Hobeon

Assessment report

Research Master in Fluid Dynamics

von Kármán Institute for Fluid Dynamics

De kracht van kennis.

Lange Voorhout 14
2514 ED Den Haag
T (070) 30 66 800
F (070) 30 66 870
I www.hobeon.nl
E info@hobeon.nl

Assessment report

Research Master in Fluid Dynamics

von Kármán Institute for Fluid Dynamics

Hobéon
Dated:
18 April 2014
Audit team
Prof. Dr. M. Pandolfi, chair
Prof. Dr. Ir. G. Ooms
Ir. P. De Swert
Y. Durodié, MSc

Secretary-co-ordinator
H.R. van der Made

CONTENTS

1. GENERAL INFORMATION

1.1. Administrative data

NAME OF UNIVERSITY	von Kármán Institute for Fluid Dynamics (VKI)
Status of institution	Geregistreerde Instelling/Registered Institute – mixed funding
Country	Belgium
COURSE TITLE	Research Master in Fluid Dynamics
Fields of study	(i) Aeronautics and Aerospace, (ii) Environmental and Applied Fluid Dynamics, (iii) Turbo machines and Propulsion
Degree and title awarded	MSc (Res)
Course orientation	Master-after-Master /academic
Course level	Research Master
No of credits (ECs)	60ECs
Didactic format(s) applied	Competence based
Mode of study	Full time
Location	Chaussée de Waterloo/ Waterloosesteeenweg 72 B-1640 Rhode-St-Genèse/ Sint-Genesius-Rode Belgium
Date of audit / course assessment	30th of January 2014
Contact person (name and e-mail address)	Professor Em. R.A. Van den Braembussche vdb@vki.ac.be

1.2. Quantitative data

Intake [1]

Year	Applications	Accepted	Attendance
2008-2009	42	32	27
2009-2010	63	48	37
2010-2011	73	45	35
2011-2012	60	40	30
2012-2013	61	41	32

Drop-out rate

[1] The drop-out between accepted and attendance is in many cases of financial origin (shortage of scholarships) or because students have already accepted a position at their home university or elsewhere.

Over the last 5 years: 4.5% (in numbers: 7) left the course without being awarded the RM degree.

Staff

2012-2013 Teaching staff	**AR**	**EA**	**TU**	**FTE**
Full time professors	4	4	4	12
Visiting & part time professors	4	1	4	2.9
Post Doc. research engineers	9	7	2	18
PhD students	27	18	22	67
Technical staff	5	5	5	15

2012-2013 MSc Students	8	11	11	30

Student-staff ratio

On the basis of full-time professors: 2.75

Including the visiting professors: 2.2

2. SUMMARY

The Research Master in fluid dynamics is a high level programme of lectures and guided research designed for graduate engineers or scientists wishing to specialise in a selected area of fluid dynamics after having been awarded a university Masters Degree. It is offered by the von Kármán Institute of Fluid Dynamics that was established in 1956.

The main aim of the programme is training engineers and scientists for research and/or advanced product development and design in fluid dynamics. The objectives of the programme are clear and tie in well with what should be expected of a Master-after-Master programme. The learning outcomes as a whole are, beyond any doubt, of Masters level and have a distinct academic orientation.

The curriculum offers a wide variety of courses which guarantee the development of the knowledge and skills necessary to execute the research project, which represents half of the study load and is pivotal to the programme. Research is done in small groups and facilitates intensive academic contacts between professors and students.

The research that is being conducted is topical and the preparation of experiment set-ups is explicitly included in the training, providing students with a practical understanding of numerical and experimental techniques. The course has clear links with the current professional practice as research is being conducted for a wide range of industries. The entire programme adequately covers the topics of the domain and the full range of the intended learning outcomes of the course, thus enabling students to achieve all of the final qualifications of the programme.

Admission to the programme is well formalized and executed. The course study load is considerable, but supervision and tutoring are intense and appear to assist students adequately, without 'pampering' them. Moreover, the success rate of the course is incredibly high. Restructuring some of the small courses into larger units might lend more transparency to the curriculum.

Learning assessment is done systematically and thorough: test methods tie in well with the objectives, content and educational format of each course. Assessment mode and criteria for each course unit are laid down in course descriptions and students are familiar with the criteria on which they are assessed. With regard to the Master Research Project students are assessed on the extent to which they are capable of independent and creative research. This is explicitly stipulated on the assessment form and in the assessment criteria used.

The educational staff in general is well-equipped to execute the research programme. They clearly have in-depth expertise in the relevant domains of fluid dynamics, they bring along an academic orientation and they have knowledge and understanding of the professional field. The staff/student ratio is exceptionally favourable. VKI has adopted a mentoring scheme for young professors; students in general were very satisfied with the didactic competences of their professors.

VKI possesses experimental facilities which are unique in the world and for that reason well-known among colleagues. The facilities are well-maintained. Some of the classrooms could be renovated and the logistics in the workshops rethought. By and large, the facilities are perfectly adequate to contribute to the achievement of the intended learning outcomes.

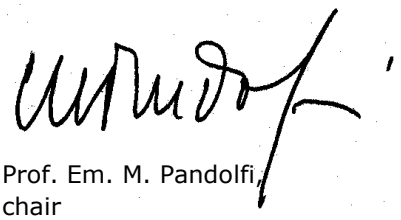
VKI now has a working internal quality assurance cycle, that was enhanced in the wake of the initial audit: systematic evaluations among the relevant stakeholders render results that are used to draw up and implement measures for improvement. The design of a set of explicit standards/verifiable objectives/criteria for VKI that indicate whether or not VKI considers improvement measures necessary, must be the next step.

The selection of research projects reviewed by the panel members clearly demonstrate students' ability for analytic and synthetic reasoning and independent problem solving at an academic level. Some of the theses were considered of an exceptionally high standard and very relevant to the professional field.

Given these considerations the panel recommends the NVAO to take a positive decision regarding the quality of the Research Master in Fluid Dynamics of the von Kármán Institute for Fluid Dynamics and to accredit the programme for another eight (8) years.

The Hague, 18 April 2014

On behalf of the panel convened to assess the Research Master in Fluid Dynamics of the von Kármán Institute for Fluid Dynamics in Sint-Genesius-Rode, Belgium,



Prof. Em. M. Pandolfi,
chair

H.R. van der Made,
secretary/coordinator

3. INTRODUCTION

The *Research Master* under scrutiny is offered at the von Kármán Institute for Fluid Dynamics (VKI). The research Master (Master-after-Master) in fluid dynamics is a high level programme of lectures and guided research designed for graduate engineers or scientists wishing to specialise in a selected area of fluid dynamics. The VKI Research Master in Fluid Dynamics complements the Master programmes of universities with a research oriented specialisation.

In view of its re-accreditation, VKI commissioned the Dutch Evaluation Agency Hobéon to organize and coordinate an accreditation audit at the von Kármán Institute in January 2014. The audit procedure and the panel composition are described in the Annexes III and V respectively.

The panel has based its assessment on the standards and criteria described in the NVAO Accreditation Framework for existing higher education programmes in Flanders (1 September 2009).

Outline of the panel report

This report is made up of several chapters in which the panel outlines its findings regarding the advanced Master's programme Research Master in Fluid Dynamics offered at the von Kármán Institute for Fluid Dynamics.

The previous chapter provides an executive summary of the conclusions of the panel. The current chapter functions as an introduction to the Research Master programme, its position within the higher education system of Flanders (Belgium) and the international context into which it can be placed. Also, it gives a description of the von Kármán Institute and explains the profile of the Master programme as a whole.

In the fourth chapter the panel will present its assessment. The programme is assessed by examining the themes and standards in the Accreditation Framework. For each standard and theme the panel presents an outline of its findings, its considerations and its concluding judgement.

The 'findings' comprise the objective facts as found by the panel in the Self Assessment Report, the underlying documents provided by the faculty, either before or in the audit and the factual information obtained during the panel discussions as part of the site visit.

The 'considerations' are made up of the panel's inter-subjective evaluations regarding these findings and the importance of each. The considerations presented by the panel logically lead to a concluding judgement. In tune with the NVAO regulations, the panel is to assess each standard on a four-point-scale, as either unsatisfactory, satisfactory, good or excellent. Each theme is evaluated on a two-point scale and, thus, can either be satisfactory or unsatisfactory. For a positive final conclusion regarding the programme, the judgement on each theme must read satisfactory.

The report will be concluded with a summarizing table containing an overview of the panel's assessment per theme and per standard.

The annexes contain (i) the course specific intended learning outcomes, (ii) the programme of the site visit, (iii) an overview of documents reviewed and (iv) a concise overview of the panel's expertise.

Profile of the von Kármán institution

The VKI was established in 1956 as an international centre for the study of fluid dynamics. More specifically its core business is:

- training scientists and engineers in the field of fluid dynamics with application to (i) aeronautics and astronautics, (ii) turbo-machinery and propulsion as well as (iii) environmental and applied fluid dynamics;

- stimulating research in fluid dynamics and
- disseminating knowledge in the domains mentioned.

Since its founding 1527 students participated in the 9 month post graduate degree course. The programme was initially audited in 2009 on the basis of NVAO's Initial Accreditation Framework.

VKI receives only partial funding from the Belgian government. For nearly 40% of its budget VKI depends on funds from NATO countries, which are granted on a yearly basis. The additional budget comes from contract research, consultancy and fees of some students.

The VKI offers several educational programmes:

- a final-year project programme in which students enrolled in an undergraduate programme elsewhere can carry out their final-year project in VKI laboratories under the supervision of a VKI faculty member,
- a short training programme in which qualified undergraduates can get acquainted with the practices of modern fluid dynamics,
- an applied research orientation programme in which graduates of the research Master may be further instructed in the methodology of applied fluid dynamics and the practice of independent research,
- a multi-year doctoral programme of basic research in fluid dynamics carried out with a national university,
- a lifelong learning programme for professionals, called Lecture Series, consisting of a series of one week lectures by experts,
- the research Master in fluid dynamics which is subject of this accreditation assessment.

