team seems a little bit under-resourced to efficiently respond to all the software needs of the institute, to the development, diffusion and maintenance of the freewares, databases and webpages, and to manage the experimental laboratory.

What is the board's evaluation of the support provided for junior scientists?

The number of junior scientists (MSc and PhD) is too small. Supervising MSc and PhD students is very important for brainstorming and idea renewal in a laboratory.

Other good initiatives to support junior scientists are:

- a) the weekly informal talks 'Info-Talk', which are intended to introduce master and PhD students, as well as scientists from other disciplines to ARI's research areas,
- b) the 'long night of research' (LNF) meetings, in which the institute employees exhibit research demonstrations to pupils and students,
- c) visits of school classes (3d year of primary school), lecture on hearing, interactive experiments in the laboratory.

□ ***What is the board's evaluation of the support of female scientists?***

The number of female scientists is 5 over 21 scientists. It is low, but it is the typical female proportion in engineering sciences in most comparable countries.

According to the auto-evaluation document, the institute aims at increasing this percentage by giving priority to female applicants if candidates have equal qualification. Moreover, ARI encourages their employees to take full or part-time parental leaves (in the reporting period four employees have taken this chance to take care of their children).

□ ***What is the board's evaluation of the effective application of the resources available to the institute and its research fields (including third-party funds), and their distribution relative to the scientific significance of research projects?***

ARI has got 16 research contracts, active or finished, and 16 research grants, among which 10 are in progress. The total amount of projects and funding due to project is quite impressive. However, we can observe that almost all the current funding is coming from Austria, a few from Austrian-German programs, and nothing funded by EU.

The overall budget of ARI and the distribution of funds to the different research projects seem satisfactory. We discussed with the directors and the team leaders about the idea of adaptive allocation of budgets to the groups which could be implemented in the future. It seems a good idea that might put some pressure on the groups and favour synergy.

□ ***What is the board's evaluation of cooperation within the institute, with other AAS institutes, as well as with universities and other external partners both in Austria and abroad?***

Cooperation appears at national level through projects. International cooperation appears through visits to other institutes, visits to ARI, and a few modest projects (Amadeus with France, PhD with Denmark, etc.). In addition to the list, a few explanations, and the related list of actions, would be informative.

The close cooperation between the research groups is mentioned many times throughout the auto-evaluation report and is supported by some common publications and research grants. This group interaction has been confirmed by our visit to ARI, creating a strong multidisciplinary research environment within the institute. The core of cooperation seems to be the team Mathematics and Signal Processing for Acoustics »

ARI has many partner scientific institutions with which it regularly cooperates. The list includes the most important Austrian research institutes and universities, but also many

international partners. Some of the institute's staff is also involved in limited teaching activities in the Universities of Vienna, Graz, Munich, etc. Cooperations must also be detailed in the presentation of ARI, and sorted according to the level of cooperation (common publications, common projects, co-tutelle PhD, etc.).

For PhD, the situation must be clarified and enhanced. A new PhD program is announced to be under reflection with IEM, KUG Graz and the University of Vienna. The supervision of PhD in coordination with laboratories abroad should also be considered (for instance the PhD "en co-tutelle" with French Universities).

□ *What is the quality of knowledge transfer within the scientific community and/or to society and policymakers?*

ARI's technological transfer strategy involves discussing all possible patent applications in the steering committee and, if the patent is considered feasible, contacting the administration of the OeAW to clarify if a patent application should be initiated. This way the technological potential of the know-how can easily find its way towards the market and eventually the society. That seems to be a good policy. But the evaluation board would have expected more than 1 patent issued during the 6 year period, especially, with respect to the large number of industrial contracts along the period.

The scientific community also benefits from the very good software systems developed at ARI and of the HRTF database (one of the very few existing worldwide) which are free for scientific users. Most of the toolboxes are open-source available for continued research.

Other good initiatives to support junior scientists have been mentioned before.

