

## Measuring performance of applied R&D

A study into performance measurement of applied R&D  
in the Netherlands and some other countries

*Report for the Center for Science and Technology Studies (CEST)*

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# 1 Introduction

## 1.1 Background information

The Swiss Centre for Science and Technology Studies (CEST) has asked CHEPS to make a report on the experiences with the measurement of research performances in the applied R&D. CEST is particularly interested in the performance measurement of applied research in the professional higher education sector. This study addresses this issue in depth for the Netherlands and in a broad perspective for a number of other countries.

With regard to the Netherlands the issue of applied R&D has substantially gained importance in universities of professional education (*Hogescholen* or HBO-institutions) with the appointment of “lectors” since 2001. These “lectors” are to stimulate research at the HBO-institutions and the valorisation of knowledge between HBO-institutions and business. “Lectors” as such can be regarded as a sort of professors. They are appointed at “lectorates”, which are comparable to university “chairs”. In some cases, more “lectors” can be appointed at one “lectorate”.

Though within the university sector performance measurement has a longer history, performance measurement of applied research in the non-university sector is an area that is currently being developed in the Netherlands. With the position of “lectors” at the HBO-institutions, research is a relatively new type of activity at these institutions. This means that experiences with performance measurement of applied research is not fully crystallised yet and often consists of a direct translation of academic research quality evaluation methods. This is partly logical because part of university research also consists of applied research which is also addressed in the official research evaluation systems. However, many governments increasingly emphasise the social relevance of research and stronger university-industry relationships. As a result one can identify greater interest in the specific instruments required to address the peculiarities of applied R&D within research evaluation mechanisms.

## 1.2 Methodology and structure of this report

This study is mainly based on a literature review and participation in the working group discussions of an experiment to set up a quality monitoring system in a few Dutch HBO institutions. It provides an introduction into research performance measurement in the Netherlands in general (Chapter 2) as well as a more elaborate discussion on the current developments towards a research performance measurement system for the Dutch HBO-institutions (Chapter 3). The focus is on the methodological aspect of developing indicators for applied R&D performance measurement.

In addition, international experiences with research performance measurement are briefly summarised in Chapter 4 with a special focus on applied R&D. The countries involved are Australia, Germany, New Zealand, Norway and the UK. This comparison offers several interesting perspectives and indicators that can also be useful for the evaluation of applied research. The conclusions of this study are presented in Chapter 5.

## 2 Monitoring research performance in the Netherlands

In the Netherlands research performance is monitored and presented in a range of ways. Such information is made available by means of general statistics on the Dutch R&D sector and higher education, but also as a way to describe the innovative capacity of the Dutch economy. A final source of information is formed by the monitoring and evaluation of university research through the periodical disciplinary research evaluations. More recent is the extension of these latter disciplinary research evaluations to the recently established “lectorates” that specialise in conducting and disseminating applied research. In the following sections, the longer existing general frameworks of research performance measurement will be addressed.

### 2.1 General statistics on R&D and economic competitiveness

Research and Development (R&D) is monitored by several institutions in the Netherlands. Most of the reports are at national level and have an ad-hoc character without real systematic data collection. According to the Frascati Manual (2002; 30) R&D covers three activities; basic research, applied research and experimental development. Most evaluations and reports in this area do not differentiate between these different R&D activities. Thus applied R&D is not made explicit in such reports and such reports generally focus on R&D carried out by universities or business. As research in HBO-institutions is relatively new it is not yet included in such reports. In addition, output indicators generally are on the national or university level and focus mainly on citation scores, patents, funding and expenditure.

#### *The Netherlands Observatory of Science and Technology (NOWT)*

The NOWT is an important organization in publishing R&D statistics in the Netherlands. Since 1994 it has published six “Science and Technology Reports with the latest in 2005. This report uses data from different sources (CBS, Eurostat, OECD) in order to show the Dutch situation and make international comparisons. The indicators used in the latest reports are: R&D personnel, R&D expenditures and financing, bibliometrical data, patents and patent applications, start-up and spin-off companies originating from universities or other public knowledge institutes and the so called technostarters.<sup>1</sup> The indicators compare several groups of institutions: business, universities and other knowledge institutes; business sectors; universities; disciplines etc. The reports furthermore present data on the use of scientific knowledge by business. Scientific output data are generally based on ISI statistics and consist of publication outputs of universities and business and citation impact scores per university (in general and per discipline).

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<sup>1</sup> Technostarters are starting or young companies which are knowledge intensive. They can be entrepreneurs or students or staff members from a university who wish to establish their own, technology-based firm (Rietveld 2004, [www.technopartner.nl](http://www.technopartner.nl)).

### *Central Statistics Agency (CBS)*

The CBS is the national statistics agency for the Netherlands which participates in the Community Innovation Survey (CIS) conducted by EUROSTAT in association with the national statistical agencies. Among other things, CBS annually publishes the report “*Kennis en Economie*” (Knowledge and Economy) which focuses on innovation in the Netherlands. This includes indicators in the areas of:

- Innovation,
- Percentage of innovative products (new or highly improved products),
- Business R&D- intensity (this is the expenditure on R&D as a percentage of the added value of the branch of industry),
- Financing and expenditures

### *Ministries*

The Ministry of Education, Culture and Science and the Ministry of Economic Affairs both publish information on research and innovation performances in the Netherlands. They use several performance-indicators for the knowledge society as a whole, like:

- Proportion of innovative companies that received patents in the previous 3 years
- Number of European patents, per million inhabitants in the labour force
- Total realised turnover of technostarter companies in the TechnoPartner-programme
- Results from clients’ satisfaction surveys
- Proportion of medium sized businesses that have a cooperation contract with TNO (a major national technological research centre) as a result of ministerial subsidies
- Number of cooperation projects among innovative companies or with knowledge institutions, like research organisations and universities

## **2.2 Evaluation of university research performance**

Another existing monitoring system of research performance measurement concerns the national university research evaluation system run by the Association of Dutch Universities (VSNU). This is a mixture of peer review and self-evaluation, where once every 5 years universities per discipline have to conduct a self-evaluation followed by a site visit of an external evaluation committee. During these research assessments (*onderzoeksvisitaties*) the review committee examines the quality, productivity, relevance and vitality of the research of a university faculty. According to the Standard Evaluation Protocol 2003-2009 for Public Research Organisations the main criteria to be used in the evaluation are:

- Quality (international recognition and innovative potential)
- Productivity (scientific output)
- Relevance (scientific and socio-economic impact)
- Vitality and feasibility (flexibility, management, and leadership).