The VKI is organized in three departments: (i) *the Aeronautics and Aerospace Department* (AR), which mainly comprises the study of the external aerodynamics of airplanes and space vehicles, (ii) *the Turbo-machinery and Propulsion Department* (TU), studying all types of turbo-machines used in industrial processes, energy production as well as propulsion and (iii) *the Environmental and Applied Fluid Dynamics Department* (EA) is interested in all fluid dynamics problems that are not covered by the other departments such as environmental flows, industrial processes, air-conditioning and biological flows.

Although each department has its own staff, test facilities and students, there is a lot of collaboration and exchange between them. The main differences are in the topics that are studied. Services and administration are common to all three departments

Profile of the programme

The curriculum provides a specialized training in fluid dynamics research in a multinational context combined with a hands-on training in project management, reporting and presentation of results in technical English. This is reflected by the fact that half of the credits is allocated to the Master Thesis Project.

It is an intensive nine month programme, starting in the first week of October and finishing end of June of the next year. It is taught by 12 full-time professors (4 in each department) and 9 part-time faculty members.

4. ASSESSMENT PER THEME AND PER STANDARD

This chapter presents the evaluation by the assessment panel of the six themes and nineteen standards. In its assessment the panel applied the NVAO criteria. For each standard the panel presents (i) a brief outline of its findings based on the programme documents provided by the institution and the site visit, (ii) the considerations the panel has taken into account and (iii) the conclusions of the panel.

4.1. Aims and objectives

4.1.1 Level and Orientation

The intended learning outcomes of the program correspond with the following descriptions of a Master's degree:

- *general competences at an advanced level such as the ability to reason and act in an academic manner, the ability to handle complex problems, the ability to reflect on one's own thoughts and work, and the ability to convert this reflection into the development of more effective solutions, the ability to communicate one's own research and solutions to professional colleagues and laymen, and the ability to develop an opinion in an uncertain context*
- *general academic competences at an advanced level such as the ability to apply research methods and techniques, the ability to design research, the ability to apply paradigms in the domain of the sciences or the arts and the ability to indicate the limits of paradigms, originality and creativity regarding the continuously expanding body of knowledge and insight, and the ability to collaborate in a multi-disciplinary environment*
- *advanced understanding and insight in scientific, discipline-specific knowledge inherent to a certain domain of the sciences or the arts, insight in the most recent knowledge in the subject/discipline or parts of it, the ability to follow and interpret the direction in which theory formation is developing, the ability to make an original contribution towards the body of knowledge of one or several parts of the subject/discipline, and display specific competences characteristic for the subject/discipline such as designing, researching, analysing and diagnosing*
- *the competences needed for either independent research or the independent practice of the arts at the level of a newly-qualified researcher (in the arts), or the general and specific professional competences needed for independent application of academic or artistic knowledge at the level of a newly-qualified professional*

Findings

The key objective of the programme is to offer Master students a specialized training in fluid dynamics research in a multinational context combined with a hands-on training in project management, reporting and presentation of results in technical English. The training is aimed at *'engineers and scientists, capable of performing independent research and/or doing advanced product development and design on an autonomous basis in all fields where fluid dynamics are involved.'*

To achieve this objective VKI has adopted 7 domain specific competencies to be obtained by all students and a specific set of requirements for each of the three programme specialisations: *Aeronautics and Aerospace (AR)*, *Environmental and Applied Fluid Dynamics (EA)* and *Turbo-machinery and Propulsion (TP).*

The domain specific outcomes of the course are formulated at Masters level (level 7 of the EQF), with a reference to the ACQA criteria for Academic Master's curricula which are generally acknowledged as the operationalization of the Dublin Descriptors for academic engineering programmes. Academic wise, the intended learning outcomes of the course specify the complexity of the analytic approach, the level of synthesis and abstraction that will be required in order to come to a statement, model or theory that can be applied to a variety of concrete situations.

For example, the capability to do research at this level is defined as the ability *'to translate a fluid dynamic problem into a research project and have the competences to manage research projects, in particular the techniques of planning and execution, valorization and communication of results. This requires for the respective fields of specialization, the understanding of the functionalities of the different experimental facilities and CFD software. Important in this context are: the ability to define an appropriate research strategy, the methodology to translate problems into targeted research projects, the competence to correctly interpret the experimental or numerical results and to come up with an improved insight and new models.'*

Furthermore the set of course qualifiers requires the graduates (i) to be competent in one or more specific disciplines, (ii) to be able to apply advanced design and optimization techniques to complex multidimensional and multidisciplinary problems, (iii) to be capable of applying advanced numerical and experimental techniques, (iv) to possess basic intellectual skills such as critical reflection, logical reasoning, deduction, abstraction and scientific argumentation and to apply them on a higher level so as to facilitate out-of-the-box thinking, (v) to have Mastered co-operation and communication skills that enable them to manage complex research and multidisciplinary design projects in an international context and (vi) to contextualise their research within the global scientific community, showing awareness of ethical and environmental issues in their field of specialisation.

The set of final qualifications has been further detailed in learning objectives for the various educational units. The full set of intended learning outcomes of the course is incorporated in the Annex I of this report.

Considerations

The panel has established that the aims and objectives of the programme are clear and tie in well with what should be expected of a Master-after-Master programme. The learning outcomes as a whole are, beyond any doubt, of Masters level and have a distinct academic orientation.

Moreover, the panel is of the opinion that the intended learning outcomes of the course exceptionally well contribute to the central idea of the programme to train Master students in conducting independent research and/or in doing advanced product development and design on an autonomous basis in the field of fluid dynamics. The panel believes the level and orientation of the intended learning outcomes of the course serve as an example for comparable courses both nationally and internationally.

Conclusion

The panel rates standard 1.1 *'Level and Orientation'* as excellent.

4.1.2 Domain Specific Requirements

The intended learning outcomes of the program correspond with the requirements set by professional colleagues, both nationally and internationally, and the relevant domain concerned (subject/discipline and/or professional practice or practice of the arts). In case of regulated professions, the requirements correspond with the regulation or legislation concerned. The learning outcomes stem from requirements set by the academic and/or artistic discipline, international academic practice and, for study programmes to which this applies, practice in the relevant professional field.

Findings

The course has presented a comparison with other European and American institutions offering Master courses or Master degrees in the three fields of specialisation in the programme. VKI concludes that its curriculum, compared to these other programmes, is more oriented to research, more specialised and more systematic within its specialised research orientation. VKI explains its distinction from other educational centres by the combination of (i) a multinational en multicultural environment, (ii) unique facilities, (iii) intensive contacts with the outside world through e.g. the VKI lecture series, (iv) a strong industrial dimension of research topics and (v) an intensive training in research methodology, presenting and reporting. VKI further illustrates its qualities by presenting the results of an alumni enquiry which confirm that 86% of their alumni benefit form the VKI diploma as it created additional opportunities to find an interesting job. 89% indicate that the extra effort to obtain a second Master degree is rewarded by their employer and 95% of the freshly graduated alumni say they use the technical and scientific knowledge they acquired in the Research Master program.
Moreover, 40% of the students who graduated over the last 50 years have a position in the academic world or research centers, 37% of whom are working in industry (mostly R&D centers).

Considerations

To the perception of the panel the intended learning outcomes of the programme have been well-attuned to the international academic practice and meet the subject-specific requirements. The intended learning outcomes are comparable to similar, in some aspects less specialised, Dutch and Belgian Master programs. In addition to the general requirements to qualify for the Research Master degree, a more specific set of technical requirements has been set for each of the three main fields of application.

The intended learning outcomes of the course show a combination of in-depth knowledge, understanding and research which clearly and exceptionally well facilitate the enhancement of careers for the alumni in fluid dynamics. The figures presented by VKI about the job positions held by alumni illustrate this.

Conclusion

The panel assesses standard 1.2 *'Domain specific requirements'* as excellent.

4.1.3 Concluding judgement on Theme 1 'Aims and Objectives'

The panel rates the two standards of the theme 'Aims and objectives' for VKI's Research Master in Fluid Dynamics as 'excellent'. Therefore the panel's overall judgement on theme 1 according to NVAO's assessment rules reads 'satisfactory'.

4.2. Curriculum

For a description of the programme profile see the introductory Chapter 3 of this report.

4.2.1 Requirements for academic orientation

The proposed curriculum meets the following criteria for an academic orientation:

- *Students develop their knowledge through the interaction between education and research (including research in the arts) within relevant disciplines.*
- *The curriculum corresponds with current developments in the relevant discipline (s) by the verifiable links with current scientific theories.*
- *The programme ensures the development of competences in the field of research and/or the development and practice of the arts.*
- *Where appropriate, the curriculum has verifiable links with the current relevant professional practice*.

Findings

The curriculum of this Master-after-Master programme consists of a research project and a number of courses. The pivot of the individual programme of the student is the research project of 30 EC. The student is allocated to a project within the first month of being at VKI.
The research project is leading in making choices for experimental or numerical courses as well as for the main field of interest: (i) aeronautics and aerospace, (ii) environmental and applied fluid dynamics or (iii) turbo-machinery and propulsion.

There are common courses on basic knowledge which have to be followed by every student (8.75 EC for the experimental option or 10 EC for the numerical option). In line with their specialisation they further follow specialised courses in one of the three main fields (varying from 20.5 EC to 21.75 EC depending on the option and the field of interest). It is possible to choose optional courses (5 EC max) from all courses offered when necessary for the research project. Thus, in total the curriculum to be followed by students consists of a minimum of 60.5 and a maximum of 65.75 EC.