B. Recommendations for further development

□ *What is the board's evaluation of the institute's medium-term research program?*

According to the auto-evaluation report, ARI intends to focus in the next five years on the following major projects:

- a) Language Varieties of Austria in Production and Perception.
- b) Spatial Hearing and Speech Perception in Noise: From Normal Hearing to Cochlear Implants.
- c) Frames and Linear Operators for Acoustical Modelling and Parameter Estimation.
- d) Detection and Simulation of Noise and its Propagation for Developing Efficient Countermeasures.

These are important topics in acoustics, both for fundamental research and for applications. ARI has the potential to undertake successfully these projects. Acoustics is a very complex research field that necessitates a multidisciplinary approach in order to cover all relevant aspects. The structure of ARI is very well adapted for that.

In addition, a new group may join ARI in a near future with Prof. T. Reichenbach. The arrival of this new "*Biomathematics of Hearing*" group would be beneficial for ARI, since it will address similar problems already tackled by ARI, especially in the field of hearing, but

with another approach.

Overall score: 2

. What are the prospects of the research fields in which the institute is active and the new scientific ideas and fields with high development potential?

Spoken languages production and perception will remain active domains of research for a long time. Auditory perception in acoustic hearing (both normal-hearing and hearing-impaired listeners), and in electric hearing (cochlear-implant listeners) is also a growing research field. A closer cooperation on this topic with the University of Innsbrück, and also with surgeons could be fruitful.

Psychophysics-based hearing research will be necessary, especially for auditory scene analysis, spatial hearing, etc. The application-oriented (forensic, speaker verification, speech synthesis) use of phonetic, phonological, and sociolinguistic results, will grow in the future, in complement to statistical models. New methods in vocal tract modelling will give better insight into the relations between acoustics and articulation, with potential applications to speech synthesis and recognition.

As far as theory is concerned, operator theory and frames theory (wavelets, alpha-modulation, etc.) need still to be investigated in order to design robust and efficient methods, in particular for boundary element calculations in acoustics, as well as the application of frame theory to adaptive signal representations.

Research concerning the origins, the control and the abatement of noise, in particular in connection with human perception will become more and more important in our societies.

ARI is very well equipped for remaining at the front of research in these different areas of acoustics.

Besides, the experimental room and software developments are excellent facilities, particularly for psychoacoustic experiments and acoustic measurements, and must be preserved and developed, if possible.

□ Does the board have recommendations for modifications and restructuring?

Cooperation is already satisfactory, and all efforts must be made to maintain it very high, but also to more clearly present and illustrate it in the various presentations of the ARI.

As indicated above the software team seems a little bit under-resourced to efficiently respond to all the software needs of the institute, to the development, diffusion and maintenance of the freewares and databases, and to manage the experimental laboratory.

The possibility for ARI to create Spin-Offs was evoked. The research on CIs, the STx package, the numerical simulation methods have obviously a great practical potential. Therefore, this possibility should be considered, while having in mind that it is of primary importance to keep the unity, and the multidisciplinary structure of ARI.

□ Does the board have recommendations for the continuity, expansion or termination of the institute?

The board recommends the expansion of ARI, with possibly a better equilibrium of the teams: that means to increase the number of permanent peoples (except in M&SPiA which is large enough), to work with a larger number of PhD students by proposing more scholarships, and to intensify the efforts to apply for projects funded by the European Union, and to implement a better cooperation with other research institutes within the Austrian Academy

Efforts must be done for maintaining the experimental laboratory. Software toolboxes are also very useful and the efforts must be continued. These two efforts require to increase the number of research and software engineers.

Expansion, by creating the “Biomathematics of Hearing” group, is recommended. This represents a good opportunity for ARI, especially if the Austrian Academy can open research positions corresponding to this new thematic.

Does the board have recommendations for modification and restructuring taking into account other research facilities (e.g., universities)?

Increasing the team size and working with PhD students could be possible if ARI teams were also constituted of associate professors or professors. The creation of joint groups between ARI and Universities could be a good way for ARI to open toward the University. However, the fundamental multidisciplinary character of the institute necessitates to keep ARI within the Austrian Academy, independently of universities.