The productivity criterion uses quantitative indicators like academic staff numbers, number of PhDs conferred and bibliometrics (publications and citations). In some cases technometrics (largely concerned with patents and citations of patents) or sociometrics (concerned with socio-economic performance or embedment of research) can be applied.

In recent years there is a tendency to not only review the research but also the management, strategy and mission of the faculty. With regard to this broader approach

the sci-Quest method is seen as an interesting approach. The method attempts to assess the academic and societal impact as well as the networking function of the research done in a specific unit. This method has already been used as an extra element in RPM for a few university faculties.

Finally, the VSNU collects general data regarding university research, including:

- The deployment of scientific personnel, the type of funding, the university profile and its broad category of disciplines
- The output of research, like dissertations, scientific publications and disciplinary publications
- Information on how many PhD-places are created and how many PhD's are completed.

#### *Indicators for specific fields*

The Royal Netherlands Academy of Arts and Sciences (KNAW) published a report by their Council for the Humanities and the Social Sciences Council in 2005<sup>2</sup> which aimed at creating a specific evaluation method for the humanities and social sciences. In order to evaluate research in the public domain the report said that one has to realize that:

“research fields differ with respect to research issues, methodologies, target groups and communication patterns. Research evaluations therefore have to be tailor-made. Evaluation standards are required which are based upon the current or desirable forms of communication within disciplines. The great variety of the target groups and, consequently, of the most appropriate communication means, needs to be recognized, following the mission of the humanities and the social sciences.”

With regard to the indicators that are being used for current evaluations the Council's report stated that:

“one can conclude that the evaluation of research activities in most fields in the humanities and the social sciences cannot be based on simple and uniform bibliometric indicators, and certainly not only on journals in English.”

The report sketches a framework for an evaluation method for research in the humanities and the social sciences and gives a tentative list of target groups and indicators. These lists closely resemble the ones in use by the sci-Quest method which will be discussed in the next chapter.

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<sup>2</sup> KNAW (2005) Judging research on it's merits, An advisory report by the Council for the Humanities and the Social Sciences Council  
[http://www.knaw.nl/cfdata/publicaties/detail.cfm?boeken\\_\\_ordernr=20051029](http://www.knaw.nl/cfdata/publicaties/detail.cfm?boeken__ordernr=20051029)

### 3 Measuring performances of applied R&D in Dutch HBO-institutions

The Netherlands has a binary system with two distinct types of higher education. The first sector comprises 13 academically oriented universities. The second sector concerns universities of professional education (*hogescholen* or HBO-institutions) that offer more practically oriented study programmes leading towards professional careers (Nuffic Glossary). There are 44 HBO-institutions, some of which are general multi-disciplinary institutions and some of which are institutions specializing in one of the seven sectors of higher professional education:

- agriculture,
- engineering and technology,
- economics and business administration,
- health care,
- fine and performing arts,
- education (teacher training),
- social welfare.

As the HBO-institutions primarily focus on professional education, their programmes particularly prepare students for particular professions. In addition to lectures, seminars, project work and independent study, students are required to complete an internship or practical period (stage) in the later stages of their studies, as well as a final project or a major paper in the final year.

Research in the HBO-institutions only seriously came off ground with the appointment with “lectors” at the HBO-institutions as from 2001 onwards. A lector occupies a chair at a HBO, called a “lectorate”. Lectors are aimed at forming knowledge networks, called *kenniskringen*. Lectors have four formal tasks (Covenant 2004):

- Improvement of the external orientation and exposure of the HBO-institutions,
- Curriculum innovation,
- Professionalisation of lecturers,
- Strengthening knowledge development (research), circulation and dissemination.

Lectors carry out applied research in a specific area of expertise and maintain contacts within the relevant branch of industry. Within the knowledge networks lectors play a central role in the dissemination of knowledge by interacting with industry, lecturers, students and other scientist. HBO-institutions allow their lectors to refer to themselves as 'associate professor' in international contexts, or even 'professor' if their own executive board allows them to do so (Nuffic Glossary). But it must be mentioned that lectors officially cannot be called professors. Their official title remains “lector” and their core working unit remains called a “lectorate”.

One nowadays can find lectors and lectorates in all seven sectors of higher professional education. Agriculture has the least lectorates of all sectors, namely 11; social welfare has 18; health care 19; education and fine and performing arts both 29; economics and business administration 33 and finally technology 34. There are also 58 additional lectorates that cover several sectors.<sup>3</sup>

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<sup>3</sup> This information comes from the database on lectorates which can be found on the internet on [www.lectoren.nl](http://www.lectoren.nl). (in Dutch)

From 2001 onwards the number of lecturers steadily increased and in 2005 there were 219 lectorates with 258 lecturers appointed. There are currently 40 HBO-institutions who have at least one lectorate. Thus only 4 HBO-institutions have none. The creation of lectorates was implemented by a covenant between the Ministry of Education, Culture and Science and the Council of the HBO-institutions (*HBO-raad*). This covenant stated that lecturers had to be evaluated in 2004.

Since 2002 a number of evaluation activities took place which will be discussed in the following sections.

### 3.1 A first evaluation by the HBO-Council in 2004

In 2002 an instrument was developed for the first formal evaluation of “lectorates” and “lecturers” at institutional level in 2004. The evaluation was carried out by the Council of the HBO-institutions (HBO-Raad, 2004). The indicators to assess the operation of lectorates within the HBO-institutions were grouped in four categories. The HBO-institutions were asked to what extent they were satisfied with the operation of their lectorates.