Considerations

As part of the audit the panel reviewed the contents of the curriculum and found that the courses guarantee the development of the knowledge and skills necessary to execute the research project. The course Introduction to Numerical Fluid Dynamics is taken from the VKI's lecture series, thereby offering all students a concentrated exposition of current numerical methods. This is essential for students interested in the numerical option, but is also an important basis for students in the experimental option as it provides a common language to communicate research and design steps**.**

In the discussions with the faculty members and students it became clear that the development of knowledge through the interaction between tuition and doing research is both intense and well-balanced. The panel noticed that topical research was conducted, among other things, into a new space vehicle and sloshing effects in reactors as a result of earth quakes; also environmental studies of European Community buildings were presented, using open FOAM.
In addition, the panel learned and explicitly expressed its content with the fact that the preparation of experiment set-ups is firmly included in the training, something which is quite exceptional at other universities. The panel values it a great asset that VKI provides the students with a practical understanding of experimental techniques.

The panel also established that the course has clear links with the current relevant professional practice in the sense that it conducts research for a wide range of industries.

The pivotal role of the research project and the small groups facilitating intensive academic contacts between professors and students are regularly highlighted in the audit discussions.

Conclusion

The panel assesses standard 2.1 '*Requirements for academic orientation'* as excellent.

4.2.2 Correspondence between the aims/objectives and the curriculum

- *The curriculum is an adequate realisation of the intended learning outcomes of the programme with regard to the level, orientation and subject-/discipline-specific requirements.*
- *The intended learning outcomes are properly reflected in the educational goals of the curriculum or parts thereof.*
- *The contents of the curriculum enable students to achieve the intended learning outcomes.*

Findings

The educational concept of VKI is: 'teaching research by doing research'. For that reason the research project runs during the whole programme and covers half of the credits, 30 EC. Learning through the research project requires specific knowledge, techniques and skills already mastered through courses. The panel ascertained that the development of knowledge, techniques and skills is equally spread over the courses and well-aligned with the requisites for the research project.

The panel reviewed the reading list of the course and considered the references relevant to the objectives of the course and also topical and substantial. Except for some of the introductory courses, all courses make reference to current scientific literature. The panel also reviewed a cross-section of lecture notes and considered them of a high technical scientific level.

The faculty has presented a table to clarify how the objectives of the separate courses contribute to each of the intended learning outcomes of the course. It shows that the learning objectives all of the programme components combined cover the full range of the intended learning outcomes of the research Master.

Each course comes with a description that indicates the number of ECs involved, the learning objectives, the course lecturer(s), the literature to be studied and used, and the assessment format and criteria.

Considerations

The courses of the programme cover the topics of the domain and the full range of the intended learning outcomes of the course adequately, thus enabling students to achieve all of the final qualifications of the programme.

The panel considers the educational concept of 'learning-by-doing', i.e. teaching research through doing research a very good one, that clearly facilitates the ambitions of the research Master programme on fluid dynamics.

Students' research projects are being scaffolded by a diversified course programme in the three main fields of study to safeguard the development of knowledge, techniques and skills within the curriculum.

Conclusion

The panel assesses the standard 2.2 '*Correspondence between the aims/objectives and the curriculum'* as good.

4.2.3 Consistency of the curriculum

Students follow a curriculum that is coherent in terms of content

Findings

The documentation presents the programme as a set of courses and a research project. In the discussions with staff and students it became clear that the programme can better be interpreted, and is experienced, as a research project and courses. Since the emphasis of the programme is on the research project, the assignment to this project is crucial and therefore done carefully (see standard 2.5 Admission requirements).

Related to the research project a student chooses the main field of specialisation, the courses within his or her specialisation and, when necessary, also from other specialisations. Thus each student composes his or her individual study programme.

Nevertheless, the programme of each student follows a sequence from basic and common courses to specialisation and application. In some of the courses knowledge and skills are not just transferred, but also applied and this is always the case in the research project. In the first two trimesters students have relatively much course work and less work on their research project whereas in the third trimester it is the other way round, although variations between students happen.

Considerations

The panel very much appreciates the possibilities for students to reach the intended learning outcomes via almost individual programmes. The flexible programmes give room for the remediation of deficiencies, acquisition of the basics of the field and specialisation in one of the three designated areas of specialisation. The individual programmes still appear to be consistent and to have a focus in a certain field of specialisation. The consistency in this programme does not primarily become visible in the cohesion between the courses offered but rather in the research project on the basis of which students select the relevant courses. The panel considers this a viable and effective study approach that in itself renders consistent study programmes to the individual students.

Conclusion

The panel judgement on standard 2.3 *'Consistency of the curriculum'* reads good.

4.2.4 Workload

• *The actual duration of the programme is assessed and corresponds with the statutory standards.* • *The intended learning outcomes are attainable because factors relating to the curriculum that could hamper study progress are eliminated wherever possible.*

Findings

The research Master in Fluid Dynamics 'Master-after-Master' programme comprises 60.5 to 65.75 European credit points. These credits are divided over the programme as follows:

- a research project (30 EC)
- a selection of mandatory courses in a specified field (30.5 – 30.75 EC)
- optional courses if appropriate for the project (5 EC)

The previous audit panel expressed its concern about the relatively high workload of the students. The present panel went into detail on this issue and established that:

(i) students on the panel, indeed, experience a considerable workload, but generally seem to accept this as part of the deal. They say that a 9-months intensive course at this level can only be tough and demanding;

(ii) a systematic measurement of students' workload, particularly when doing project work, is now part of the student evaluations and remarks made by students indicate relatively few problems with the workload as such, but rather resurface inaccuracies in planning and scheduling that require attention;

(iii) the alumni enquiry indicates that 60% considered the workload heavy, but doable, whereas only 10% say the workload was too much;

(iv) the enquiries also show that students find the RM course very awarding and that some of them even opt to take additional courses without claiming ECs for them;

(v) the course has an extremely high success rate (see standard 6.2 Success rate).

Considerations

It is clear that the Research Master of VKI is an intensive course. It is demanding and requires students' non-negligible effort; all the same, both in the audit and in questionnaires the vast majority of the students testify that for this type of course a heavy workload is inevitable, but still feasible.

Supervision and study guidance are intense and appear to assist students in surviving the considerable course load. Moreover the success rate of the course is incredibly high.

As was the case at the time of the initial audit the programme still has many different courses of few ECs. The panel acknowledges the fact that this practice ties in with the concept of the programme through which research and courses are integrated and geared towards specialised knowledge, but by the same token causes a fragmented curriculum which appears to render quite a few scheduling and organizational problems, as indicated by students in both questionnaires and audit discussions.

Another reason suggested by the management for the relatively large number of small courses is the mixed population of students that on entry sometimes have different levels in specialised areas. Students on the audit panel, however, maintained that levels in general do not vary that much to justify such a large amount of small specialized courses. Therefore the panel suggests restructuring some of the small courses into larger units.

Conclusion

The panel assesses the standard 2.4 '*Workload*' as satisfactory.

4.2.5 Admission requirements

The structure and contents of the intended curriculum are in line with the qualifications of the incoming students for an advanced Master's programme:

- *A Master's degree, with a qualification or qualifications specified in more detail by the management of the institution, possibly supplemented with an assessment concerning the fitness or capability, or with a preparatory programme.*

Findings

The application presents the following admission requirements:

- a five year engineering or science degree (3 year BSc + 2 year MSc) from a European University or a MSc from an American, Canadian or Turkish University,
- a working knowledge of the English language. Students that did not obtain their degree from a university with lectures in English have to deliver a proof of having studied in English or an English language test result from an international organisation,
- endorsement of the applicant by an RTO National delegate. Citizenship of one of the NATO countries is required in view of the financing organisation. Non NATO nationals residing in NATO countries will be considered for admission if they are recommended by the RTO National delegate of their country of residence on the ground that their attendance at VKI would be beneficial to that country,
- recommendations by three professors from a university where the candidate has studied previously,
- there is no tuition fee for students from countries financing VKI.

The application form on VKI's website makes it clear that proficiency in English is required. If the applicant needs to prove his or her knowledge of English, this will be tested via a TOEFL test. No more explicit criteria are mentioned as far as proficiency in English is concerned. In the audit students all show at least a fair command of English and the panel established that the use of written English in papers and theses was generally outstanding.

The application form also inquires extensively into motivation and future plans of the applicants and how they think following the Research Master in Fluid Dynamics will serve their career. In this perspective applicants are asked to describe their area of interest. According to their specific interest they also have to choose and rank five research projects from a list of VKI projects.

During the site visit it has been explained to the panel that professors of VKI departments review the application forms and make a proposal to the selection committee. The selection committee consisting of the heads of department discusses the proposed applications, taking into account the quality of the candidates and a balanced intake among countries. Normally about 50% of the applicants can be admitted. Students have a variety of MSc diplomas when entering the programme; for example in thermo fluids, physics engineering, chemical engineering, biomechanics, metallurgy, mathematics, electro-mechanics, energy conversion, civil engineering, nuclear engineering, etc. VKI offers a set of small courses to remedy differences between students' entrance levels.

The selection committee preliminary looks at the projects applicants would like to commit themselves to. The selection committee also looks at the possibilities for assigning the students in preferred projects as proposed by the departments.

Upon arrival at the VKI the applicants gets an intake interview in which the assignment of a project is finalised. Accordingly, the individual study programme for each student is fixed.

Considerations

The panel found the formal rules for admission clear and adequate. The selection procedure is done thoroughly and effectively, also taken into account the very low drop-out rate (see standard 6.2 Success rate). The students met by the panel were eligible for this research Master as they demonstrated the right academic attitude and had obtained a relevant degree before they were allowed to enter the Master-after-Master programme.

