

INTERNATIONAL WORKSHOP

Science, Training and Career

CHANGING MODES OF KNOWLEDGE PRODUCTION
AND LABOR MARKETS

University of Twente, Enschede, The Netherlands, 21-22 October 2002

PROCEEDINGS

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Programme of the Workshop

Monday, 21 October

11.00 - 11.30 : Registration / welcome

11.30 - 13.00 : Opening

- *Prof. Dr. J. Enders*
CHEPS
- *Prof. Dr. F.A. van Vught*
Rector Magnificus, University of Twente
- *Prof. Dr. H.R. Friedrich*
Ministerial director, German Federal Ministry of Education and Research
- *Drs. E.A.A.M. Broesterhuizen*
Deputy Director, Research and Science Policy, Dutch Ministry of Education, Culture and Science

13.00 - 14.30 : Lunch

14.30 - 16.00 : **Strategic research, post-modern universities and research training**

Prof. Dr. A. Rip
Faculty of Philosophy and Social Sciences, University of Twente, the Netherlands

Current science policies and their implications for the concept of academic identity

Prof. Dr. M. Henkel
Centre for the Evaluation of Public Policy and Practice, Brunel University, United Kingdom

Session chair: *Drs. E. de Weert*
CHEPS

16.00 - 16.30 : Coffee/tea break

16.30 - 18.00 : Roundtable
"Postgraduate training and postdoctoral careers: recent reforms and experiences"

- *Dr. R.P. Königs*
Head of the Department of "Graduiertenkollegs", Deutsche Forschungsgemeinschaft (DFG)
- *Prof. Dr. J.A. Michon*
Chairman Accreditation Committee for Research Schools in the Netherlands (ECOS), Royal Netherlands Academy of Arts and Sciences (KNAW)
- *Prof. Dr. J-J. Paul*
Vice-president of the University of Bourgogne, Irédu-CNRS, France
- *Dr. N. Watts*
Founding Member of the Executive Committee of the UK Graduate Council (UKCGE)
- Session chair:
Prof. Dr. Ch. de Weert
Director Research Institute for Cognition and Information, Catholic University of Nijmegen, the Netherlands

20.00 : Dinner at 'De Broeierd'

Tuesday, 22 October

09.00 - 09.45 : *Mr P. Van der Hijden*
Deputy Head of the unit in charge of Higher
Education, Directorate General for
Education and Culture, European
Commission

Session chair: *Prof. Dr. J. Enders*
CHEPS

09.45 - 10.15 : Coffee/tea break

10.15 - 11.45 : **The PhD in the US: Criticisms, Facts and Remedies**

Prof. Dr. M. Nerad
Center for Innovation and Research in
Graduate Education, University of
Washington, Seattle, U.S.A.

**The Double Face of PhD Students.
The Example of Life Sciences in France**

Prof. Dr. V. Mangematin
INRA/SERD, Université Pierre Mendès-
France, Grenoble, France

Session chair: *Dr. S. Kyvik*
NIFU, Oslo, Norway

11.45 - 13.00 : **Research training - education and science policy between profession, discipline and academic institution**

Prof. Dr. I. Bleiklie
Rokken Center for Social Studies,
University of Bergen, Norway

Session chair: *Prof. Dr. J-J. Paul*
Vice-president of the University of
Bourgogne, Irédu-CNRS, France

Preliminary conclusion: *Prof. Dr. J. Enders*
CHEPS

13.00 : Lunch

Zusammenfassender Bericht über den Workshop

Jürgen Enders & Egbert de Weert, CHEPS

Zum aktuellen Stellenwert des Themas

Gegenwärtig lässt sich für viele Länder ein wachsendes Bewusstsein der Bedeutung der Funktion der Hochschulen in der postgradualen und postdoktoralen Nachwuchsförderung und ihrer Beziehungen zu den Arbeitsmärkten für hochqualifizierte Wissenschaftlerinnen und Wissenschaftler beobachten. Dies hat u.a. zu Kontroversen über Status und Funktion der Promotion und die geeigneten Ausbildungsformen und -wege für die Promotionsphase und die daran anschließenden Berufsverläufe geführt. Zumindest drei wichtige Themenkomplexe lassen sich in diesem Zusammenhang benennen:

Die Relevanz der Doktorandenausbildung für die außerhochschulischen Arbeitsmärkte, der Bedarf an hochqualifiziertem F&E-Personal im Beschäftigungssystem insgesamt, und die Attraktivität einer wissenschaftlichen Laufbahn im besonderen;
das Verhältnis zwischen den Modi der Doktorandenausbildung und den Modi der Wissensproduktion in der Forschung, die stärkere Betonung der Anwendungs- und Disseminationsfunktion; verschwimmende Grenzen zwischen öffentlicher und privater Forschung; zwischen Grundlagenforschung, angewandter Forschung und Entwicklung;
die Rolle der Wissenschaftspolitik für die Gestaltung der Nachwuchsförderung an den Hochschulen und ihr Verhältnis zu anderen *stakeholdern*, die Verbindungen und Konflikte zwischen Bildungspolitik einerseits und Forschungspolitik andererseits, die Entwicklung einer European Research Area in einem sich zunehmend internationalisierenden Kontext forschungsbezogener Ausbildung und Karrieren.

Diese Themen standen im Vordergrund eines internationalen Workshops '*Science, Training and Career: Changing Modes of Knowledge Production and Labour markets*', den das Center for Higher Education Policy Studies (CHEPS) der Universität Twente am 21. und 22. Oktober 2002 durchführte. Anliegen des Workshops war es, diese und verwandte Themen mit Hochschul- und Wissenschaftsforschern aus Europa und den USA zu diskutieren und den Austausch zwischen den Forschern und Repräsentanten der Bildungs- und Forschungspolitik zu befördern. Der Workshop wurde vom Bundesministerium für Bildung und Forschung unterstützt.

Insgesamt 50 ausgewählte Vertreter von Forschung und Politik beteiligten sich an den Workshop, der in der Tat internationalen Charakter hatte. Die Liste der Teilnehmer und Referenten des Workshops umfasst sowohl viele europäische Staaten (Belgien, Tschechische Republik, Deutschland, Finnland, Frankreich, Italien, Mazedonien, Niederlande, Norwegen, Vereinigtes Königreich) als auch Vertreter aus Australien, Japan und den USA.

Dieser Bericht gibt eine Zusammenfassung der wichtigsten Ergebnisse des Workshops. Wir folgen zunächst der übergreifenden Struktur der Veranstaltung und wenden uns dann einigen wesentlichen Schlussfolgerungen zu.

Überblick zu den Vorträgen

Eröffnungssitzung

In der Eröffnung des Workshops betonten die Vortragenden, dass die Ausbildungsfunktion der Hochschulen in der postgradualen und postdoktoralen Nachwuchsförderung – einst ein relativ unumstrittenes Terrain und selten expliziter Gegenstand politischer Steuerung – sich aufgrund verschiedener Entwicklungen im Umbruch befindet. In seinem Eröffnungsvortrag weist *Jürgen Enders* (CHEPS, Universität Twente, NL) auf die Folgen der Hochschulexpansion und veränderter Arbeitsmärkte und Berufsbilder für Hochqualifizierte, auf veränderte Erwartungen an die Relevanz der Nachwuchsförderung auf den Arbeitsmärkten außerhalb der traditionellen Einsatzbereiche in Hochschule und Forschung, auf die Debatte um die *changing modes of knowledge production*, und auf die internationale und europäische Dimension der Forscherausbildung und -mobilität hin. Diese Veränderungen stellen auch neue Anforderungen an die nationale und internationale Bildungs- und Forschungspolitik.