#### *Position in the knowledge infrastructure*

- Number of joint activities with other knowledge institutions
- The nature of such joint activities
- The number of jointly developed products and services
- The quality of these products and services

#### *Inputs from society and economy (embeddedness in the knowledge infrastructure)*

- Number of joint activities with businesses and other organizations
- The relative size of external revenues generated
- The number of jointly developed products and services with businesses and other organizations
- Recognition and appreciation of the social relevance of education and research (outside support to help the professionalisation and standardization of lectorates)

#### *Contribution to the economy and society in general*

- Number of products and services that satisfy the needs of companies (research results, methodologies, and other knowledge products)
- The quality of these products and services
- The appreciation by clients
- External exposure (e.g. publications, lectures, key notes)
- The quality of these types of external exposure

#### *Contribution to teaching*

- Number of study programmes that are addressed by the lectorates
- The contributions to curricular innovations
- The nature of the contributions to curricular innovations
- Contribution to the external orientation of study programmes
- The nature of this contribution to the external orientation of study programmes
- Number of teachers in the knowledge circle (network of the lectorate)
- The rate of involvement of the knowledge circle in teaching activities
- The rate of involvement of students in the lectorate.

Based on survey results, in which HBO-institutions scored the functioning of their lectorates on these indicators, it was concluded that the scores were often a bit lower than the target scored defined beforehand. This however was not regarded a problem as the lectorates were still relatively young. The evaluation showed that the lectorates are developing rapidly and thus are a viable and valuable contribution to the work of the HBO-institutions.

### **3.2 The SKO evaluations in 2003 and 2004**

In 2003 a commission was installed by the Association for Knowledge Development HBO (SKO-HBO) to evaluate the 18 lectorates that operated for at least 1.5 years by mid 2003. Unlike the HBO review that addressed the institutional level, the SKO review focused at the level of the individual lectorates and the evaluations took place in the end of 2003 (SKO, 2004). The evaluations had a more qualitative nature in which many different aspects of the lectorates were discussed and some recommendations were made. We will briefly discuss the main themes and conclusions.

#### *The concept of lectorates and regulations*

In general the concept of a lectorate and its related knowledge network are very well received in practice. All regulations embedding the lectorates seem to operate well too. Nevertheless the expectations are sometimes unrealistically high considering that they were established only recently.

The financial contributions of the HBO-institutions to the lectorates are still considered too limited, but in cases where it is substantial, the lectorates seem to be better embedded within the institution.

To increase the impact of lectorates, the number of lectorates should be increased as well as their research orientation should be strengthened.

#### *The objectives of the lectorates*

The objectives of curricular innovation, professionalisation of teachers, knowledge circulation & development (research) have not been addressed equally by any of the lectorates. Most particularly focus on one or a few of these objectives, based on the own preferences of the lecturers. The commission stressed that in general the research function should be intensified.

#### *Knowledge innovation and –circulation*

Regardless the lecturers' ambitions in the direction of research, most still concentrate on the application of existing "innovations" to the practice of teaching, without the production of new practice oriented knowledge. As such lectorates are not yet fully embedded in the Dutch knowledge infrastructure. Except for the cooperation with local and regional authorities, lecturers still have a long way to go in setting up joint activities with business and universities.

#### *The introduction and functioning of the lectorates within the HBO-institutions*

Most of the lectorates that were evaluated were just recovering from their first practical start-up problems. Their roles within the HBO-institutions often were not fully clear which particularly led to practical problems. This was partly related to the fact that the lectorates were still largely oriented on teaching rather than research. Also the competences of the participating teachers were often very limited in the area

of research. However, most lectors made serious efforts to change into the desired direction.

Shortly after the first round of evaluations, 30 more lectorates were included in a follow-up evaluation in 2004. This follow-up review particularly focused on providing information on the development of the lectorates and to get into a serious dialogue with the lectors about their function (SKO 2005: 20). The main positive conclusions from the evaluation were that:

- There is a growing acceptance of the lectorates
- The number and critical mass of lectorates is growing rapidly
- The professionalisation of staff increases
- Lectorates are stronger embedded within the institutional strategy
- Lectorates are involved in curricular development
- Lectorates recruit enthusiastic and competent staff

The major problematic areas of the lectorates concerned:

- Most lectorates still have uncertainty about their future
- Human Resource Management policies are not yet adjusted
- At most lectorates research is still in its infancy
- Cooperation with companies, other institutions and universities is still poor
- The revenues from contract activities are still below expectations

The major conclusion in view of this study is that the research function of lectorates is still underdeveloped. They first build their expertise base before going on to the research market. But research carried out to a large extent is of a practical nature and different from fundamental university research. There is serious need for a quality assessment of this type of research.

Based on this evaluation, the commission formulated a number of critical success factors for lectorates:

1. Lectors are main external representatives of the HBO-institutions and as such need institutional financial support
2. The lectorates should make part of the central institutional strategy
3. The lectorates should be based on a thorough internal and external analysis of the innovation needs in teaching and external organizations (companies)
4. Members of the knowledge network should have a part time appointment within the lectorate.
5. The lectorate should be intensively involved in curriculum development.
6. Teachers should be professionalized in the area of research.
7. The lectorate should connect its research activities to that of national and international partners.

### **3.3 Preparation of the 2008 evaluation of the lectorates**

Overall the evaluations were positive and the ministry and the HBO-Raad renewed the existing covenant in December 2004. In this covenant the importance of the lectors was stressed and the funding increased to strengthen the position of the current lectors and create more lectorates. The covenant states that the lectorates should be seriously evaluated in 2008. For this reason the SKO is developing an instrument which includes quantitative indicators to also measure the efficiency and effects of the lectorates. For this, a first zero-measurement has taken place in 2005 (Consort, 2005). The next step

in the process, in the first half of 2006, will be a refinement of the indicators by the lecturers themselves. After a final approval of the SKO these indicators will be used by the Ministry and the HBO-Raad for the 2008 evaluation. So far the indicators developed are (Consort, 2005):