Conclusion

The panel assesses the standard 2.5 '*Admission Requirements'* as good.

4.2.6 Credits

The programme meets the legal requirements regarding the range of credits. • Advanced Master's programme: 60 ECTS.

Findings

The programme of the *Research Master in Fluid Dynamics* comprises 60,5 or 65,75 ECs for a nine months programme.

Considerations

As part of the audit, the panel members reviewed the curriculum and programme documents, and conclude that the programme meets the legal requirement of a minimum of 60 EC for an advanced Master's programme. It also noticed that students at the conclusion of the course are either awarded 60.5 or 65.75 ECs depending on the variant of the programme they have followed.

Conclusion

The panel concludes that standard 2.6 '*Credits'* ties in with the legal requirements regarding an advanced Master's programme.

4.2.7 Coherence of structure and contents

The educational concept is in line with the aims and objectives. The study methods correspond with this educational concept.

Findings

As stated, the educational concept of the course is: 'teaching research by doing research'. The education provided is truly research oriented in the sense that (i) students spend half of the programme (30EC) on conducting research within the framework of their research projects, (ii) the physical study environment comprises research laboratories and workshops with a specialised technical staff, through which students have access to an extensive set of advanced facilities and equipment, some of which are of a unique nature, (iii) students are furnished with an intensive training in research methodology, reporting and presenting and (iv) students' research activities are supported by a wide variety of courses to furnish them with in-depth knowledge and skills, (v) the activities are carried out in an international/multicultural environment in terms of staff and students alike, (vi) intensive contacts, in small groups, are stimulated between students and professors, doctoral and post-doctoral researchers.

Courses take different educational formats, such as formal lectures (concepts/knowledge transfer), workshops, exercises or laboratory sessions (skills/application).

Teaching formats different slightly for each department. The generic and specialized courses that aim to transfer knowledge are mostly taught in formal lectures (68%) eventually complemented by practical exercises (18%) and hands-on lab sessions (14%) to help students in acquiring the competence and skills needed to apply the theoretical knowledge into practical cases.
In addition to this, visits to companies have occasionally been organized (Paris Air show, SNECMA, Techspace-aero) and students have participated in conferences organized by ERCOFTAC, ASME and Euroturbo).

Considerations

The educational concept of teaching research by doing research has been well implemented and is very much in tune with the aims and objectives of the course. Also, the didactic formats being used facilitate practice-based learning and, thus, tie in well with the educational concept.

Conclusion

The panel rates the standard 2.7 '*Coherence of structure and contents'* as good.

4.2.8 Learning assessment

By means of evaluations, tests and examinations, the students are assessed in an adequate manner which is insightful to them to determine whether they have achieved the intended learning outcomes of the programme or parts thereof.

Findings

Course assessments take different shapes depending on the course objectives. Courses, covering the basic theories or requiring an insight into the physics of the flow, are mostly evaluated by oral (open and/or closed book) exams with theoretical questions whereby mainly student's understanding and insight is measured.

Open book exams, sometimes complemented by exercises and reports describing the results of homework and small design projects are deployed to verify students' command of specific skills and competences, i.e. in how far the student understands the physics and models and is able to apply them.

Oral presentations of lectures prepared by the student about a specific topic are used to measure students' capacity for synthesis.

Attitudes, general scientific competences and the ability to do scientific research are evaluated during the Project Evaluation Team (PET) meetings, public presentations and reports.

The course descriptions encompass detailed information on the test format, the content of the test, the weighting of the different test components and examples of typical questions that might be asked. Through this students are well-informed about the course objectives and the criteria on which they are assessed.

As part of the audit the panel reviewed a selection of tests/interim-exams. These were all considered up-to-the mark content wise and transparent with regard to the assessors' judgements. Students on the panel reported that they experience the grading as fair and comprehensible.

Research projects have their own assessment procedure. The project evaluation team (PET) consists of at least three professors: one supervisor and at least one member from each of the other departments. The PET supervises the project from the start to the end. The student has regular contact with the supervisor; day to day supervision is partly realised by research engineers who can advise the PET. The student meets the other PET members three times for the presentation of the project in its distinctive phases. The advisory members have mainly an advisory role and participate in assessing the project work. Because staff members have an advisory role in several PETs it is possible to compare between projects and safeguard consistency between assessments.

A first public presentation to the faculty and fellow students of 15 minutes duration and 5 minutes discussion is delivered at the end of the second trimester to practice the art of public speaking; no grade is assigned.

The final grading for the project at the end of the third trimester consists of two parts. First there is an assessment of the report, a presentation and cross questioning of the student of about one hour by the PET (23 EC). This is followed by a public presentation and a question-and-answer session of about half an hour which is graded by all faculty members present (7 EC). Adjacently, students are awarded grades and credits for Presenting, Reporting and Management (PRM) skills for a total of 5EC.

VKI has designed an assessment scale which describes the different competence levels and relates them to numerical grades. A numerical grade between 60 and 64 represents, for example: 'satisfies only minimum project requirements', 'minimum interpretation and validation of results' and 'shows no creativity or innovation'. A grade between 75 and 79 represents: 'good overall achievements', 'might eventually be capable of doctoral research', 'possible international conference paper', 'capable of selecting appropriate techniques and/or test methods'.
A grade between 90 and 94 represents: 'fully capable of independent research at highest doctoral level', 'project report of high level journal quality', 'project of exceptional breadth and depth' and 'creative approach with innovative solutions'. The grading criteria correspond with the intended learning outcomes of the research Master.

In order to be awarded a diploma the student needs to have numerical grades of 60 or more in both course work and the project.

If the team members cannot reach a consensus on a pass/fail case, a special evaluation session is organized for a group consisting of PET members and additional faculty members chosen for their expertise and representing all departments.

Complaints against grading can be lodged with the Ombudsperson, a procedure for which has been detailed in the Regulations document of the course. It appeared that hardly any students complain about the grading of their work, and whenever complaints arise the procedure is conducted with care, as was confirmed by both students and lecturers during the audit.

Considerations

Students' performance is assessed in an adequate manner. It is done systematically and through a variety of test methods, which are applied in tune with the objectives, content and educational format of each course. The use of various methods of assessment is the more appreciated by students as the time factor to absorb a subject is considered an assessment criterion.

Students are well-aware of the way in which and the criteria on which they are assessed. Assessment mode and criteria for each course have been laid down in a course description. Students consider the assessment system well-balanced, fair and solid.

Conclusion

The panel evaluates the standard 2.8 '*Learning assessment'* as good.

4.2.9 Master's thesis

- *The Master's programme is concluded with the Master's thesis whereby the student demonstrates the ability for analytic and synthetic reasoning, independent problem solving at an academic level or artistic creation. The work reflects the general critical reflective attitude or the research attitude of the student.*
- *The Master's thesis corresponds to at least a fifth of the total number of credits with a minimum of 15 and a maximum of 30 credits.*

Findings

The Master's thesis consists of a substantial research project that corresponds to 30EC. The project should be conducted independently, starting with a problem definition. It also must exhibit originality in the sense that it contributes to the field.

Computational projects are mostly related to software development; experimental projects often study a phenomenon in view of the development or validation of a numerical model or the development of a new experimental technique. Projects are often part of the larger industrial research projects performed at VKI but can also be more fundamental VKI funded exploratory research. A limitation in the choice of projects for students preparing their Master's thesis is that these projects cannot have a confidential nature since it should be possible to publish the research findings.

While realising the research project, students are supervised and assessed by a project evaluation team (PET) which consists of professors: one supervisor and a staff member from each other department. The PET supervises the project from the start to the end; day-to- day supervision is partly realised by research engineers who may advise the PET (also refer to standard 2.8 Learning assessment).

At the end of the first trimester the student has to present a summary of the work accomplished until then to the PET; this should at least include results of the literature search and future plans. At the end of the second trimester the presentation to the PET has to include a report on the literature survey which is assessed as part of the course on presenting, reporting and research management.

There are also two public presentations; one as an exercise at the end of the second trimester and one final presentation of the project which is the basis for the final assessment.

The main purpose of these changes is to make sure that all information needed for the follow up of the project, either as a project or as a publication, is available. They do not influence the grade. For more details on the assessment of the Master's thesis see the previous standard 2.8, Learning assessment, and standard 6.1, Achieved learning outcomes, for the achievement of the intended learning outcomes.

The faculty provided the panel with a list of their Master theses that had recently been delivered. The panel at randomly selected 9 of these for a review. They all represent thorough work (see also standard 6.1 Achieved learning outcomes).

Considerations

Guidance of the Master's thesis is well structured with several moments of evaluation and relevant feedback by the project evaluation team (PET). Also the supervision by the research engineers is usually rather intense. Research projects sometimes are part of a continuing research line of the department. The panel was convinced that students are assessed on the extent to which they are capable of independent and creative research. This is explicitly stipulated on the assessment form and in the assessment criteria used.

Conclusion

The panel assesses the standard 2.9 '*Master's thesis'* as good.

4.2.10 Concluding Assessment of Theme 2 'Curriculum'

The panel has assessed six of the nine standards of the theme 'Curriculum' as 'good'. The panel judgement on the study load reads 'satisfactory' and the requirements for academic orientation have been evaluated as 'excellent'.

On the basis of these, according to NVAO's assessment rules the panel rates the Master-after-Master Research Master in Fluid Dynamics regarding the theme 'Curriculum' as satisfactory.

4.3. Staff

4.3.1 Requirements for academic orientation

The programme meets the following criteria for the deployment of staff for a programme with an academic orientation:

- *teaching is principally provided by researchers who contribute to the development of the subject/discipline;*
- *in addition, and where appropriate, the sufficient staff will be deployed with knowledge of and insight in the professional field.*

Findings

The core staff of VKI consists of 12 full time professors. In addition there are 9 part-time professors, visiting and adjunct professors included.