Frans Van Vught (Rektor, Universität Twente, NL) greift diese Thesen auf und legt den Schwerpunkt auf die Veränderung der traditionellen Strukturen disziplinärer Forschung. Forschung bewegt sich zunehmend in Richtung auf eine trans-disziplinäre Wissensproduktion, in der Anwendungsorientierungen auch mit Blick auf die 'stakeholder' stattfindet. Diese Veränderungen haben Auswirkungen auch auf die Nachwuchsförderung. Darüber hinaus thematisiert er die Position der Doktorandenausbildung im Kontext der Liberalisierung der Ausbildungsmärkte durch die entsprechenden Initiativen der Welthandelsorganisation (WTO), insbesondere im Rahmen des General Agreement on Trade in Services (GATS). Er argumentiert, dass die Forschungsausbildung auch nach wie vor als öffentliches Gut in den Verantwortungsbereich staatlicher Steuerung fallen sollte. Schließlich wird die Europäisierung von Hochschule und Wissenschaft Auswirkungen auf die Inhalte und Orte der Forschungsausbildung zeitigen, die sich mit dem Begriff der *cultural dislocation* umreißen lassen.

Im Anschluss an diese beiden Eröffnungsvorträge stehen Fragen der politischen Gestaltung im Vordergrund der Vorträge der beiden folgenden Redner. *Hans-Rainer Friedrich* (Bundesministerium für Bildung und Forschung) begründet in seinem Eröffnungsvortrag die Notwendigkeit weiterer Modernisierung und Strukturierung der Forschungsausbildung an deutschen Hochschulen. Den Ausbildungsangeboten mangelt es oft noch an verbindlichen Strukturen, die Betreuung ist nicht selten inadäquat, und es gibt keine Standards der Regelung der Rechte und Pflichten der Doktoranden und ihrer Betreuer. Elemente einer stärkeren Institutionalisierung beinhalten die Anerkennung eines Doktorandenstatus an den Hochschulen. Die Graduiertenkollegs und Graduiertenschulen haben Modellscharakter bei der Verbesserung von Qualität und Reichweite der Ausbildung und bei der Verkürzung von Ausbildungszeiten.

Zugleich argumentiert Friedrichs für eine Vielfalt der Formen der Beschäftigung und Unterstützung der Doktoranden, einschließlich der Graduiertenkollegs, der *graduate schools* sowie verschiedener Typen der Finanzierung über Stipendien oder Beschäftigungsverhältnisse.

Gleichwohl müssen die Hochschulen ihr Privileg der Erteilung der Dokortitel im Sinne größerer Verantwortlichkeit und einer Sicherung der Qualität der Betreuung und Unterstützung der Doktoranden nachkommen. Die Anbindung der Doktoranden als

reguläre Mitglieder des Personalkörpers der Hochschulen im Nachwuchsbereich und auch die Einführung der Juniorprofessuren für postdoktorale Wissenschaftlerinnen und Wissenschaftler werden den Status des Nachwuchses befördern.

Im Anschluss diskutiert *Emil Broesterhuizen* (Niederländisches Ministerium für Erziehung, Kultur und Wissenschaft, NL) Fragen der gegenwärtigen Wissenschaftspolitik in den Niederlanden. Er fordert die Hochschule auf, sich weniger der Klage um die gegenwärtigen Budgetkürzungen zu widmen. Im Vordergrund sollte die Verbesserung der besseren Positionierung der Forschung an den Hochschulen durch Maßnahmen qualitätsbezogener Mittelzuweisungen, die Etablierung von Forschungsprioritäten, der Stützung der Grundlagenforschung als auch verbesserter Transferwege zwischen Grundlagenforschung und Anwendung stehen. Er fordert weitere Schritte der Internationalisierung der Forschungsaktivitäten im Kontext der European Research Area durch die Entwicklung größerer Konsortia, um erfolgreich am 6. Rahmenprogramm der Forschungsförderung der EU teilnehmen zu können. Vor dem Hintergrund dieser Entwicklungen betont Broesterhuizen die Notwendigkeit für ein effektives *Human Resource Management* in der Wissenschaft. Hier stellen sich dem niederländischen System einige dringende Probleme. Die Attraktivität einer Forscherkarriere für jüngere Absolventen sinkt, der Anteil der Wissenschaftlerinnen an den Hochschulen ist gering, und die (internationale) Mobilität der Forscher wird durch bürokratische Hürden behindert. Um diese Probleme anzugehen, wird ein übergreifendes Konzept für Forschung und Entwicklung unterstützt. Die anvisierten Maßnahmen umfassen sollten die Fachwahl von Schülern in der Sekundärausbildung und der Studienanfänger, die Gestaltung der Studienprogramme an den Hochschulen und die Förderung der Attraktivität einer Forscherlaufbahn einschließen.

Die post-moderne Universität, die Forschungsausbildung, und das Berufsbild der Hochschullehrer

Im Anschluss an diese Eröffnungssitzung stellen zwei Vorträge die Frage in den Vordergrund, wie die Universitäten durch Veränderungen der Forschung selbst und der Hochschulpolitik beeinflusst werden, und welche Auswirkungen dies für die Forschungsausbildung hat.

Arie Rip (Universität Twente, NL) verweist darauf, dass die traditionelle Arbeitsteilung zwischen Grundlagenforschung und angewandter oder problemorientierter Forschung sich mehr und mehr auflöst, und damit auch die funktionale Arbeitsteilung zwischen Universitäten, außeruniversitärer öffentlicher Forschung und privater Forschung. Die Doktorandenausbildung wird sich somit mit Blick auf ihre Inhalte und Orte ebenfalls diversifizieren. Insbesondere der Aufstieg strategischer Forschung macht es notwendig die Anforderungen an Karrieren in der Wissenschaft neu zu spezifizieren. Disziplinen, wie wir sie kennen, mögen nicht mehr den Stellenwert einnehmen, aber Interdisziplinarität allein kann nicht die Antwort sein. Die besondere Aufgabe für die post-modernen Hochschulen, wie Rip sie nennt, besteht vielmehr darin, sich kognitiv und institutionell zu diversifizieren und neu zu kombinieren und damit auch Brücken und Allianzen mit Zentren der Exzellenz und Relevanz in der außeruniversitären öffentlichen Forschung und dem privaten Sektor zu etablieren. In dieser Universität wird ein Doktorand seinen/ihren Weg durch die verschiedenen institutionellen Orte der Ausbildung gehen und damit auch auf entsprechende Anforderungen in der weiteren Karriere vorbereitet sein. Die Rolle staatlicher Aufsicht und Kontrolle wird sich im Prinzip verringern und auf wichtige Fragen der Finanzierung sowie der Qualitätskontrolle beschränken. Die Unterstützung der Mobilität der Doktoranden und

der Hochschullehrer und geeignete Instrumente der Qualitätssicherung in den verschiedenen institutionellen Räumen der Ausbildung werden ebenso im Vordergrund stehen, wie staatliche Steuerung für die Gestaltung der strategischen Forschung wichtig sein wird.