- Number of knowledge institutions with which intensive knowledge exchange takes place
- Number of guest lectures at other knowledge institutions
- Number of projects carried out for other knowledge institutions
- Number of joint research projects other knowledge institutions that have been started by the lectorate
- Number of research projects that are co-financed by other knowledge institutions
- Number of professional networks in which the lectorate participates
- Number of conferences organized by the lectorate
- Number of presentations given at conferences, seminars, etc.
- Number of branche organizations with which intensive knowledge exchange is taking place
- Number of medium sized and large companies with which intensive knowledge exchange is taking place
- Number of small-sized companies with which intensive knowledge exchange is taking place
- Number of (semi-public and public) institutions with which intensive knowledge exchange is taking place
- Number of projects for companies and institutions
- Number of joint research projects with companies or institutions
- Number of research projects that are co-financed by companies and/or institutions
- Number of projects that are initiated by the lectorate itself?
- Number of external persons that through the lectorate is involved in teaching activities
- Publications of lector himself or as second author
  - Scientific
  - Professional
  - Popular
- Number of graduation theses started at the lectorate
- Number of graduates at the lectorate
- Number of students that did a practical period through the lectorate
- Number of PhDs in which the lector is involved as promoter
- Number of graduates that got a job appointment at an organisation with which the lectorate closely cooperates

### **3.4 The Sci-Quest monitoring system: an experiment at Hogeschool Utrecht**

The Hogeschool Utrecht (HU) is a rather large university of professional education which currently has 22 lectorates in five of the seven HBO-sectors: social welfare, health care, education, economics and business administration and technology. The HU perceives quality assurance of the lectorates not only as a system-wide responsibility to be carried out by the HBO-Raad or the SKO, but as a responsibility for individual institutions as well. The responsibility for individual institutions is an important aspect of the upcoming new Higher Education law in the Netherlands. For this reason the HU decided for a self-initiated evaluation of its lectorates and installed

a special commission to guide this process (Van der Wende, 2005). The goals of the evaluation are as follows:

- To give further direction to strategic goals on the domain of knowledge circulation and research. The evaluations are to give policy and management information about the effectiveness, quality and content of the lectorates.
- To enable lecturers to develop a professional identity (standards, practice & ethics) in order to establish a position and acquire recognition in the professional field.
- To give faculty management instruments and a framework to govern and facilitate the development of lectorates.

The evaluation uses an approach which targets the further development of the lectorates within the institutions looking both at the organisation and the lecturers as professionals. From this perspective, the HU considers it crucial to involve the lecturers themselves in this evaluation.

The executive board of the HU has stressed that the lectorates play a key role in the applied research function of the HBO. Research by lectorates can be classified as Mode 2 research which focuses on knowledge that is created through networks and aims at direct use and applicability (Gibbons et al, 1994). To evaluate this type of research the HU will use a combined method of peer & stakeholder review preceded by a self evaluation. The peer review carried out by an “extended peer group” will give information for management and policy purposes and will give the lecturer the opportunity to compare himself with peers. To assess the relevance and applicability of produced knowledge various stakeholders will be involved. The peers will consist of other lecturers and professors from Dutch or foreign higher education institutions. The stakeholders will represent the relevant sector of the lecturer and can for example be a colleague, client or an intermediary. The stakeholders will preferably come from the geographical region of the HU. The evaluation will focus on the contribution of the research to both teaching and stakeholders. Two other HBO-institutions have shown interest in this procedure and are willing to participate (Van der Wende, 2005).

The executive board and the lecturers of the HU have decided to use the sci-Quest method for their evaluation and to adjust this method for the specific situation of the HU. The sci-Quest method is developed by Jack Spaapen and Frank Wammeling<sup>4</sup> and is described in more detail in (Spaapen et al. 1999). The method has been used several times in the university sector. The method is now in the process of being adjusted to the more applied nature of research in the lectorates. The traditional sci-Quest method uses four “building blocks” or phases (HU, 2006):

- First a self-image of the research group will be created. This shows the domains in which the research group is active and how it thinks it is performing. Then the strategy of the research group is described and measurable goals that result from this strategy are formulated.
- Secondly, for each domain a variety of quantitative and qualitative indicators are developed and calculated. The Research Embedment and Performance Profile (REPP) will graphically represent the profile of the research group based on these indicators for the different domains.
- Thirdly the stakeholders and customers will be surveyed.
- Finally the findings will be reported and confronted with the self-image defined above.

In order to develop assessment criteria to evaluate research, the Sci-Quest method makes a distinction into different areas of work and impact (called “domains”) of the units under assessment. After a series of consultations the sci-Quest method has

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<sup>4</sup> See <http://www.xs4all.nl/~jbspaa/>

defined the following 5 domains for analysing the work of “lectorates”: network formation; professional practice; teaching and education; science; and administration and policy. For each of these domains a number of assessment criteria has been developed. The basis for the indicators is that they not only map the reputation and certified research, but that they will include:

- Science in action
- Research in context of application
- Knowledge circulation
- Knowledge production in different social domains
- Problem solving
- Participation in innovative networks

The REPP will be based on indicators that focus on the one hand on communications and interactions with the active domains (embedding) and on the other hand on the impact and use (performance) of the lectorate’s products. The criteria that have been selected within the five domains are (HU, 2006):

#### *Network formation*

- Number of cooperation relationships (consortia)
- Quality of such relationships
- Involvement of end users in defining the research program

#### *Professional practice*

- Number of professional publications (articles in professional journals, magazines and newspapers; books, book chapters, internet publications, policy papers, research reports, etc.)
- Knowledge products for the professional practice or business (patents; contributions to the operation and research of businesses; product design; commissioned reports, development of production methods, products and research methods, etc.)
- Formal policy and advisory functions for professional organisations and enterprises
- Contribution to the knowledge and skills within professional organisations and businesses (number of courses, in company training, lectures, presentations, etc.)

#### *Teaching and education*

- Contribution to quality improvement of teaching:
  - Development of a vision on the professional profile
  - Integrate actual practice and international standards in the education program
  - Contribution to the development of accredited master programs
  - Provide a research element in education programs
  - Promote (international) mobility of teachers
  - Promote competence development of teachers
  - Develop learning paths for excellent students
  - Contribution to special quality elements that are recognised by the National Accreditation Authority (NVAO)

#### *Science*

- Number of publications in “refereed journals”
- Research competencies of staff (number of staff with a promotions)
- Collaboration in research with scientific institutions
- Research funding allocated according scientific criteria

- Contributions to scientific education programs and conferences (program development, guest lectures, invited lectures, conference papers and workshops)

#### *Administration and policy*

- Contributions to policies of governmental and societal organisations and public debates (through presentations, (commissioned) reports, etc.)
- Formal governance and advisory functions in policy and public (memberships of advisory councils, interest groups, governance boards, etc.)