The curricula vitae of the educational staff were provided to the panel. It shows that all of the VKI teaching staff are specialized in the different aspects of fluid dynamics. All professors, were awarded their PhD on a topic related to fluid dynamics and have a substantial professional and research experience. Several of them are also lecturing at Belgian and foreign universities.

Many professors are globally acknowledged experts in their field of competence, invited speakers at international conferences and institutions, and have received international awards.

Their expertise covers both experimental and numerical research. From both the panel discussions and their CVs the auditors learned that the staff members keep their scientific competences up-to-date by personal study, participation in international conferences and workshops, and by conducting their intensive research studies, which take up more than 50% of their time.

All professors participate in international research consortia as partner or project leader.
In view of the high specialization and the limited number of places where specialized tuition in fluid dynamics is provided, it is not surprising that many VKI professors have received their education or a large part of it at VKI. Many have prepared their PhD at VKI but all received the degree from a university. Several ones prepared their PhD thesis outside VKI or/and have an substantial external experience in industry or research centers outside VKI.

Considerations

Judging from the curricula vitae, including the lists of publications and the research topics of staff members, and the audit discussions with the educational staff members, the panel gained a good overview of the research qualities of the staff and the selection criteria applied to recruit new staff.

The panel considers the international contacts and visibility adequate. Also, staff is employed with knowledge and understanding of the professional field. The institute has a good scientific reputation particularly because of the very specialized nature of its technical facilities and research projects.

The panel considers the academic quality of the staff adequate to carry out this Master-after-Master programme taking into account that the staff members are for a considerable amount of time involved in contract research and consultancy.

Conclusion

The panel assesses the standard 3.1 '*Requirements for academic orientation'* as good.

4.3.2 Quantity of staff

Sufficient staff is deployed to realize the intended quality of the programme.

Findings

There are 12 full time professors at VKI. Each department has 4 full time professors, one of them being head of the department. At the time of the audit the complete staff is composed as indicated in Chapter 1 (1.2 quantitative data).

Taking into account only the full time professors, the student/staff ratio is less than 3 : 1. When including the deployment of the visiting professors the ratio goes down to almost 2 : 1. This is considered an extremely favourable ratio by students and staff alike; the panel interviews confirm that this student/staff ratio results in a very intense and personalized contact between lecturers and students.

The 12 full-time professors supervise 30 to 40 students every year and around 50 PhD students and 60 members of the short training program as well. They spend on average 40% of their time exclusively on teaching and supervision of RM students, excluding PhD supervision and research contracts. In addition, each faculty member also organizes two Lecture Series every 3 year.

The teaching staff is assisted by more than 80 researchers who are all specialized in fluid dynamics at doctoral and post doctoral level. This large number of professors, doctoral and post-doctoral researchers and technical personnel provide an interesting and challenging study environment, confirm students in the audit.

From the audit it has become clear that many staff members work long hours. This is partly due to their firm commitment to the institute and their never ending dedication and hard work.
On the other hand, some staff members appear to be on the verge of being overworked. In the audit it was discussed that more administrative support might be needed to ease the workload of the educational staff. The panel supports this suggestion.

The panel was pleased to learn that a policy has been implemented to recruit younger staff members as some of the older professors will shortly retire or have already retired. The panel would recommend to preferably recruit new staff from outside the VKI network, in order to bring in fresh ideas and initiatives.

Considerations

The panel considers a staff/student ratio of 1:3 extremely fortunate. The same holds good for the 12 FTE available for the degree programme at the level of full time professors. As there is also the contribution of visiting and part-time professors, doctoral and post-doctoral researchers and research engineers to the realisation of the programme, it can be concluded that, education-wise, the quantity of staff is exceptionally good. Recruitment of younger staff members is recommended.

Conclusion

The panel assesses the standard 3.2 '*Quantity of staff'* as 'excellent'.

4.3.3 Quality of staff

The staff deployed are sufficiently qualified to ensure that the aims and objectives of the programme, in terms of content, didactics and organisation, are achieved.

Findings

The tenured faculty all spend a substantial part of their time on research activities including publishing, conferences etc. Thus, their expertise regarding the content of the programme is guaranteed. The qualifications and expertise of the educational staff members as presented in their resumes fully covers the aims and objectives of the programme in terms of content.

Staff are expected to have already acquired didactic competences prior to their appointment – which is mostly the case - but didactic competences do not appear to play a key-role at VKI as teaching is often delivered almost in a one-on-one context. However, in lecturing a well thought-out and effective didactic approach does matter. As part of the audit and the tour of the premises the panel members received mini-lectures from several young professors on specialized topics. The panel members were impressed by these mini-lectures that were presented in an appealing way.

The panel did not perceive any severe organizational issues to be addressed. However, in the meeting with students some problems were raised with the scheduling of courses. Some of them appear to overlap and others are not entirely well-organized, say students. The panel considers this a point that needs attention.

Educational training within the course is done through a mentor system between younger staff and experienced staff, sometimes even retired professors. The panel learned that experienced professors assist the younger ones in structuring their lectures during their first years. Lecturers who were interviewed by the panel maintained that this mentoring system clearly contributes to transfer of knowledge and internal professionalization. An external specialized educational training will be considered by VKI as soon as it becomes available in English at Belgian universities.

The quality of staff is safeguarded by both the Educational Committee and the Assessment Committee (also refer to standard 5.1 Evaluation of results). This is done on the basis of student questionnaires and the Assessment Committee's evaluation of staff members' contribution to (i) *science*, (ii) *education,* (iii) *contract work* and (iv) *service to society*. For each of these components quantitative and qualitative criteria have been set. Confidential minutes of Assessment Committee meetings were presented to the panel to substantiate the application of these criteria.

At the time of the audit VKI experiences difficulties in attracting qualified staff. The management makes the point that this results from the uncertain financial situation of the VKI. The NATO budget, which is the main financial support for the programme, has to be reconfirmed every year for a one year period.
Together with the requirement to bring in more than 2/3 of the budget (including all salaries) by sponsored research contracts this has frightened prospect staff members. If the issue of financial uncertainty remains, the panel fears this might eventually effect the excellent quality of the staff at present and, in the long run, the continued existence of the institute.

Considerations

The quality of staff regarding the content of the programme is adequate to train young researchers (see standard 3.1 Requirements for academic orientation). The panel is positive about the adopted mentoring scheme and was pleased to learn that students are generally very satisfied about the didactic qualities of their professors. Motivation, competence and input are extremely high. The panel is positive about the staff evaluation work of the assessment committee.

A threat to the quality of staff may present itself through uncertainties in VKI's funding; these worries certainly need attention, but as yet this has not affected VKI's high standards for appointing educational staff.

Conclusion

The panel assesses the standard 3.3 '*Quality of staff'* as good.

4.3.4 Concluding assessment of Theme 3 'Staff'

The panel has assessed the three standards of the theme '*Staff'* as good. Therefore the Research Master in Fluid Dynamics receives the overall judgement 'satisfactory' on the theme 'Staff'.

4.4. Services

4.4.1 Facilities

Housing and facilities are sufficient to the realization of the curriculum.

Findings

As part of the audit the panel members went on a conducted onsite tour. Although some of the classrooms could do with a refurbishment and some of the desktop computers looked somewhat outdated, the panel perceived an impressive number of specialised test facilities, most of which had been specially designed by VKI staff. These test facilities are equipped with advanced instrumentation and a powerful computer centre. During the site visit the panel members noticed several unique experimental facilities.

The design and drawing office facilitates the technical drawings for the wind tunnel models, experimental set ups, facility modifications and figures and charts for reports and presentations.

Most of the electronic instrumentation for the measurement in fluid mechanics can be found in the electronic laboratory. New instruments and electronic devices are also developed here. VKI has a specialised library and publishing office with a substantial number of specialised reports of aeronautical /aerospace organisations. The metal and woodworking shops are equipped with a range of machining tools and welding equipment, including the recently developed „high precision mechanics“ section for constructing dedicated instrumentation. Finally there are study and conference rooms, a catering service, secretaries and an administrative and purchasing service.

It became clear that students can only use the laboratory facilities when supervised. A Safety Engineer is responsible for the safety of all installations and together with the committee for health and hygiene assures a proper working environment.
During the audit some of the students suggest that the accessibility of workshops and computer facilities could be improved: 'Sometimes workshops can be really overloaded. We particularly experience problems with the availability of measurement equipment,' say some, 'and this is particularly annoying when pressed for time finishing your research project.' The staff confirms that the logistics in the workshops should be reconsidered.

Considerations

According to the panel numerical, theoretical and modelling facilities are adequate. The experimental facilities of VKI are unique and for that reason well-known among colleagues. The panel recommends to use these facilities as their spearhead in making themselves more known to the outside world and in collaborating with research universities.

The facilities are generally well-maintained. The logistics in the workshops should be rethought, as some students pointed out that measuring equipment is not always available when needed.

In summary, the panel judges the facilities to be perfectly adequate to contribute to the achievement of the intended learning outcomes.

Conclusion

The panel assesses the standard 4.1 *'Facilities'* as good.

4.4.2 Tutoring

- *Tutoring and the provision of information to students are adequate in view of study progress.*
- *Tutoring and information provision are geared to students' needs.*

Findings

The information on the Research Master for prospect students is presented on the VKI website. A leaflet can be downloaded which in brief highlights the features of the course. The information on the website contains course descriptions and the Regulations document. It is concise but adequate, and enables prospect students to consider their applications.