Mary Henkel (Universität Brunel, UK) stellt in ihrem Vortrag in Anknüpfung an Rip die Auswirkungen der gegenwärtigen Wissenschaftspolitik auf traditionelle Konzepte der Identität des Hochschullehrerberufs in den Vordergrund ihres Vortrags. Sie weist daraufhin, dass bis vor kurzem die Doktorandenausbildung weitgehend auf die Selbstreproduktion des Hochschullehrerberufs fokussiert war. Die Doktorandenprogramme waren Orte der Sozialisierung und Formierung wissenschaftlicher Identitäten, die sowohl in die Disziplinen, den wissenschaftlichen Gemeinschaften und der Hochschule eingebettet waren. Zweifellos tragen Veränderungen in der politischen Steuerung der Wissenschaft dazu bei, dass sich Erwartungen und Charakter der wissenschaftlichen Identitätsbildung an den Hochschulen verändern. Henkel verweist in diesem Zusammenhang auf die wachsende Betonung strategischer Forschung, veränderte Konzepte der Wissensproduktion und des Technologietransfers, die Kommodifizierung des wissenschaftlichen Wissens und die Debatte um die Idee der Wissenschaft als öffentliches Gut. All dies hat Einfluss auf die normativen, sozialen und organisatorischen Strukturen der wissenschaftlichen Arbeit im Allgemeinen und der Doktorandenausbildung im Besonderen. Hybride Formen der Wissensproduktion und Forschungskooperation verändern die Rollenkonzepte und Außenbeziehungen für den Hochschullehrerberuf. Für die Wissenschaftlerinnen und Wissenschaftler bedeutet dies, dass sie sich mit einer Vervielfältigung relevanter institutioneller Umgebungen, offeneren und flexibleren Strukturen und weniger überschaubaren Karrierepfaden auseinander zu setzen haben. Damit stellen sich grundlegende Fragen an die Forschungsausbildung: Anforderungen an übergreifende Kompetenzen und Fähigkeiten treten verstärkt zur fachlich-methodischen Ausbildung hinzu.

Reform der Nachwuchsförderung: Erfahrungen und Perspektiven

In diesem Rundgespräch stellen Vortragende aus Deutschland, Frankreich, den Niederlanden sowie dem Vereinigten Königreich die jüngsten Erfahrungen mit der Reform der Doktorandenausbildung in ihren Ländern vor.

Robert Paul Königs (Deutsche Forschungsgemeinschaft) verdeutlicht in seinem Vortrag, wie sich in Deutschland das klassische Lehrlingskonzept der Doktorandenausbildung zunehmend in Richtung auf stärker strukturierte Ausbildungsformen verändert. Die Einführung der Graduiertenkollegs hat dabei besondere Sichtbarkeit erlangt. Die Graduiertenkollegs haben sich sowohl mit Blick auf die Verkürzung der Ausbildungszeiten, die Förderung interdisziplinärer Forschung, der Kooperation zwischen Hochschule und Industrie und der internationalen Kooperation in der Forschungsausbildung bewährt. Inzwischen werden auch verschiedene andere Formen strukturierter Doktorandenausbildung (Stichwort: *graduate schools*) implementiert und es sind eine Vielzahl lokaler Initiativen zu beobachten. Aus der weiteren Verbreitung dieser Ausbildungsstrukturen ergeben sich Anforderungen an eine stärkere Profilierung der Graduiertenkollegs selbst als Zentren wissenschaftlicher Exzellenz mit einer ausgeprägten internationalen Dimension.

John Michon (Royal Netherlands Academy of Sciences and Arts - KNAW) stellt in seinem Vortrag die in den 90er Jahren erfolgte Einführung der *research schools* in den Niederlanden, die als integrierte Einrichtungen der Forschung und

Doktorandenausbildung fungieren, hervor. Als Vorsitzender des Ausschusses zur Evaluation dieser Einrichtungen erläutert er Prinzipien und Kriterien der Leistungsbewertung. Mit Blick auf die Ausbildungsleistungen stehen Kriterien der Qualität und Transparenz des Curriculums und der Betreuung, sowie der Attraktivität und Kapazitäten der *research schools* im Vordergrund. Michon weist gleichwohl daraufhin, dass die Anforderungen an ein Curriculum der Doktorandenausbildung aus seiner Sicht noch nicht deutlich genug definiert sind. Er unterstützt eine explizitere Berücksichtigung der späteren beruflichen Verwendungskontexte, die eben nicht allein auf die Hochschullehrerlaufbahn beschränkt sind. Darüber hinaus müsse deutlicher werden, dass die *research schools* nicht als weitere spezialisierte Einrichtungen der Hochschulen, sondern als eine Kerneinheit des Hochschulsystems zu trachten seien.

Jean-Jacques Paul (Universität von Burgund, F) erläutert die Strukturen postgradualer Ausbildung und der Reform der Nachwuchsförderung an den französischen Universitäten. Traditionell ist die Doktorandenausbildung in zwei Stufen gegliedert. In der ersten Stufe wird in einer ein-jährigen Ausbildung das DEA vorbereitet (*Diploma of Advanced Studies / Diplôme d'études approfondies*). Das DEA ist als Einführung in die Forschungsarbeit mit entsprechenden Lehrveranstaltungen weitgehend disziplinär strukturiert und an die Arbeit der Forschergruppen gekoppelt. Das DEA ist üblicherweise Eingangsvoraussetzung für die zweite Stufe einer theoretisch auf drei Jahre konzipierten eigentlichen Promotionsphase.

Seit 1992 sind an den französischen Hochschulen ebenfalls strukturierte Kontexte der Doktorandenausbildung durch die *doctoral schools* eingeführt worden. Die Diskussionen konzentrieren sich seither auf das Verhältnis dieser *doctoral schools* zu den traditionellen Formen der Doktorandenausbildung. Man kann argumentieren, dass der Einfluss der Hochschule selbst gestärkt wurde, in dem diese nunmehr über die Verteilung der Mittel an die *doctoral schools* direkt entscheidet. Der Wettbewerb zwischen den *doctoral schools* und den klassischen Lehrstuhlinhabern um diese Ressourcen steht ebenso auf der Tagesordnung der Debatten, wie auch die Strukturierung der Doktorandenausbildung im Zuge der Einführung von Bachelor- und Master-Abschlüssen an den Hochschulen.

Nicholas Watts (Council for Graduate Education, UK) gibt einen Überblick über die verschiedenen staatlichen und intermediären Einrichtungen der Förderung und Aufsicht der postgradualen Ausbildung an den Hochschulen im Vereinigten Königreich. Die traditionelle Form der Doktorandenausbildung wurde schon in den 80er Jahren abgelöst durch stärker strukturierte und curricular entwickelte Formen. Im Vordergrund dieser politisch gewollten Veränderungen stehen Verbesserungen der Leistungsfähigkeit und Effizienz des Systems. Gegenwärtig stehen weitere Verbesserungen des Übergangs in die Doktorandenausbildung, die Ausrichtung der Stipendienförderung an den Bedarf der Fächer, die Förderung der sog. *transferable skills* in der Ausbildung, Verbesserungen der Forschungsstruktur und der Betreuung, sowie der Begutachtung der Einrichtungen in verschiedenen Phasen auf der Tagesordnung. Auch werden die Akkreditierung der Programme und die Ausbildung der Betreuer diskutiert. Insgesamt gesehen reflektieren die verschiedenen Bemühungen einer Reform und Neustrukturierung der Doktorandenausbildung und ihre Ausrichtung sowohl auf innerhochschulische als auch außerhochschulische Berufsziele auch die gestiegene politische Beachtung dieser Ausbildungsfunktion der Hochschulen. Allerdings ist dies auch mit einer Vervielfältigung evaluativer Maßnahmen und bürokratischer Kontrollen verbunden.