### **3.5 Synthesis**

The research at the HBO-institutions has been stimulated by the creation of lectorates since 2001. The research carried out by these lectorates is mostly of an applied nature. Next to conducting research, the lectorates also have other functions, like the innovation of curricula (through integrating more research) and the dissemination of knowledge. The evaluations of the lectorates, and thus also the research at the HBO-institutions, so far have recognised that the lectorates have been in their start-up period. Therefore the evaluations particularly addressed the issue of the stage of development of research at the lectorates, rather than the actual content and quality. They indicated that the research function of the lectorates was not yet fully developed. However, based on the preliminary evaluations, the need for a quality assessment of the lectorates' applied research is needed.

At the moment there are two processes towards the development of an assessment framework for applied research carried out by lectorates. One is a national evaluation of all lectorates planned for 2008. The SKO is currently developing a set of quantitative and qualitative indicators for this. The indicators that are currently being proposed particularly look at the different positions lectorates take with regard to various stakeholders, like policy, academe and business. As such these indicators address various aspects of the knowledge networks of lectorates. With respect to the evaluation of the applied nature of the research conducted by lectorates, we can point indicators being developed that express the professional orientation of lectorates: presentations at conferences, guest lectures, externally funded projects, publications in professional magazines and graduates. In the 2004 SKO evaluation it was recognised that the differences between the sectors could lead to problems of comparability. This has not yet resulted in field specific indicators for the different sectors, but one can imagine that lectorates therefore are particularly compared to lectorates within the same discipline.

The second process concerns the self-initiated evaluation by the Hogeschool Utrecht using the sci-Quest method. This method is currently being adapted for an evaluation of the 22 lectorates at this HBO. The indicators that are currently being discussed focus on the performance and contacts in each relevant domain: network formation; professional practice; teaching and education; science; and administration and policy. The interesting part of this method is that it encompasses a variety of possible products of applied research for each domain. There are no indicators for specific disciplines in this evaluation method yet. The HU does not have any arts or agricultural lecturers so these sectors are not in this evaluation at all.

Altogether, the evaluation of applied research at HBO-institutions is being developed into a more mature type of assessment where traditional academic evaluation criteria are extended with more professionally oriented indicators. In addition, the indicators also aim to address the importance of the knowledge networks

and the impact of research. This approach gives some interesting reference points for measuring applied R&D.

## 4 Research performance in other countries

This chapter provides an international comparison of research performance indicators. The comparison is primarily based on general performance measurement of university research and not so much on applied research or research in non-universities specifically. Nevertheless general performance measurement systems can have some interesting links to applied R&D. The indicators with an asterisk (\*) are possibly interesting indicators for applied R&D. This part of the report is derived from earlier research done by CHEPS. The information was updated with special attention for output indicators used to measure applied R&D. The countries under study are Australia, Germany, New Zealand, Norway and the United Kingdom (UK).

### 4.1 Australia

The reporting of research output is part of the accountability framework in Australian higher education. Research outputs are reported by universities in Research and Research Training Management Reports (RRTMR). The RRTMR reports provide the following measures of research performance which may be interesting for applied R&D:

- research income
- active research staff
- number of staff who generated research income
- number of staff who generated publications
- number of staff eligible to supervise higher degree by research (HDR) students
- number of staff who supervise HDR students
- number of areas of research strength \*
- HDR students<sup>5</sup> and HDR commencing students in areas of research strength
- HDR supervisor characteristics
- commercialisation activities in Australian universities and controlled entities \*
- data on the stock of patents held by Australian universities and/or their controlled entities (Australian patents and overseas patents) \*

The Higher Education Research Data Collection (HERDC) is a database in which performance data on Research Income and Research Publications is collected. These data are used to allocate performance based funds to universities. The data on research income shows all income generated by universities and its controlled entities. This income is categorized in three groups: competitive government grants, other public funding and industry and other non-public funding. The HERDC has four categories of research publications, each having a weight:

- Books, authored research (5)
- Book chapters (1)
- Articles in scholarly refereed journals (1)
- Full written conference papers – refereed proceedings (1) \*

The results of the 1999 Knowledge and Innovation (K&I) reforms were evaluated in 2003/2004 by an External Reference Group chaired by Chris Fell.<sup>6</sup> This evaluation

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<sup>5</sup> Higher Degrees by Research students are students working towards Masters degrees or Doctoral degrees. Doctoral degrees fall into two categories, PhDs and Professional Doctorates.

indicated the need to focus on the quality of research outputs. The amount of publications as a funding mechanism has received criticism by stakeholders, who often cite the findings of Linda Butler (2003) that a rise in the number of publications has been accompanied by a significant decline in citation impact.

Interesting from an applied R&D perspective is that in 2003 the Coordination Committee on Science and Technology (CCST) established the Working Group on Metrics of Commercialisation (WGMC). This Working Group had the task of developing a set of metrics of commercialisation to position member agencies/departments to provide a consistent approach to measure the benefits from science and technology investments. The working group concluded:

*“Current metrics emphasize the commercialization of intellectual property (IP), especially through patents, licenses and spin-out company formation. These data capture only a small portion of the commercially significant interactions that take place between the publicly funded research sector and private enterprise (i.e. including current and emerging business). The WG proposes that the metrics be expanded to include measures relating to research consultancies and contracts, and the development and deployment of appropriate skills.”* (WGMC 2005: 4).

The table below shows the set of potential metrics the WGMC proposed to use based on its analysis of metrics already in use in Australia and other countries, as well as those suggested in submissions. The WGMC selected a core group of metrics from which agencies and institutions can further develop more detailed metrics that meet their own strategic goals. (WGMC 2005: 16-17)

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<sup>6</sup> See: [http://www.dest.gov.au/highered/ki\\_reforms/default.htm](http://www.dest.gov.au/highered/ki_reforms/default.htm).