Once they are enrolled the students have access to the timetables and further documentation of the course. In the wake of the previous audit the student information booklet has been substantially extended and now includes the Regulations document. The panel members browsed through these to conclude that they clearly provide the package of information required to accommodate study progress.

In addition, the course now has a digital platform 'Alfresco' that gives access to all study information. It is used by the students to download reports, presentations, home works etc. In the audit students express their satisfaction about the course information provided.

Supervision
The supervisor of the research project also supervises students in their course work, in cooperation with the individual professors. The technical advisor of the project supervises and assists the student as far as laboratory and technical aspects are concerned.

Individual study results are communicated to the whole faculty and discussed in faculty meetings, if necessary. Results of exams are communicated and eventually discussed with the student before being archived. The Dean is available to discuss any problems that might occur.

In meetings with students and alumni it became clear that the students felt well taken care of. They feel stimulated in choosing and executing their project right from the beginning of the degree course. Due to the small scale of the institute, students experience a low-threshold- approach bilateral contacts between students and staff. These appear to take place frequently, say students. The class representative reported it is also easy to contact staff if more generic topics like laboratory planning (see 4.1 Facilities) deserve attention.

Considerations

The panel found the information provided to both prospect students and students adequate. Interviews with students confirmed that tutoring is very intense, in line with the educational concept.

The previous audit panel suggested that the downside of such a tight tutoring scheme could be that it hampers critical reflection and creative independent thought.
The management, however, made it clear to the panel that the PET meetings are very similar to contract meetings with a brief introduction followed by critical questions encouraging the student to reflect on his or her approach. Also the supervisor has adopted this approach.

The panel learned, both from staff and students, that it still remains the responsibility of the student to take the decisions, to organize and perform the work. Moreover, the input and initiative of the student are major points in the evaluation of the Master Thesis Project.

The students with whom the panel spoke confirmed this challenging approach to tutoring and expressed their satisfaction about it.

Conclusion

The panel assesses the standard 4.2 '*Tutoring'* as excellent.

4.4.3 Concluding assessment of Theme 4 'Services'

The panel has assessed the two standards of the theme 'Facilities' as good. The panel therefore considers the Research Master in Fluid Dynamics as 'satisfactory' regarding the theme 'Facilities'.

4.5. Internal quality assurance system

4.5.1 Evaluation of results

The curriculum is periodically evaluated in the light of verifiable objectives and other measures.

Findings

The curriculum is evaluated systematically with the relevant stakeholders (see 5.3 Involvement of staff, students, alumni and the professional field). The panel has seen evaluation forms and (aggregated) results of student evaluations. The outcomes of these evaluations are subsequently analysed and discussed in the Education Committee, in the Assessment Committee and by the Management, if need be. Measures for improvement are suggested and taken, if so required (see 5.2 Measures for improvement). This demonstrates an effective Plan-Do-Check-Act cycle.

However, no verifiable objectives for the internal quality assurance have been set. In other words: the questionnaires result in a large amount of aggregated, and relevant, figures that are being analyzed and discussed, but for which no explicit standards or targets have been set.

Considerations

The panel established the presence of a working PDCA cycle, but did not yet come across a convincing set of explicit verifiable objectives. The panel recommends to explicitly attach target figures to each of the parameters or themes of the questionnaires, in such a way that it becomes clear which caesura VKI has adopted to consider any of the evaluated aspects either satisfactory or unsatisfactory, and thus in which case measures for improvement are required.

Conclusion

The panel assesses the standard 5.1 *'Evaluation of results'* as satisfactory.

4.5.2 Measures for improvement

The outcomes of the evaluation form the basis for verifiable measures for improvement that contribute to the achievement of the objectives.

Findings

The course management has provided an overview of measures for improvement taken in the wake of the previous audit. The overview indicates how the issues addressed by the initial audit panel were fixed or on what grounds no explicit improvements had (yet) been implemented.

In addition, the panel was given insight in some recent measures for improvement as a follow-up to several inquiries among stakeholders.

The panel members reviewed several (aggregated) surveys of evaluations and minutes of meetings of the Educational Committee and the Assessment Committee the content of which clearly demonstrated that the output of evaluations is structurally analyzed and, if need be, followed by relevant and adequate measures for improvement.

Considerations

Among other things, the improvements that had been implemented after the initial audit (i) have overcome the established shortcomings in study information provided to students and (ii) have created a more systematic approach to quality assurance, also incorporating an enhancement of internal critical reflections, which, too, was part of the former panel's criticism.

Current outcomes of evaluations have resulted in the following measures for improvement: (i) a review and strengthening of the course on Presenting, Reporting and Management (PRM), (ii) a more transparent system of collecting and presenting grades is under construction, (iii) a policy to enhance VKI's visibility with regard to the output of the Research Master programme has been put in place and (iv) steps have been taken to expand VKI's campus.

Thus, the results of the programme evaluations are verifiably used to implement relevant improvements.

Conclusion

The panel assesses the standard 5.2 *'Measures for improvement'* as good.

4.5.3 Involvement of staff, students, alumni and the professional field

Staff, students, alumni and the relevant professional field will be actively involved in the internal quality assurance system.

Findings

From the documentation and the audit discussions it became clear that the following actors are involved with quality assurance. The actors, tasks and instruments presented are:

- students elect a student representative per department who meets regularly with the head of department;
- one student delegate meets regularly with the Dean of the faculty;
- the dean is responsible for organising the course schedule, exams, PET meetings, the information booklet and respecting rules for examination;
- the assessment committee consists of the heads of department, the dean and the director (chair). They periodically evaluate all faculty members regarding their scientific performance, their education performance and their contract work;
- the educational committee is composed of the dean (chair) and two honorary professors, a representative of the alumni and a senior faculty member of each department. They evaluate faculty members periodically on educational matters. For this purpose enquiries are organised for every course by means of a questionnaire and for the academic year after the Master thesis,
- the alumni association and an alumni questionnaire;
- the technical advisory committee (TAC) which is established by NATO-STO and is composed of senior professors and leaders of large research centres. The TAC makes a yearly audit of the performance of VKI regarding education and research.

The panel discussions during the site visit show a great number of mutual interactions between the actors involved in quality assurance, including the board of directors.

Considerations

All important actors are actively and systematically involved with internal quality. Minutes of various meetings (Assessment Committee/Educational Committee) demonstrate a strong commitment of the participants.

Conclusion

The panel rates the standard 5.3 *'Involvement of staff, students, alumni and the professional field'* as good.

4.5.4 Concluding assessment of Theme 5 'Internal quality assurance system'

The panel has assessed the standard 'Evaluation of results' as satisfactory. The other two standards of the theme 'Internal Quality Assurance System' were considered 'good'.

The panel therefore considers the Master-after-Master Research Master in Fluid Dynamics as ' 'satisfactory' regarding the theme 'Internal Quality Assurance System'.

4.6. Results

4.6.1 Achieved learning outcomes

The achieved learning outcomes correspond with the aims and objectives regarding level, orientation and subject-/discipline-specific requirements..

Findings

For a detailed description of the research project and the graduation process, please refer to Standard 2.9 Master's thesis.

Prior to the audit the panel was presented an overview of 37 Master Thesis reports that had been delivered over the past years of study. From the list the three expert panel members each randomly selected and reviewed three Master theses. In addition, a cross-section of the other 28 theses was inspected during the site visit.

All of the Master Thesis reports the panel members scrutinized were considered of a fine quality, some of which were even thought to surpass the intended outcomes of the course. Examples of research topics are: 'Flow analysis and blade lifetime computation on a commercial gas turbine', 'Investigation of interaction of coherent structures on heat transfer in ribbed duct' and 'Analysis of unsteady flow phenomena in the Longshot wind tunnel'.

The panel established that all Masters theses deal with highly specialized topics within the range of fluid dynamics. Some of the research is part of a larger research scheme to which several project groups subsequently contribute. The research is done thoroughly and delivers results that clearly contribute to the field, as the representatives from the professional field confirmed in the audit.

Students are explicitly assessed on the extent to which they are capable of independent and creative research, as this is one of the explicit assessment criteria. The panel members were able to understand the assessors' substantiations of the grades awarded and generally agreed to their judgements.

Considerations

Prior to the audit the panel assessed a selection of nine Master theses as thorough work, clearly contributing to the field. Some of the theses reviewed were considered exceptionally good and of a very high standard. A review of additional theses confirmed the initial findings without exception.

The research projects reviewed by the panel members clearly demonstrated students' ability for analytic and synthetic reasoning and independent problem solving at an academic level. The work that the panel members reviewed randomly demonstrated the general critical reflective and research attitude that should be expected of research Masters; quite a number of them, in the eyes of the panel members, had delivered outstanding theses.

The faculty has provided an overview of student publications that have arisen from VKI research projects and were published in well-established journals.

Conclusion

The panel rates the standard 6.1 *'Achieved learning outcomes'* as 'excellent'.

4.6.2 Success rate

Target figures regarding success rate have been formulated on the basis of a comparison with relevant other programmes. The programme's success rate is in line with these target figures.

Findings

Statistics of the last 5 years demonstrate that of the total of 153 students enrolled in the VKI Research Master in the last 5 years only 7 (4.5%) were not awarded the RM degree. VKI's analysis of drop-out figures show that a small number of failures are due to family or personal problems.

However, most failures can be attributed to an insufficient technical background of the student before coming to VKI. As this is a matter of formal qualifications, the panel recommends to observe this criterion more closely on entry.

All the same, this relatively high success rate seems certainly related to the careful and strict selection procedure already in place, which is based on an examination of transcripts of results and three references by former professors of the students (also refer to standard 2.5 Admission requirements). Also VKI is able to select students from a relatively large number of candidates. And, as already stated under standard 2.4 Workload, the tight and intensive system of supervision also significantly contributes to the high success rate.