Die Perspektive der Europäischen Kommission

In seinem Vortrag stellt *Peter van der Heijden*, Abteilungsleiter ‚Higher Education‘, die Perspektive der europäischen Kommission vor. Er unterstreicht die Bedeutung der Nachwuchsförderung im Kontext der weiteren Entwicklung der wissensbasierten Ökonomie und der Wettbewerbsvorteile des Wissenschaftsstandortes Europa im internationalen Maßstab. Die Ziele und Standards der Doktorandenausbildung sollten klar formuliert und anhand ausgewählter Indikatoren (*benchmarking*) überprüfbar sein. Im europäischen Kontext stellen sich Herausforderungen an die gemeinsame internationale Entwicklung von Doktorandenprogrammen und -curricula, eine bessere Verbindung von Lehre und Forschung, die für die Doktorandenausbildung gleichermaßen bedeutsam sind. Darüber hinaus kündigt er den Aufbau von Informationssystemen zur Kartografierung der europäischen Förderlandschaft in der postgradualen Ausbildung auf dem Master- und Promotionsniveau an, um die Qualität der Programme transparent zu machen und Beispiel guter Praxis zu unterstreichen. Diese Informationen sind notwendig um die systematische Unterstützung der postgradualen Ausbildung auf europäischem Niveau zu sichern. Strittig bleibt einstweilen, inwieweit die Förderung von Doktoranden stärker im Rahmen des ERASMUS-Programms, etwa im Sinne eines europäischen Fullbright Programms, oder im Rahmen der Marie Currie-Initiativen erfolgen sollte.

In der anschließenden Diskussion wurden in der Tat Fragen der Passung der lehrbezogenen Austausch- und Förderprogramme für die Doktorandenausbildung, der Entwicklung internationaler Kooperationen auf der Basis der Zusammenarbeit von Forschergruppen sowie der Berücksichtigung disziplinärer Differenzen in den Vordergrund gestellt.

Die Promotion in den USA und Europa

Maresi Nerad (Center for Innovation and Research in Graduate Education, University of Washington, USA) diskutiert die Situation der Doktorandenausbildung in den USA. Kritische Anfragen an die Inhalte, Strukturen, und Prozesse der Doktorandenausbildung und ihre Funktionalität für die Ausbildung für den gegenwärtigen und zukünftigen gesellschaftlichen Bedarf finden derzeit große nationale Beachtung. Im Vordergrund der Kritik stehen folgende Punkte: Die Ausbildung der Doktoranden ist zu spezialisiert angelegt, Schlüsselqualifikationen werden nur unzureichend vermittelt, die Ausbildung für die Lehre ist mangelhaft, die Promotionsphase dauert zu lange, und Doktoranden werden nur unzureichend über außerhochschulische Beschäftigungsperspektiven informiert.

Nerad diskutiert diese Fragen vor dem Hintergrund der Ergebnisse ihrer landesweit angelegten Befragung der Ausbildungs- und Berufswege der Promovierten in den USA und verweist auf drei Initiativen, die die kritische Debatte aufgreifen. Erstens werden im Rahmen des Integrative Graduate Education Research and Traineeship Program (IGERT) themenzentrierte Doktorandenkollegs gefördert, die in ihrem Charakter den deutschen Graduiertenkollegs ähneln. Zweitens unterstützt Carnegie Initiative on the Doctorate (CID) mehrjährige Fachbereichsinitiativen um die Strukturen der Doktorandenausbildung zielgerichteter zu gestalten. Schließlich werden Reformen der Nachwuchsförderung auch durch das Programm The Responsive PhD der privaten Woodrow Wilson National Fellowship Foundation unterstützt.

Vincent Mangematin (Universität Pierre Mendès, Grenoble, F) unterstreicht in seinem Vortrag die Bedeutung der Doktorandenausbildung sowohl für die hochschulische Forschung als auch für die industrielle Forschung und Entwicklung insbesondere in den Natur- und Ingenieurwissenschaften. Doktoranden sind in diesen Bereichen wichtigster

Faktor der Erneuerung des Wissens. Sie sind zugleich Träger für den Wissenstransfer in andere Sektoren und Organisation der Wissensgenerierung und –anwendung. Während der universitären Ausbildung tragen die Doktoranden in den Labors und Forschergruppen zur Wissensproduktion bei, beteiligen sich an der Lehre und zunehmend auch an Kooperationen mit außeruniversitären Partnern. In den Naturwissenschaften stellen sie mehr als 30 Prozent des hochqualifizierten Personals. Im Anschluss an diese Ausbildungsphase wechselt die Mehrheit der französischen Doktoranden in außerhochschulische Berufsbereiche, denn nur etwa 25 Prozent der Promovierten verbleiben längerfristig an der Hochschule.

Vor dem Hintergrund der Bedeutung der Promovierten für die inner- und außerhochschulischen Berufsfelder stellen die zunehmenden Beschäftigungsprobleme dieser Gruppe und die damit verbundenen Auswirkungen auf die Attraktivität der Promotionsphase für jüngere Absolventen einen Hauptgrund der Besorgnis dar. Falls sich dieser Trend fortsetzt sind mittel- und längerfristige negative Auswirkungen auf die Wissensproduktion an den Hochschulen und die Wissensdissemination in andere Bereiche zu erwarten. Hier sollten Maßnahmen des Human Resource Management als auch der Förderung der Mobilität innerhalb und zwischen den Sektoren gezielt ansetzen.

Ivar Bleiklie (Universität Bergen, N) stellt ausgewählte Ergebnisse eines internationalen Vergleichs der Entwicklung der Hochschulpolitik mit Blick auf die Forschungsausbildung vor. Auf der Grundlage einer Studie zu den Auswirkungen hochschulpolitischer Reformen in England, Norwegen und Schweden auf die Situation der Hochschullehrer in diesen Ländern konstatiert er, dass ähnliche Reformprogramme aufgrund nationaler Besonderheiten des Hochschulsystems, der Traditionen des Hochschullehrerberufs und disziplinärer Besonderheiten zu sehr unterschiedlichen Auswirkungen führen können.

Insbesondere für die genannten nordischen Länder lässt beobachten, dass die Laufbahnen an der Hochschule einen starken inhouse-Charakter haben, und Karrieren häufig nicht nur an derselben Hochschule, sondern auch im selben Fachbereich der Graduierung und Promotion verlaufen. Dies fördert tendenziell lokale Idiosynkrasien in der Entwicklung unterschiedlicher disziplinärer Traditionen. Schließlich behindert die geringe institutionelle Mobilität in der Hochschullehrerlaufbahn den Aufbau eines funktionierenden internen Arbeitsmarktes für die Hochschulen.

Zusammenfassung und Schlussfolgerungen

Im Folgenden werden einige der wesentlichen Ergebnisse der Vorträge und Diskussionen des Workshops zusammengefasst, wobei verschiedene Aspekte zweifellos weiterer Beachtung in der hochschulpolitischen Diskussion und der Forschung über Fragen der Nachwuchsförderung bedürfen.

1. Die Entwicklungen in verschiedenen europäischen Ländern verweist darauf, wie sich die Promotionsförderung mehr und mehr von klassischen Konzepten des Lehrlingsmodells und der individuellen Betreuung entfernt und strukturierte

Ausbildungsprogramme auf- und ausgebaut werden. Die Graduiertenkollegs in Deutschland, wie auch ähnliche Entwicklungen in Frankreich, den Niederlanden und dem Vereinigten Königreich illustrieren dies. Zunehmend werde solche Konzepte in lokalen Initiativen aufgegriffen. Hinzu treten in zunehmenden Maße internationale Vernetzungen in der Doktorandenausbildung sowie Vernetzungen mit der außeruniversitären öffentlichen Forschung sowie privaten Einrichtungen. Diese Prozesse der Proliferation und Differenzierung der Inhalte und Orte der Nachwuchsförderung werfen neue Fragen an den Status, die Ziele und die Sicherung der Qualität der Doktorandenausbildung auf.