**Table 1: Matrix of research commercialization metrics**

Main data groups	Supply side: Publicly Funded Research Sector		Demand side: Business & Community	
	Inputs/ Activities	Outputs/ Deliverables	Intermediate Outcomes	Final Outcomes
<b>Intellectual Property</b> (identification, protection, transfer, exploitation)	<ul style="list-style-type: none"> <li>Patent Applications (including Plant Breeders Rights) &amp; Patents Issued (No.)</li> <li>Invention disclosures (No.)</li> <li>Commercialization Staff (No. &amp; Costs)</li> <li>Commercialization Administration (Cost)</li> <li>IP policies &amp; practices (Documented &amp; Applied)</li> </ul>	<ul style="list-style-type: none"> <li>Licenses, Options, Assignments (No. &amp; Value)</li> <li>Royalty agreements (No. &amp; Value)</li> <li>Pilots/ Prototypes/ Clinical Trails (No.)</li> <li>Client relations (No. of contacts/ interactions)</li> </ul>	<ul style="list-style-type: none"> <li>Gross revenue from licensed technology</li> <li>New products, services or business processes</li> <li>Start-ups/ Spin-outs (No., capitalization &amp; revenue)</li> <li>Joint Ventures (No., capitalization &amp; revenue)</li> <li>Initial Public Offerings (No., &amp; capitalization)</li> <li>Venture capital deals (No. &amp; value)</li> </ul>	<p>Changes in:</p> <ul style="list-style-type: none"> <li>GDP</li> <li>investment</li> <li>employment</li> <li>exports</li> <li>health outcomes</li> <li>environmental outcomes</li> </ul> <p>That can be reasonably linked to research commercialisation on intermediate outcomes (using econometric analyses and studies).</p>
<b>Research Contracts &amp; Consultancies</b>	<ul style="list-style-type: none"> <li>Research contracts (No. &amp; Gross Revenue)</li> <li>Consultancies (No. &amp; Gross Revenue)</li> <li>Joint Ventures (No. &amp; Capitalization)</li> <li>ARC Linkage Projects (No. &amp; Value)</li> <li>Administration (Cost)</li> </ul>	<ul style="list-style-type: none"> <li>Reports (No.)</li> <li>Publications (No. &amp; type)</li> <li>Conferences/ Seminars (No. &amp; attendance)</li> <li>Client relations (No. of contacts/ interactions)</li> <li>standards &amp; best practices</li> </ul>	<ul style="list-style-type: none"> <li>Business expenditure on R&amp;D (BERD) in the public sector (Quantum &amp; % of total BERD)</li> <li>Repeat business (% of contracts with previous clients)</li> <li>Flow-on business (No. of clients who become patent licensees and/or partners in JVs, spin-outs etc)</li> </ul>	
<b>Skills Development &amp; Transfer</b>	<ul style="list-style-type: none"> <li>Commercialization &amp; entrepreneurial training for researchers (No. of courses offered, No. of graduates)</li> <li>Scientific &amp; research training for Industry (No. of courses offered, No. of graduates)</li> <li>Course design - industry input &amp; endorsement (No. of postgraduate courses with industry input to design and/or industry endorsement)</li> </ul>	<ul style="list-style-type: none"> <li>Research graduates employed in industry (No. &amp; % of total cohort)</li> <li>Industry funded postgraduate places</li> <li>Staff exchanges (No. of Researchers to industry; industry to research sector)</li> <li>Research student placements in industry (No.)</li> </ul>	<ul style="list-style-type: none"> <li>Industry sector satisfaction with quality of research graduates</li> <li>New practices</li> <li>New products/ services</li> <li>Research postgraduate income</li> <li>Research postgraduate Start-ups &amp; Spin-outs</li> </ul>	

## 4.2 Germany

By and large, the use of explicit performance indicators has only started recently in the German research system. Research performance indicators in use in Germany are usually the indicators used for the OECD. The Deutsche Forschungsgemeinschaft (DFG) has commissioned a study<sup>7</sup> on the development of performance indicators. The results of this study are expected in September 2006. Since 1997 the DFG produces university rankings on the basis of DFG grant criteria and a wide array of other criteria. Performance indicators used in this ranking only address the university level and include the following:

1. Number of DFG approved grants in the past three years
2. Number of professors
3. Number of scientists and academics in total
4. Total third party funding \*
5. Centrality in networks of DFG-funded coordinated programs
6. Number of DFG reviewers
7. Number of Alexander von Humboldt visiting researchers
8. Number of DAAD scientists and academics
9. Number of DAAD students/graduates
10. Participation in the European Union Framework Programs \*
11. Publications in international journals

The DFG is currently debating the merits of establishing a specific institute for scientific information (research information and quality assurance) which will be responsible for the assessment and quality assurance of the DFG's funded programs.

The Centre for Higher Education Development (CHE) has developed another classification system which collects and presents statistics on numbers of dissertations produced, bibliometrical figures (which are weighted), numbers of promotions in the preceding four semesters and numbers of patents (particularly for engineering) of universities. More specifically, concerning research this mechanism shows indicators for individual faculties at a large number of institutions including:

- Citations per publication
- Doctorates per professor
- Patents per professor
- Professors' judgment of the research situation
- Publications per academic
- Publications per professor
- Qualifications to teach at professorial level per 10 professors
- Third party funds per academic \*
- Third party funds per professor \*

The detailed methodology behind this system can be found at CHE's Internet website, <http://www.dashochschulranking.de/>.

## 4.3 Norway

In general, Norway has an extensive system of providing R&D statistics at the national level, also indicating innovativeness and competitiveness.

To allocate performance related research funds, publications are used to measure research output. Patents and other indicators of innovation and commercialisation are

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<sup>7</sup> [http://www.isi.fraunhofer.de/p/Projektbeschreibungen/us\\_performanz.htm](http://www.isi.fraunhofer.de/p/Projektbeschreibungen/us_performanz.htm)

considered to be used in the future. Performance measurement for this type of funding was only recently introduced in 2003. Publications will be weighted according to publication form (articles, monographs) and publication channel (scientific journals, series, web-sites and book publishers). Both international publications and those in Norwegian are included in these bibliometrical analyses. Some specified publication channels are given stronger weight than others to create incentives towards quality in different areas of research. The relative weights are presented below. The different levels (level 1 and level 2) are used to create incentives towards quality in different disciplines.