VKI has not formulated any target figures with regard to the success rate and no comparison is made with relevant other programmes in e.g. Belgium or the Netherlands. With several years of experience the panel would recommend the course to take its present figures as a future target. The panel acknowledges the fact that a valid comparison with other courses would be hard, as the course does not have a true equivalent elsewhere.

Considerations

The panel considers a success rate of over 95% to be absolutely exceptional.

Conclusion

The panel assesses the standard 6.2 *'Success rate'* as excellent.

4.6.3 Concluding assessment of Theme 6 'Results'

The panel considers both standards of the Theme 'Results' of an excellent quality. Therefore, in line with NVAO's assessment rules the theme as a whole is rated 'satisfactory'.

5. OVERALL JUDGEMENT

The panel presents its assessments per theme and per standard, as outlined in chapter 4, in the following table.

Theme	***Judgement***	***Standard***	***Judgement***
1. Aims and Objectives	satisfactory	1.1 Level and orientation	excellent
		1.2 Domain specific requirements	excellent
2. Curriculum	satisfactory	2.1 Requirements for academic orientation	excellent
		2.2 Correspondence between the aims/objectives and the curriculum	good
		2.3 Consistency of the curriculum	good
		2.4 Workload	satisfactory
		2.5 Admission requirements	good
		2.6 Credits	Cf. legal requirements
		2.7 Coherence of structure and contents	good
		2.8 Learning assessment	good
		2.9 Master's thesis	good
3. Staff	satisfactory	3.1 Requirements for academic orientation	good
		3.2 Quantity of staff	excellent
		3.3 Quality of staff	good
4. Facilities	satisfactory	4.1 Services	good
		4.2 Tutoring	excellent
5. Internal quality assurance system	satisfactory	5.1 Evaluation of results	satisfactory
		5.2 Measures for improvement	good
		5.3 Involvement of staff, students, alumni and the professional field	good
6. Results	satisfactory	6.1 Achieved learning outcomes	excellent
		6.2 Success rate	excellent

Overall judgement: positive

ANNEXES

ANNEX I Course specific intended learning outcomes

The following domain specific outcomes are common for the three departments (AR, EA, TU), although the intensity can be different depending on the 3 areas of application. Students should:

- **be competent in one or more specific disciplines:** the students must have an advanced theoretical understanding of fluid dynamics, i.e. an in depth understanding of the physical and mathematical models that are needed to understand and explain the phenomena in his field of application and be aware of the limits of validity and the possible extensions to other fields. The students must have a profound knowledge of the relevant numerical and/or experimental techniques, have an understanding of their advantages and limitations in terms of applicability and accuracy and be aware of the complementarities of both approaches.

- **be competent in doing research:** the students must be able to translate a fluid dynamic problem into a research project and have the competences to manage research projects, in particular the techniques of planning and execution, valorization and communication of results. This requires for the respective fields of specialization, the understanding of the functionalities of the different experimental facilities and CFD software. Important in this context are: the ability to define an appropriate research strategy, the methodology to translate problems into targeted research projects, the competence to correctly interpret the experimental or numerical results and to come up with an improved insight and new models.

- **be competent in designing:** the students must have an insight into the advanced design and optimization techniques and have the ability to apply them to complex multidimensional and multidisciplinary problems. They must be able to define the boundary conditions, recognize conflicting objectives and verify that the objectives and functionalities are reached. This concerns not only the design of industrial products but, in view of the specific orientation of this program, also the conception of new experimental facilities and instrumentation. End of life problematic is an important aspect in this context.

- **have the skills to apply advanced numerical and experimental techniques:** the student must have the skills to use fluid dynamic related research methods and experimental techniques at an advanced level. They should be familiar with "best practice procedures" for the use of advanced CFD and experimental tools, they should Master complex data acquisition, reduction and visualization tools in order to validate and interpret the results of complex experiments and CFD calculations.

- **have the basic intellectual skills:** critical reflection, logical reasoning, deduction, abstraction and scientific argumentation are part of any engineering education and should have been acquired before starting this MaM program. However they will be further developed and brought to a higher level. Out of the box thinking and the originality of the approach have an extra dimension in a research oriented education.

- **be competent in co-operating and communicating:** the students should already Master these competences when starting a MaM program. However organizing team work, communication and reporting must be further strengthened as they are key issues in planning and managing complex research and multidisciplinary design projects in an international context.

- **be aware of the temporal and social context of sciences:** the students must be able to position their research in the worldwide scientific community and have insight into the structures and customs of the international scientific world. International networking and the knowledge of the large international research organizations and their ongoing research programs are important in this respect. Students should also be aware of the ethical and environmental aspects of the scientific developments in their field of specialization.

In addition to these general requirements, the VKI Master program responds also to more specific technical requirements by providing a specialized education in the three main fields of application.

- **Aeronautics and Aerospace:** The main technical requirements are the knowledge of flight mechanics and operation efficiency at low and high speed, 2D and 3D boundary layers at different Reynolds and Mach numbers, hypersonic flows including aero-thermal chemistry and plasma physics.

- **Environmental and Applied Fluid Dynamics:** In addition to the general knowledge on aero-acoustics, multiphase flows, wind engineering and atmospheric flows related to the environment, the program also responds to the need for more specific analysis techniques and methodologies to cope with the large variety of industrial and biological related problems.

- **Turbo-machinery and Propulsion**: The main technical requirements are an advanced competence in the experimental and/or numerical analysis of the flow in compressors, pumps and turbines allowing for an improved design of new geometries in view of energy savings and noise reduction. Emphasis is on multidisciplinary aspects including aerodynamics, heat transfer, stresses, vibration and.

ANNEX II Programme overview in outline

Course Abbreviation and Title		AR		EA		TU	
		Exper. Option	**Num. Option**	**Exper. Option**	**Num. Option**	**Exper. Option**	**Num. Option**
		Nbre ECTS	Nbre ECTS	Nbre ECTS	Nbre ECTS	Nbre ECTS	Nbre ECTS
COMMON COURSES							
DEFM	Differential equations of Fluid Dynamics	1,25	1,25	1,25	1,25	1,25	1,25
IMT	Introd. to Measurement Techniques in Fluid Dynamics LS	2,50	2,50	2,50	2,50	2,50	2,50
PRM	Presenting, Reporting and Research Management	5,00	5,00	5,00	5,00	5,00	5,00
NMFD-1	Numerical methods in Fluid Dynamics, part 1		1,25		1,25		1,25
	TOTAL	**8,75**	**10,00**	**8,75**	**10,00**	**8,75**	**10,00**
SPECIALIZED COURSES AR							
GENERAL COURSES AR							
APSC	Aircraft Performance, Stability and Control	2,00	2,00				
IAAI	Inviscid Aerodynamics in Aeronautics, Incompressible case	2,50	2,50				
IAAC	Inviscid Aerodynamics in Aeronautics, Compressible case	1,50	1,50				
2DBL	Two-dimensional Boundary layers	4,00	4,00				
WTAD	Low Speed Wind Tunnels Analysis and Design	1,00					
CFD Lab	Computational Fluid Dynamics Laboratory	1,50					
ICFD	Introd. to Computational Fluid Dynamics Lecture Series	1,25					
MT Labs	Advanced Measurement Techniques Laboratories	6,00	1,50				
NMFD-2	Numerical methods for Fluid Dynamics 2		3,00				
CMCF-T	Computational Methods for Compressible Flow - Theory		1,50				
CMCF-L	Computational Methods for Compressible Flow - Lab		2,50				
	TOTAL	**19,75**	**18,50**				
OPTIONAL COURSES AR (minimum 2 courses to be selected)							
PHYSGD	Physical Gas Dynamics	4 ,00	4 ,00				
3DBL	Boundary Layers and flow separation in 3 dimensions	1,25	1,25				
ACOUS	Introduction to Aeroacoustics	1,00	1,00				
TRANS	Transonic Aerodynamics	1,00	1,00				
HYP	Hypersonic Aerodynamics	2,00	2,00				
PWT	Design and operation of plasma wind tunnels	1,00					
WTTT	Low Speed Wind Tunnel Test Techniques	1,00					
DAP	Data Acquisition and Processing	2,00					
CMIF-T	Computational Methods for Incompressible Flow - Theory		1,50				
CMIF-L	Computational Methods for Incompressible Flow - Lab		2,50				
	MINIMUM TOTAL	**2,00**	**2,00**				
SPECIALIZED COURSES EA							