2. Allgemein wurde betont, dass die Doktorandenausbildung – soweit sie es denn je war – nicht mehr allein auf die Selbstreproduktion des Hochschullehrerberufs bezogen sein kann, sondern Relevanz für andere außerhochschulische Einsatzbereiche besitzt. Es wird angenommen, dass der Anteil der Promovierten, die außerhalb der Hochschulen tätig werden, zunehmen wird. Dies wirft Fragen an die Zentralität der Promotionsschrift als produktbezogener Bewertung von Erfolg und Misserfolg auf. In jedem Fall betont wird die stärkere Berücksichtigung von Ausbildungselementen, die Fähigkeiten und Fertigkeiten für einen beruflichen Einsatz in verschiedenen Beschäftigungssegmenten fördern.
3. Große Aufmerksamkeit findet die Frage nach der Sicherung der Qualität der Ausbildung angesichts des Trends zu internationalen und sektoralen grenzüberschreitenden Kooperationen, der verschiedenen Konzepte über Art und Nutzen der Doktorhüte. In welchem Maße können und sollten außerwissenschaftliche Relevanz- und Qualitätskriterien berücksichtigt werden, insbesondere wenn die Forschung in anwendungsbezogenen Kontexten und in teamförmigen Strukturen durchgeführt wird? Neue Herausforderungen stellen sich damit an Rechenschaftslegung und Qualitätssicherung in den neu eingerichteten Strukturen und Programmen der Promotionsförderung, die oftmals von US-amerikanischen Vorbildern inspiriert sind. Das Beispiel USA zeigt aber, dass dies nicht per se Qualität und Effizienz sichert. Auch die europäischen Reformmodelle bleiben – bei allen Erfolgen – nicht ohne Kritik. Interessanterweise wurde das Monopol der Universitäten zur Verleihung der Dokortitel in den Diskussionen aber nicht in Frage gestellt. Dieses Privileg bringt aber auch eine zentrale Verantwortung der Universitäten für die Qualität der Ausbildung und Betreuung mit sich.
4. Die zunehmende Betonung der Berücksichtigung außeruniversitärer Einsatzfelder sollte allerdings nicht die Bedeutung der Nachwuchsförderung für die Hochschullehrerlaufbahn in den Hintergrund treten lassen. In der Tat sind in einer Reihe von Ländern angesichts wachsender Schwierigkeiten der Rekrutierung von Doktoranden neue Herausforderungen für die Sicherung der Attraktivität des Arbeitsplatzes Hochschule sichtbar. Verschiedene Beispiele für die Reform der Karrierepfade an den Hochschulen, die Etablierung neuer Nachwuchspositionen, die Förderung sektoraler und internationaler Mobilität wurden in diesem Kontext angeführt.
5. Verschiedene Aspekte der internationalen Dimension von Nachwuchsförderung gewinnen an Bedeutung. Die internationale Mobilität der Forscher wird zunehmen und sollte durch entsprechende Angebote für Doktoranden, einen Teil ihrer Ausbildung und Tätigkeit im Ausland wahrzunehmen, unterstützt werden. Europäische Programme werden hierbei eine wichtige Rolle spielen. Zugleich führt

das schwindende Interesse der Absolventen – vor allem in den Natur- und Ingenieurwissenschaften – in einigen Ländern dazu, in zunehmendem Maße Absolventen aus anderen Ländern und Regionen zu rekrutieren. Ausländer- und Hochschulpolitik sind auf diese Migrationsbewegungen der Wissenschaftler oftmals nur unzureichend vorbereitet. Bestehende Hürden werden nur zögerlich abgebaut.

6. Die Internationalisierung der Doktorandenausbildung enthält zusätzliche Dimensionen durch die Etablierung sowohl des europäischen Hochschulraums als auch des europäischen Forschungsraums. Hier wird die Suche nach gemeinsamen europäischen Antworten auf gemeinsame europäische Probleme betont. Die Unterzeichner der Bologna-Erklärung stimmen darin überein, dass kompatible Strukturen auch in der Forschungsausbildung gefördert und entsprechende Pilotprojekte der Europäischen Kommission unterstützt werden sollen. Auf der Tagesordnung – auch der Berlin-Konferenz 2003 – steht die Frage, wie sich die Promotionsphase an das zweistufige Modell der Bachelor-Master-Ausbildung anschließt und mit dieser integriert.
7. Das 6. Rahmenprogramm der Forschungsförderung der EU stimuliert die Bildung internationaler Forschungskonsortia als ein zentrales neues Element der Förderung. Diese Entwicklung stimuliert eine weitere Verschränkung nationaler und internationaler Wissenschaftsprogramme und wirft die Frage auf, inwieweit sich nationale Programme für ausländische Wissenschaftler öffnen. In diesem Zusammenhang ist auch die Forderung nach der Etablierung einer European Science Foundation zu diskutieren. In jedem Fall wird sich ein Mehrebenensystem internationaler, nationaler und lokaler Wissenschaftspolitiken herausbilden. In diesem Zusammenhang wird die nationale Verantwortung für die Wissenschaftspolitik insgesamt und für die Nachwuchsförderung im Besonderen neu zu verorten sein.

Der Workshop brachte Vertreter aus Forschung, Politik und Praxis zusammen, um Fragen der Nachwuchsförderung im Licht sich verändernder Dynamiken im Wissenschaftssystem selbst und in der Wissenschaftspolitik auszuleuchten. Verschiedene Entwicklungen deuten darauf hin, dass dieses Thema eher noch an Aufmerksamkeit gewinnen wird, wenn man die wichtige Rolle der Nachwuchsförderung für Wissensproduktion und -transfer, die inter-sektorale und internationale Kooperation in der Forschung und die Rekrutierung für die Hochschullaufbahn bedenkt. Weitere internationale Zusammenarbeit in der Forschung gerade auch auf europäischer Ebene wird notwendig sein, um weitere Einsichten in die lokalen, nationalen und internationalen Bedingungen, Strukturen, Prozesse und Erträge der Nachwuchsförderung zu gewinnen. Das Center for Higher Education Policy Studies hat hierzu mit diesem Workshop erste Schritte unternommen, denen weitere folgen werden.

Summary Report of the Workshop

Jürgen Enders & Egbert de Weert, Center for Higher education Policy Studies (CHEPS), University of Twente, the Netherlands

Actuality of the theme

In many countries there is increasingly concern about the postgraduate and postdoctoral training function of higher education and its relationship to the job market for younger academics and scientists. This has led to controversial debates on the status and function of the doctoral degree and on the conditions and the best practice to prepare doctoral candidates for their professional future. Important themes in this area are:

- The relevance of doctoral training to the world outside higher education, the demand for high quality scientists and engineers across the economy, and the attractiveness of the academic workplace for the new generation.
- The relationship between the nature of the research training and the modes of knowledge production, emphasis on 'problem solving' and dissemination, blurring boundaries between public and private research as well as between fundamental research, applied research and development.
- The reappraisal of public policy and its relationship to other stakeholders for the research training function of higher education, links between education and policy and science policy, and the development towards the European Research Area in a globalising context for research training and careers.

These and related issues were central at the international workshop '*Science, Training and Career: Changing Modes of Knowledge Production and Labour markets*', organised by the Center for Higher Education Policy Studies at the University of Twente, the Netherlands on 21 and 22 October 2002. The purpose of the workshop was to discuss these and related issues with scholars from Europe and the USA and to stimulate an exchange of views between researchers and representatives from the policy field. The workshop was supported by the German Federal Ministry of Education and Research.

A selected group of 50 people took part in the workshop. It was a truly international workshop as participants came from many European countries (Belgium, Czech Republic, Finland, France, Germany, Italy, Macedonia, the Netherlands, Norway, United Kingdom) as well as from Australia, Japan and the US.

This report provides a summary of the contributions and an overview of the main results. In this overview we kept to the general structure of the workshop. At the end some major conclusions are drawn.