**Table 2: relative weights attached to publications**

Publication type	Level 1	Level 2
Scholarly books (ISBN)	5	8
Articles in series and periodicals (ISSN)	1	5
Articles in anthologies (ISBN)	0,7	1

The Norwegian Research Council (RCN) evaluates research and research institutions. To measure the relative performance of the scientific field / discipline and the individual research units and institutions, the following criteria are used:

- International publication in best journals
- International front position \*
- Originality of research
- Conceptualisation of own research within framework of public health research
- Total publication activity
- Success in academic training
- Relevance and influence of research – internationally, nationally \*
- Overall impression of a research group/institute

The RCN allocates competitive research grants to researchers, institutions, projects, networks, etc. Since there are many different applications for grants, the assessment criteria vary across application types. The criteria focus on quality, efficiency and goal achievement.

#### 4.4 New Zealand

The peer review system recently has faced some criticism in New Zealand. Applied research is said to be underrepresented in the peer review process:

*“The peer review panels applied the definition in a manner inconsistent with the Performance Based Research Funding (PBRF) Guidelines and, in particular, tended to give insufficient weight to applied research, ‘non-traditional’ (or non-mainstream) research outputs (such as performance), contributions to the intellectual infrastructure of subjects and disciplines (eg, dictionaries, translations and scholarly editions), New Zealand-oriented research, and research in the area of teacher education”* (PBRF-Issues 20-10-04: 4)

Therefore some categories were made more explicit and new categories of research output were included. The PBRF assessments now includes the following indicators on research outputs:

- Published academic work (such as books, journal articles, conference proceedings, and masters or doctoral theses)
- Work presented in non-print media (such as films, videos and recordings) \*

- Other types of outputs (such as intellectual property, materials, products, performances and exhibitions) \*

More specific research outputs thus include the following types (PBRF-2005: 42-43):

- Artefact/Object/Craftwork ) \*
- Authored Book
- Awarded Doctoral Thesis
- Awarded Research Masters Thesis
- Chapter in Book
- Commissioned Report for External Body \*
- Composition \*
- Conference Contribution\*
  - abstract
  - full conference paper
  - conference paper in published proceedings
  - poster presentation
  - oral presentation
  - other
- Confidential Report for External Body \*
- Discussion Paper \*
- Design Output \*
- Edited Book
- Exhibition \*
- Film/Video Intellectual Property (eg patent, trademark) \*
- Journal Article Monograph
- Oral Presentation \*
- Performance \*
- Scholarly Edition
- Software \*
- Technical Report \*
- Working Paper
- Other Form of Assessable Output (including but not limited to new materials, structures, devices, images, products, buildings, food products and processes, internet publication, published geological and/or geomorphological maps, and explanatory texts).\*

## 4.5 The UK

In the UK the Research Assessment Exercise (RAE) is used to assess the quality of research of British higher education institutions (HEI's). The publicly funded HEI's are invited to submit information about their research activities. This information is used by a peer review panel which rates the institutions. These ratings are then used to distribute public funding for the period of the RAE, six years. There is some criticism on the RAE considering applied research. Concerns have been expressed that the exercise favours established disciplines and approaches over new and interdisciplinary work and that it does not deal well with applied and practise based research in particular. (Jongbloed et al 2005: 26). The 2008 RAE process design is meant to recognize these flaws. In 2005 the review panels formed their criteria and working methods which were published in January of 2006. These include a wider range of research outputs than before:

*“In addition to printed academic work, research outputs may include, but are not limited to: new materials, devices, images, products and buildings; intellectual property, whether in patents or other forms; performances, exhibits or events; work published in non-print media. “ (RAE 01/2006)*

There are in total 15 panels who can distinguish other types of output criteria, depending on the discipline under consideration. The description of panels and their criteria can be found on <http://www.rae.ac.uk/pubs/2006/01/>. Below are a few examples of specific criteria, some of which focus on applied research only:

**Mathematics, computer science and informatics:**

- software, \*
- patents and/or licences, \*
- experimental instrumentation and devices, \*
- other artefacts, \*
- publications in any discipline or professional journal. \*(RAE 01/2006 F)

**Engineering:**

- research monographs, in whole or part; \*
- authored articles in professional journals; \*
- conference contributions; \*
- conference reports; \*
- descriptions of new devices and instrumentation, \*
- descriptions of new processes and materials; \*
- evidence of design artefacts, patents awarded, published papers in journals; \*
- software; \*
- technical reports. \*(RAE 01/2006 G)

**Architecture and the Built Environment:**

- papers,
- books,
- materials, \*
- images, \*
- devices, \*
- patents, \*
- artefacts, \*
- designs, \*
- design codes, \*
- buildings, \*
- prototypes and installations, \*
- products and processes, \*
- time-based media, \*
- exhibits, \*
- software, \*
- work published in non-print media. \*(RAE 01/2006 H)

**Arts, Drama, Music:**

- books (authored or edited);
- chapters in books;
- journal articles;
- conference contributions; \*
- curatorship and conservation; \*

- digital and broadcast media; \*
- performances and other types of live presentation; \*
- artefacts, designs and exhibitions; \*
- films, videos and other types of media presentation; \*
- advisory reports; \*
- the creation of archival or specialist collections to support the research infrastructure. \*(RAE 01/2006 O)

## 4.6 Synthesis

In most of the countries research performance measurement still focuses heavily on traditional forms of research inputs and outputs: numbers of research staff or doctoral students, research income and publications produced. To date, only marginal attention has been given to assessing the many ethereal aspects of research production/performance like collaboration and contribution to innovation.

While most agree that research output is not strictly limited to publications, the impact of commercialisation, innovation and strategic development remains ill defined and highly subjective across countries. If such activities are part of research performance measurement (RPM) systems at all, they are often assessed by means of peer review exercises instead of by quantitative assessment.