Course Abbreviation and Title		AR		EA		TU	
MAFD	Methodology of Applied Fluid Dynamics			5,00	5,00		
IDE	Industrial Design Exercise			3,50	3,50		
TURB	Introduction to the Mechanics of Turbulence Modeling			2,50	2,50		
DAP	Data Acquisition and Processing			2,00	2,00		
NSIP1	Numerical Simulation of Industrial Problems 1			2,75	2,75		
NSIP2	Numerical Simulation of Industrial Problems 2				3,50		
MT Labs	Advanced Measurement Techniques Laboratories			6,00	1,50		
	TOTAL			**21,75**	**20,75**		
SPECIALIZED COURSES TU							
FTM	Flow in Turbomachines					8,00	8,00
DE	Design exercise					5,00	2,00
TU Labs	Turbomachinery Laboratory Sessions					3,00	3,00
ACT (*)	Advanced Course on Turbines					4,50	4,50
ACC (*)	Advanced Course on Compressors					4,50	4,50
ICFD	Introd. to Computational Fluid Dynamics Lecture Series					1,25	
NMFD-2	Numerical methods for Fluid Dynamics, part 2						3,00
	TOTAL					**21,75**	**20,50**
(*)	One of ACT or ACC has to be selected.						
	GRAND TOTAL	**30,50**	**30,50**	**30,50**	**30,75**	**30,50**	**30,50**
OPTIONAL COURSES all dept							
ICFD	Introd. to Computational Fluid Dynamics Lecture Series		1,25	1,25	1,25		1,25
MT Labs	Advanced Measurement Techniques Laboratories				1,50	1,50	1.50
ACOUS	Introduction to Aeroacoustics			1,00	1,00	1,00	1,00
TURB	Introduction to the Mechanics of Turbulence Modeling	2,50	2,50		2,50	2,50	2,50
DAP	Data Acquisition and Processing		2,00		2,00	2,00	2,00
PWT	Design and operation of plasma wind tunnels		1,00	1,00	1,00		1,00
NMFD-2	Numerical methods for Fluid Dynamics, part 2				3,00		
CMIF-T	Computational Methods for Incompressible Flow - Theory				1,50		1,50
CMIF-L	Computational Methods for Incompressible Flow - Lab				2,50		2,50
CMCF-T	Computational Methods for Compressible Flow - Theory				1,50		1,50
CMCF-L	Computational Methods for Compressible Flow - Lab				2,50		2,50
2DBL	Two-dimensional Boundary layers			3,25	3,25		
3DBL	Boundary Layers and flow separation in 3 dimensions			1,25	1,25		
WTAD	Low Speed Wind Tunnel Analysis and Design			1,00	1,00		
WTTT	Low Speed Wind Tunnel Test Techniques			1,00	1,00		

ANNEX III Programme, approach and assessment rules

Programme

Site visit of the Master in Fluid Dynamics of the von Kármán Institute on 30 January 2014.

Location: Chaussée de Waterloo, 72, B-1640 Rhode-St-Genèse, Belgium
Telephone (reception): +32 2 359 96 11; **Telephone** (secretariat): +32 2 359 96 04; **Email:** secretariat@vki.ac.be
Contact person: Mr R. van den Braembussche

Time	Auditees	Possible topics for discussion
08.00 – 08.30	**Arrival of panel members and audit preparation**	
08.30 – 09.00	**<u>Programme Management</u>** **Director, J. Muylaert, K Vanderhauwaert** **Dean of Faculty, H. Deconinck**	- mission & strategy - developments in relevant academic field - market position / competitive position - education performance / success rate - interaction with academic field / customer relationship management
09.00 – 10.00	**<u>Educational Committee /Assessment Committee</u>** **Dean of Faculty, H. Deconinck** **Profs. Sieverding, Carbonaro, Van den Braembussche, Arts, Buchlin, Chazot**	- curriculum development - international focus - intrinsic backbone of the programme's contents - distinctive features of the programme - research component & development - quality assurance of assessment/examination/ quality standards of research - students' final research projects - authority of the Assessment Committee - relation to the management - assessment expertise - intake policy
10.00 – 10.15	**Panel retrospective**	
10.15 – 11.15	**<u>Tour of the premises</u>**	- Quality of educational facilities, laboratories etc.
11.15- 11.30	**Panel retrospective**	
11.30 – 12.30	**<u>Faculty (younger faculty members)</u>** **Profs. Ch. Schram, T. Magin, G. Degrez, T. Verstraete, J.F. Brouckaert, G. Paniagua** **M.R. Vetrano, J. Van Beeck**	- curriculum development - involvement academic field - intrinsic backbone of the programme's contents - distinctive features of the programme - research component - learning assessment (methods, standards, parties involved, scoring & feedback) - tutoring - education performance / success rate - interaction with the management - involvement in quality assurance
12.30 – 13.30	**Lunch, review of additional documents**	
13.30 – 14.30	**<u>Research Master Students</u> (3 of each department, with different backgrounds)** **Ir. C. G. Bellas, T Horvath, L.P. Solano, E. Barlas, G. Galgani, L. Labarrere, G. L. Gori, A. Lahalle, S. Willeke**	- quality of professors - information and communication facilities - learning assessment / feedback - tutoring - feasibility and workload - educational facilities - research project - student participation/involvement in programme

Time	Auditees	Possible topics for discussion
14.30 – 15.00	**Panel retrospective and <u>open consultation session for staff and students</u>**	
15.00 – 15.45	**<u>Alumni</u>** **Ir. G. Grossir, D. Guariglia, I. Horvath, M.A. Mendez, C. Spaccapaniccia, A. Lambert, J Clinckemaillie, C. De Maesschalck, J. Sans, Dr. L. Villafane**	- Alignment of programme with requirements of professional field
15.45 – 16.00	**<u>Pending issues</u>**	
16.00 – 17.00	**Panel retrospective and preparation of final judgement**	
17.00 – 17.30	**Panel feedback to all invited by the VKI**	

Approach

Selection of the delegations / the auditees
In compliance with the NVAO regulations the audit panel decided on the composition of the delegations (auditees) in consultation with the course management and on the basis of the points of focus that had arisen from the panel's analysis of the course documents prior to the audit.

An 'open consultation session' was scheduled as part of the site-visit programme. The panel verified that the scheduled times of the consultation session had been made public to all parties involved in the school community correctly and timely. No students or staff members attended the open consultation session.

During the site-visit the audit panel members spoke randomly to students and reviewed a number of additional theses.

Audit procedure
The following procedure was adopted. The panel studied the documents regarding the programme (Annex II: Documents reviewed) and a number of theses. The panel secretary organised input from the auditors and distributed the preliminary findings among the panel members prior to the audit. A preparatory meeting of the panel was held the evening before the site visit took place at the von Kármán Institute, on 30 January 2014 (Annex III: Programme of the site visit).

The panel formulated its preliminary assessments per theme and standard immediately after the site visit. These were based on the findings of the site visit, and building on the assessment of the programme documents.

The draft version of this report was circulated among the members of the panel for review and comments, and the final draft was subsequently forwarded to VKI to correct factual inaccuracies. The panel finalized the report on 16 April 2014.

Assessment rules

The assessment panel judges the standards in the assessment framework according to the following assessment scale: (i) excellent - (ii) good - (iii) satisfactory - (iv)unsatisfactory.

For a positive final conclusion regarding the programme, each theme must be judged as satisfactory. The assessment panels judge the themes in the assessment framework according to a two-point scale: satisfactory or unsatisfactory. The assessment of a theme in the assessment framework is based on the assessments of the separate standards of that theme.

The assessment panel has to demonstrate clearly how the assessment of the different standards led to its final conclusion concerning that theme. In other words, the panel has to clarify how – given the criteria in this accreditation framework and the reference framework employed – it has arrived at its assessment of a theme on the basis of the analyses of the underlying standards.

In its final conclusion regarding the quality of the programme, the assessment panel needs to indicate how its conclusions are based on facts, its analysis of the evidence and its assessment of the programme on the basis of this accreditation framework and the reference framework employed. In its final conclusion regarding the programme, the assessment panel indicates whether, based on the standards in the assessment framework, sufficient generic quality
standards are in place to warrant a positive final conclusion regarding the programme.

With respect to programmes comprising various modes of study, as referred to in Article 59 of the Flemish Higher Education Act, a final conclusion can only be positive if the assessment shows that sufficient generic quality standards are in place for each mode of study.

ANNEX IV Documents reviewed

- Self Assessment Report
- Organization chart of VKI
- Set of final qualifications and Competency matrix
- Vision document on Education and Research
- Student Information Booklet and 2013-2014 diary
- Course programmes design
- Course schedule
- Course descriptions
- Resumes of faculty staff
- Minutes of meetings – Educational Committee, Assessment Committee
- Schedule of PET meetings and public presentation meetings
- Grading procedure final ET and Public Presentation
- Course Regulations 2012-2013
- Course Evaluations and summaries of student questionnaires
- Report on VKI alumni enquiry
- A cross-section of interim-exams
- Overview of graduates of recent years
- A random sample of 9 theses taken from the survey of graduates provided by the courses. The sample included the following theses[2]:

Student no.
10592
10173
10308
10444
10119
10579
10415
10177
10569

- A random selection of the remaining theses that were at display in the audit. In all, at least 15 theses were reviewed.

[2] For the sake of privacy only student numbers are indicated; names are known to the secretary/coordinator of the panel.

ANNEX V Overview of audit team

Panel composition and succinct resumes

Composition and expertise of panel members

Panel members	Expertise					
	audit/QA	education	professional field	course content	international	student affaires
Prof. Em. M. (Maurizio) Pandolfi, chair	x	x		x	x	
Prof. Dr. Ir. G. (Gijs) Ooms, expert member	x	x		x	x	
Ir P. (Peter) De Swert, expert member			x		x	
Y. (Yuri) Durodié, student member						x

H.R. (Rob) van der Made Secretary/co-ordinator	X	X				
NVAO certified on	31 September 2010					

Succinct CVs of panel members

1	Mr Pandolfi has been Emeritus Professor at the Politecnico di Torino in Italy since 2012. He is an internationally renowned expert in the field of fluid dynamics and has years of experience in managing and evaluating research and education.
2	Mr Ooms is a full professor at the Technical University Delft, the Netherlands. He is scientific director at the J.M. Burgerscentrum and scientific director of the Centre for Fluid and Solid Mechanics.
3	Mr De Swert was the Executive Vice President of KLM Engineering & Maintenance until he retired in 2012. He has an extensive career in aviation science and engineering.
4	Mr Durodié studied engineering sciences at the Vrije Universiteit Brussels (VUB). He is currently taking his Master of Science degree at the same university.

The panel of experts was endorsed by the NVAO on 27 January 2014.

All panel members signed a statement of independence and confidentiality, which is available at the NVAO upon request.

Strategische dienstverlener voor kennisintensieve organisaties

Hobeon

Lange Voorhout 14
2514 ED Den Haag

T (070) 30 66 800
F (070) 30 66 870

E info@hobeon.nl
I www.hobeon.nl