Overview of the presentations

Opening session

In the opening session all speakers pointed out that the postgraduate and postdoctoral training function of higher education – once an uncontested term and rarely an explicit object for policy-making – is changing as a result of various developments. In his opening address, *Jürgen Enders* (CHEPS, University of Twente) referred to the expansion of higher education and changes on the academic labour market, changing expectations regarding the relevance of doctoral training to the world outside higher education and science, the blurring of borders between fundamental research, applied research and development, and the international dimension of research training, career and mobility. These developments require a reappraisal of public policy and in particular to address the links between public responsibility for education and training on the one hand and research and science policy on the other.

Frans Van Vught (Rector of the University of Twente) concurred with these statements and stressed how the traditional disciplinary-based type of knowledge production has changed in the direction of transdisciplinarity with emphasis on relevance, orientation on application and the increasing role of other stakeholders. These shifts have implications for doctoral training. Moreover, he touched upon the position of postgraduate training in the context of the liberalisation of educational markets through initiatives of the World Trade Organisation, and in particular the General Agreement on Trade in Services (GATS). Van Vught argued that research training is a collective good and stressed that it should be a major responsibility of government. Furthermore, the rector referred to the emerging European profile of the scientific enterprise, which will have implications for research training in terms of content and location. In this context the term ‘cultural dislocation’ was coined.

After these opening addresses, the next two speakers approached the subject from a policy perspective. In his keynote speech, *Hans Friedrich* (Federal Ministry of Education and Research in Germany) argued that research training in Germany needs to be modernised and institutionalised to a greater extent. The research training programmes offered by universities lack structure, supervision is often inadequate and there are no standard regulations setting out the rights and obligations of doctoral studies and their supervisors. Among the elements of a further institutionalisation he referred to the recognition of a special research student status, the initiation of the research training groups programme with model structures according to which the quality and scope of qualifications can be improved while shortening the duration of training, and support programmes for doctoral training.

At the same time he advocated different forms of employment and support for doctoral candidates which includes programmes fostering scientific excellence such as the graduate schools (*Graduiertenkollegs*) and graduate research training centres including various types of fellowships and funding arrangements.

Despite this variety, Friedrich stressed that the universities, having the privilege to award doctorates, should assume greater responsibility and ensure excellent supervision and support for doctoral candidates. This will be facilitated through employment of doctoral students as members of the junior academic staff, either holding established posts or working in externally funded research projects. Also the introduction of a (time-limited) junior professorship will increase the employment status of young academics.

Next, *Emil Broesterhuizen* (Dutch Ministry of Education, Culture and Science) discussed current science policy issues in the Netherlands. Rather than complaining about the current budget cuts for higher education, he pointed to the need to enhance the positioning of university research in the outside world by developing a mechanism that links budgets to research quality and research achievements, to establish priorities in research, to protect basic research as well as to stimulate the flow of knowledge from basic research to practical application and back (including the promotion of a stricter accounting of public funds on the basis of a small set of indicators). He also advocated further steps in the direction of internationalisation of research activities in the context of the European Research Area by developing larger consortia in order to be able to effectively take part in the 6th Framework Programme. Considering these developments in science policy, Broesterhuizen stressed the need for effective human resource management and the formation of scientists. In this regards the Dutch system faces some urgent problems. There are less graduates who feel attracted to a research career, the participation of women in the higher research positions is rather low, and the mobility of researchers (inter) nationally is hindered by though bureaucracy. In order to encounter these problems, he advocated an overall plan for science and engineering which includes policies regarding pupils' choices in secondary education, students' choices and the nature of the study programmes in university and vocational education, and policies to enhance the attractiveness of research careers.

Post-modern universities, research training, and academic identities

After this opening session two papers were presented which discussed more in-depth how universities are subject to changes in the nature of scientific research and the implications for research training.

In his contribution, *Arie Rip* (University of Twente) argued that the old division of labour between fundamental and applied or problem-oriented research has almost disappeared, and with it, the functional distinctions between universities, public labs and industrial and other private research. Doctoral research training can then also become diversified in terms of its content and its location. Due to changes, in particular the emergence of a regime of strategic science, it will be necessary to specify requirements for a career in science. Disciplines as we know them may not be of major importance, but interdisciplinarity as such is not the answer. For universities, the key challenge is to diversify and recombine, both cognitively and institutionally, into what *Rip* called a post-modern university which includes overlaps and alliances with centres (of excellence and relevance), public labs and various private organisations. In such a university, a doctoral student can wend his or her way through the types of locations, just as is to be expected of later in the career. An important further element is the reduced role of (central) government in funding and earmarking of research, and in setting requirements for graduate training. Supporting mobility (of students and staff) and requiring some quality assurance for what happens in the new spaces will probably be the main government responsibility for the coming decade. Government will continue to have an important role as one of the actors in strategic science.

Mary Henkel (Brunel University, UK) continued on the line Rip had outlined by focusing on current science policies and their implications for the concept of academic identity. She analysed how until recently, a major purpose of postgraduate education has been the reproduction of the academic profession. Postgraduate programmes have provided the context for the formation of individual academic identities that are, nevertheless, embedded in defined communities, disciplines and universities that between them constitute a bounded world. However, the character of academic identity and identity

formation is changing due to various aspects of current science policies. Henkel referred to the emphasis upon strategic or exploitable research and innovation; contemporary theories of knowledge production and technology transfer; the commodification of knowledge and challenges to the idea of science as a public good. All these affect the conceptual, normative, social and organisational structures of scientific work and what that might mean for postgraduate education. More hybrid forms of collaboration are emerging which result in a variety of roles and relationships. For scientists this means that they have to manage a more varied institutional environment, more flexible and open structures, and less predictable career trajectories. This development questions on what research training is all about: it may mean the competence in research design and research techniques, but it may include generic skills as well.

Round table discussion

In this section four speakers from Germany, the Netherlands, France and the United Kingdom were invited to speak about recent reforms and experiences with postgraduate training in their countries.

Robert Paul Königs (Deutsche Forschungsgemeinschaft) showed how the doctoral education in Germany which traditionally is characterised by the individual master/apprentice relationship between candidate and supervisor is transformed in the direction of more structured forms of doctoral education. The most visible form is the introduction of the *Graduiertenkollegs*, a university graduate training programme established at a centre of scientific excellence in a particular field. These *Graduiertenkollegs* have proven to be successful and in terms of reducing the average time of completion of a dissertation and enhancing interdisciplinary research, collaboration between industry and university, and international co-operation in research training. In addition to this, a variety of structured doctoral programmes have emerged (graduate schools) as well as an increasing number of other initiatives on the local level. As a consequence of this proliferation of structured programmes, there is a move to sharpen the profile of *Graduiertenkollegs* as centres of scientific excellence and innovation along with a strong international dimension.

The most dominant development in the Netherlands in the 1990s has been the emergence of research schools, integrated environments for research and PhD-training. *John Michon* (Royal Netherlands Academy of Sciences and Arts - KNAW), chairman of the committee who evaluates the performance of these research schools, explained the criteria this committee applies. Regarding the training aspect, the quality and transparency of the curriculum and supervision and the attractiveness, capacity and 'throughput' of the school are important criteria. In the discussion, Michon argued that, in his view, the objectives of the PhD-curriculum are currently not defined in a sufficiently straightforward way. This may be related to the ill-defined status of a PhD-degree in contemporary Dutch society. He advocated more explicit attention in the PhD-curriculum for the student's later professional career which is not solely limited to a university research career. Moreover, he considered the graduate school as the core entity in a university system rather than as a specialised distinctive institute.