The countries use various approaches for measuring research performance. The UK and New Zealand rely heavily on peer review while Australia mainly uses quantitative indicators. In most countries the measurement system in use is not yet considered final:

*“What the study attests to more than anything else is that research performance measurement does not collapse neatly into a single composite number or value. Indeed, specifically for this reason places like the United Kingdom, Germany and Australia are increasingly trying to evaluate research performance by considering a broad mix of input, output and process indicators” (Jongbloed 2005: 67).*

The countries in our study tend to try and distinguish between basic and applied research as well as focus on issues like innovation and commercialization. A good example is the indicator employed by the German DFG, “centrality in networks of DFG-funded coordinated programs,” which seeks to capture the extent to which collaborative research takes place and the extent to which different units take on larger/smaller roles in such projects. In Australia, the report of the WGMC is an interesting development. Information on innovation is already present in the RRTMR the universities annually complete. In New Zealand the ‘contribution to research environment’ indicator seeks to capture this idea and with adding new or ‘improved’ indicators in their peer review they try to focus more on applied research. The British RAE also tries to capture applied research with the inclusion of a range of indicators of applied research outputs.

The general observation to be made about performance indicators in this area is the overall lack of consensus about what should or should not be included. Patents are almost invariably accounted for but tend to favour commercialisation activities in the biological, medical and physical sciences. Applied research income also shows up frequently, which probably gives the social sciences more leverage than patent activities, but again one runs into the problem of relying on a partial and input-based measure. While most agree that research output is not strictly limited to publications, the impact of commercialisation, innovation and strategic development remains ill defined and highly subjective across countries (Jongbloed 2005).

Nevertheless, for the sake of this study it can be concluded that recent developments in national research performance measurement systems shows an increasing number of indicators that focus specifically on applied research, or are interesting from an applied R&D perspective. The metrics for measuring commercialization from Australia are a good example of this. Many of these metrics, such as client relations or royalty agreements, are interesting indicators for applied R&D. The British RAE also provides an interesting list of research outputs that could be considered, such as prototypes and installations. Some of the indicators from New Zealand include design output and a list of possible conference contributions that are applicable. Third party funding is often included in the list of indicators for example in Germany. Most of such indicators are not likely to be strictly valid for university research only but could very well also function for non-university research.

## 5 Conclusions

This report addresses the issue of applied research performance measurement with specific attention paid to general quality measurement of research in the Netherlands, developments in the Dutch HBO sector, and recent experiences in a number of other countries.

The main conclusion from this report is that measuring applied R&D performance is an emerging field of study. Until recently, most attention has been paid to the publication of national R&D statistics and developing evaluation mechanisms for university research. This implies that most information available concerns key indicators in the area of science and innovation at national or institutional level. The university research evaluations often take a national disciplinary focus in which all university departments in a particular discipline are compared to each other. These evaluations particularly take an academic view on performance measurement. However, some general developments stimulate the attention for applied research and its specific characteristics. These developments include the stronger focus on the social responsibility of universities, increasing emphasis on public-private partnerships (university-industry relations), growing external revenues and the development of research at non-university higher education institutions.

In the Netherlands, as well as in most other countries considered in this study, there still is quite some focus on traditional forms of research performance measurement, primarily looking at inputs and outputs like numbers of research staff, doctoral students, research income and publications. Only marginal attention is given to assessing other aspects of research production like collaboration and contribution to innovation, commercialisation and strategic development. Next to national general statistics on R&D (expenditure, staff, patents, etc.), research performance measurement mainly consists of peer review processes in the university sector.

In this context, the developments in the Dutch sector of the universities of professional education (HBO-institutions) are interesting. With the establishment of lectorates (*chairs*) and appointment of lecturers (*associate professors*) at the HBO-institutions since 2001, these “non-university” institutions were allowed and recognised to develop their own research portfolios. The research carried out by these lectorates is mostly of an applied nature. To monitor the function and development of lectorates at the HBO-institutions, a few evaluation processes have been started up, one at a national level and one at the internal institutional level. As the research at the lectorates is of an applied nature, the evaluation mechanisms also need to specifically address this function. At the national level, a few monitoring or evaluation studies have taken place and the results now serve to develop a serious assessment framework for applied research carried out by lectorates. This framework is envisaged to be operational for the 2008 evaluation of all lectorates and will include a set of quantitative and qualitative indicators. The indicators are proposed to particularly look at the different positions lectorates take with regard to various stakeholders in their networks, like policy, academe and business. In addition, indicators should express the applied nature of the research of lectorates, like: presentations at conferences, guest lectures, externally funded projects and publications in professional magazines.

At the institutional level, the Hogeschool Utrecht initiated the development of its own evaluation mechanism to assess its lectorates. Indicators that are being discussed within the “sci-Quest method” focus on the performance and contacts in relevant domains: network formation; professional practice; teaching and education; science;

and administration and policy. In each domain a specific set of indicators is developed that represents the variety of possible products of applied research. It can be stated that the evaluation of applied research at HBO-institutions builds on the traditional academic evaluation mechanisms by integrating more professionally oriented indicators. In addition, the indicators also aim to address the importance of the knowledge networks and the impact of research.

The exploration of the international literature and practices in the area of research performance measurement shows that growing attention is given to research of applied nature. Though most evaluation mechanisms still see traditional academic (university) research as their core business, many countries or national agencies try to incorporate indicators that also address applied research, innovation and commercialization. For example, the German DFG includes indicators that express collaborative power and the role in research networks in its assessment criteria. In Australia metrics for measuring commercialization and innovation become more prominent. New Zealand has added new or 'improved' indicators that try to focus more on applied research in their peer review system, like design outputs and various conference contributions. The British RAE also tries to include criteria indicating applied research outputs such as prototypes and installations. Some of the countries also include third party funding or patents.

Overlooking all developments one can see a lack of consensus about what should or should not be used as indicators of applied research performance. The problems may be associated with difficulties of measurement, imbalances between different disciplines and difficult definitions of concepts like the impact of commercialisation, innovation and strategic development. Nevertheless, the general tendency is that research output is no longer strictly limited to publications and qualitative academic review. It can be concluded that the measurement of research gradually starts to integrate more indicators that measure applied research efforts as well, either within the university evaluation mechanisms, national statistics or in "non-university" institutions. Though this area is still in its infancy, the report shows that advancement is being made towards a more balanced treatment of academic and applied research.

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