Jean-Jacques Paul (University of Bourgogne) discussed the postgraduate training system in France and outlined recent reforms. The traditional doctoral studies in the university system are split into two stages. The first stage concerns one year to prepare the DEA (Diploma of Advanced Studies/ *Diplôme d'études approfondies*). The DEA is an

introduction into research activity (including course work), structured on a disciplinary basis and linked to research teams. The DEA is usually required for admission to the second stage which theoretically takes three years to prepare the doctorate itself.

Since 1992 doctoral schools have been implemented. These schools can be multidisciplinary. The discussion focussed on the relation between the traditional doctorate and the research schools. It was argued that the power of the universities has been strengthened, since the funding scheme allows them to allocate directly research grants to the doctoral schools. Competition between the doctoral schools (which take care of the research training) and the traditional faculties can be envisaged. The extension of the respective powers is a matter for debate within universities, especially at the moment of the introduction of the Bachelor-Master-Doctorate structure.

Nicholas Watts (UK Council for graduate Education in the United Kingdom) gave a thorough overview of the various (government) bodies in the UK, and the various reports from advisory committees regarding postgraduate education. The traditional model of doctoral preparation where a student worked almost exclusively with a major professor through completion of the dissertation was already replaced in the 1980s by a curriculum incorporating formal research training. He described the institutional changes that have taken place in order to steer the system towards higher performance and effectiveness. Current policy trends aim to tighten procedures for transfer to PhD, to stipend graduates according to discipline priority, to improve transferable skills training for PhD students, to improve the research environment, supervisory arrangements, initial review and subsequent progress. Also training and accreditation programmes for postgraduate supervisors are envisaged.

In the discussions scepticism was expressed about the evaluative load that this brings with this and increased bureaucracy and managerialism. At the same time policies are oriented to increase the flexibility of postgraduate education such as part-time, individual careers, experience in business, new route PhD which mixes taught elements, professional skills and research elements. The British case illustrates the importance policy bodies attach to postgraduate training and attempt to steer the system in a direction which prepares students not only for academic careers but for careers in business.

The European perspective

The perspective from the European Commission was sketched by *Peter van der Hijden*, deputy head of the unit in charge of Higher Education. He underlined the importance of the research training system in the context of the emerging knowledge-based economy and the competitive advantage of Europe in the world economy. He advocated a clear statement of the objectives of the training system and an identification of the quality through the development of indicators that are measurable (benchmarking).

Doctoral education in the European context would imply curricula jointly developed (international co-operation), a content orientation which is European, and a better linking of education and research which should be squeezed together.

Furthermore, he announced a survey on both masters programmes and doctoral education in order to map what is happening on the European scene, what kind of courses are taken, what their quality is, and to trace examples of best practice. This information is needed to provide more systematic support on the European level. He argued that doctoral students should be subsumed more under the Erasmus programme (as a kind of European Fullbright programme) and less under the Marie Curie association.

In the debate that followed it was questioned whether the Erasmus programme is the most suitable for research students because of the connection of their course work with their work on their thesis. It was also put forward that international collaboration is only suitable between small research groups and that in developing further plans, disciplinary differences should be taken into account.

The PhD in the US and Europe

Maresi Nerad (Center for Innovation and Research in Graduate Education, University of Washington) discussed the situation of doctoral education in the US. Present criticism on doctoral education has generated national attention to re-evaluate whether it measures up in content, structure, and process to prepare scholars and researchers for present and future societal needs. Statements like the following speak for themselves: doctoral students are educated and trained too narrowly; they lack key professional skills, such as collaborating effectively and working in teams; they are ill prepared to teach; they are taking too long to complete their doctoral studies; Doctoral students are ill informed about employment outside academia.

Nerad referred to her empirical study that shed light on the various dimensions of the criticism and discussed three recent national initiatives which address these criticisms of doctoral education. First, the Integrative Graduate Education Research and Traineeship program (IGERT). This initiative proposes the creation of doctoral programs that are theme-based and research-centered, similarly to German Graduiertenkollegs. Second, the Carnegie Initiative on the Doctorate (CID), proposes to support disciplinary departmental efforts over multiple years to structure doctoral programs more purposefully. Finally, the Responsive PhD sponsored by the private Woodrow Wilson National Fellowship Foundation, is an effort to create models for innovation and change for universities.

Vincent Mangematin (Université Pierre Mendès, Grenoble) outlined the importance of young PhD students for both academic laboratories and private firms with particular reference to the situation in the life sciences. PhD students in the life sciences (biology, medicine, health) are a living strength of the production of scientific knowledge. They are also one of the vehicles for the dissemination of knowledge since they circulate between different organisations during or after their PhD. They therefore have two faces. First, during their PhD they contribute towards scientific production in their laboratory, towards teaching and, in some cases, towards relations with the laboratory's partners. In the life sciences they account for close to 30% of skilled manpower used by academic laboratories for their scientific and technical production. Second, after their PhD, most graduates have to leave the scientific and technical environment in which they were trained, since academic research recruits less than 25% of all PhD graduates annually. PhDs' embodied knowledge is thus spread to other organisations. They are one of the vehicles for the diffusion of tacit knowledge acquired during their training through research.

Given this crucial role of PhD students, it is worrying that the specific problems of employment encountered by PhD impact on the number of graduates who opt for training through research. If this trend continues, it will have a damaging effect on the dynamics of scientific production, and in the longer run on the dissemination of knowledge between the academic and private sectors. Questions arose about how to encounter this development. Solutions should be focused on specific human resource management in academia and intra- and inter-organisational mobility of individuals.

Ivar Bleiklie (University of Bergen, Norway) discussed changes in research training policies over the last couple of decades. Drawing on material from a comparative study of reform and policy change in higher education in England, Norway and Sweden, he presented the main lines of reform policies with reference to the conditions of the academic profession in each country. Both developments over time and cross-national variation are emphasised. The effects of the reform policies is analysed with an emphasis on the close interaction between the policies that are developed for research training, national characteristics of the academic profession and differences between different disciplines within the profession.

Discussions arose about the distinctive features regarding academic careers in these countries. It appeared that in both Norway and Sweden most careers were made at the same university and even at the same department as an academic took his/her degree. The effect of this might be a strong localism in the development of the disciplinary traditions. Moreover, this absence of exchanges of personnel between universities has in many ways impeded a proper labour market within academia.

Some major conclusions from the workshop

In this concluding section we summarise some of the main points that can be identified from the presentations and the discussions during the workshop. Several of these points deserve further attention in future policy debates and research efforts on postgraduate education and postdoctoral training.

1. The developments in different European countries show how the doctorate has evolved from a rather loose concept characterised by individual master/apprentice relationships towards more structured forms of postgraduate education. The development of the *Graduiertenkollegs* in Germany, the research schools in the Netherlands, France, and the UK which have been assigned an explicit task in postgraduate training illustrate this development. At the same time other structured doctoral programmes have emerged which provide doctoral education, sometimes solely internally within the university, but also through alliances with various public and private organisations. This proliferation, 'bundling and unbundling', and diversification in term of content and location raise questions about status, purposes and quality of postgraduate education.
2. It was generally recognised that the doctoral degree is not to be seen solely as a preparation for an academic career, but that it has also relevance for a broader variety of other careers outside higher education. The proportion of PhD holders working in industry is growing. This casts doubts on the notion that the focus of postgraduate work is on the doctoral thesis. Postgraduate education should reflect different career destinations for postdoctoral researchers. This includes the need to incorporate training components in order to develop competencies making students employable in a variety of employment outlets.
3. Much attention was given to the question to what extent sufficient quality can be guaranteed given the fact that a further proliferation will continue and that there are different images, different ideas about what a postgraduate education is, or should be. To what extent can non-academic evaluative criteria be applied,

particularly when research takes place in the context of application and is the product of teamwork? New questions have been raised about accountability and quality assurance mechanisms. At the same time it was put forward that also the research schools as such are not a sufficient guarantee for optimal quality, as experiences from the US system of doctoral education show. Also in Europe there is criticism that several schools have not yet defined the objectives of the PhD-curriculum in a sufficiently straightforward way. Given these criticisms and different images of the PhD, the standpoint that the award of doctorates should remain the privilege of the university was not contested. Consequently, universities should bear all the responsibility for the quality of the PhD's including the establishment of adequate supervision.

4. The growing emphasis on transferable and employability skills training should not neglect the fact that postdoctoral training is also oriented towards the internal academic labour market. Within the university system, the attractiveness of an academic career is a major concern in many countries. Examples were given of new career structures and junior positions within the university system in order to attract more young graduates for a university career. Reference was made to the creation of new positions, junior professorships and post-doc positions which are on a tenure-track.
5. The development of postgraduate education and training has a strong international dimension in various aspects. The mobility of researchers will increase, and the opportunities for PhD students to go and work at other institutions for different periods of time should be extended. European programmes will facilitate this mobility further. Another aspect concerns the declining influx of young graduates in PhD positions in some countries, especially in the science and engineering subjects. This brings universities to recruit scientists from abroad, although national governments do not have an alert and effective policy on this migration of scientists and still many obstacles persist.
6. The internalisation of doctoral training gets a further dimension through the establishment of a European Higher Education Area and a European Research Area. These stress the search for a 'common European answer to common European problems'. The Bologna member states agreed on developing common structures for research training, including funding of pilot projects for European doctoral studies by the EU Commission. It was generally agreed that the basic structure of higher education (based on the two main cycles, bachelor-master) should be complemented by an agreement on the basic structure for doctoral training so that the latter constitutes an integral part of university education.
7. The 6th Framework Programme of the EU provokes the establishment of larger international consortia in order to be able to effectively take part in the programme. This development leads towards a further mixture of national and international research programmes whereby national programmes will gradually be accessible from other countries. In this context, the establishment of a European research council was advocated. Multiple levels of research policy will be the result: on the national, international and the local level. This is not to say that the national governments has played his part. The main government responsibility will be in the

sphere of quality assurance for what happens in the new spaces. Moreover, it will remain one of the (main) actors in strategic science.

To conclude, the workshop brought together researchers and policymakers from many countries to discuss aspects of postgraduate and postdoctoral education and training. It was acknowledged that it is a very topical theme which deserves more systematic attention given the important role of PhD students in the dissemination of knowledge, the strengthening of university-industry relationships, and not in the last place in the recruitment for university positions. The workshop has provided an abundant source of ideas and perspectives. Further collaborative efforts in the sphere of international comparative research and information gathering will be needed to inspire future debates and policies in this area.

Opening Address

Jürgen Enders, Center for Higher education Policy Studies (CHEPS),
University of Twente, the Netherlands

Dear Rector, Dear Prof. Friedrich, Dear Mr. Broesterhuizen, Ladies and Gentlemen,
Dear Colleagues,

It is my special pleasure to welcome you to this workshop on '*Science, Training, and Career*' where we want to discuss issues related to postgraduate and postdoctoral training from an interdisciplinary and international perspective. I am very happy to say that we were able to bring together such a selected group of scholars from research on higher education and research on science as well representatives from science organisations and the policy field from Europe and other parts of our increasingly international world. A special thanks goes to all our international guests who made it possible to come to our workshop during the lively harvest season of the national and international conference scenery.

In our invitation to this workshop we emphasised the point that various developments have lead to controversial debates on the status and function of the doctoral degree on the labor market and the best practice preparing doctoral candidates for their professional future. Recent attempts to initiate explicit policies for doctoral training and postdoctoral employment underline as well that the scenery has changed. In opening the agenda of this workshop, I like to address briefly just four points:

1) *Expansion of higher education and changes on the labour markets* seem to have reached a point, where doctoral training is infected by a number of issues traditionally raised in the context of undergraduate employment and work. This issues comprise, for example, the generalist-specialist debate and the growing emphasis placed on general skills and flexibility, the theory-practice debate and the growing expectations as regards so-called relevant knowledge, the disciplinary-interdisciplinary debate. The notion of relevance of doctoral training to the world outside higher education and science has become an important theme. Pressures have grown to re-think doctoral training as a preparation for an academic career as a single yardstick in order to make it more relevant for a broader variety of other careers outside higher education. At the same time, we can observe a decline of interest among graduates in certain disciplines to enter further academic training and career that raises questions on the attractiveness of the academic workplace for the new generation.

2) Postgraduate and postdoctoral training are more and more influenced by the debate to what extent higher education and science experience a *change in their mode of knowledge production* or are expected to change their modes of knowledge production. In this context emphasize is on the growing importance of "problem solving" approaches linked to the greater dissemination of knowledge capabilities throughout the economy and society. They highlight on the one hand the blurring of supposedly established borders between public and private research. On the other hand, the classical divide

between fundamental research, applied research and development seems no longer to work, borders becoming fuzzy not only between public institutions but also with industry and other knowledge producers in society. This has fostered new questioning about the specific conditions under which knowledge is generated within public-sector research and transferred to other sectors of societies. The research training function of higher education and the transfer of knowledge through 'the young generation of brains' are thus loaded by a number of principle debates on academic and scientific work and its changing nature.

3) The international dimension of research training, career and mobility become more important. In times and fields where interest for research training on the national turf is declining recruitment of international students becomes more important – a phenomena well known from the US. International markets for research training and global competition for the bright minds are growing and challenge the idea of a more or less entire national system of self-reproduction. The introduction of Bachelor- and Master-structures raise questions on the place, structure and financing of doctoral training. The recent process towards the European Research Area will certainly affect the research training function as well as the career prospects of younger academics in an increasingly internationalising context.

4) These developments challenge as well *public policy* and its relationship to other stakeholders when it comes to the research training function of higher education and public labs and the further careers of the next generation of academics and scientists. It questions both their rationale and their level of implementation in an area with multiple and overlapping authorities. For one thing, the research training function nowadays stands at the heart of the idea of academe as an institution not only combining but cross-fertilising education and science, teaching and research. Thus re-organisation and reform in this area traditionally undertaken on the national level tends to be a mix of public responsibility for education and training on the one hand and research and science on the other hand. This raises questions on the links between science policy and education policy in this area. Second, overlaps and alliances between universities, public labs and various private organisations raises questions on supporting mobility and setting mechanisms for quality assurance. And, last but not least, nowhere else than in Europe are questions related to the national and supra-national responsibility more pressing.

This list of issues is by no means exhaustive. The examples chosen, however, might suffice to open an agenda for further exchange and discussion of what we know about the various and changing faces of the relationships between science, training, and career; what can be learned from recent reforms and experiences in various countries; and what can be done to support what is a life strength of scientific production and an important vehicle for the dissemination of knowledge: the training of the coming generation of scientists and scholars.

It is my special pleasure now to invite our three speakers in this opening session to take the floor. I would like to thank very much Mr. Broesterhuizen from the Dutch Ministry of Education, Culture and Science that he made it possible to speak to us. A special thanks goes to Prof. Friedrich from the German Federal Ministry of Education and Research that kindly supports this workshop. First, I would like to give the floor to the Rector of our university, Prof. Frans van Vught, - I am grateful that you could come to give a note to us.

New Requirements and Structural Changes in Research Training in Germany and Europe

Professor Hans R. Friedrich, Federal Ministry of Education and Research (BMBF),
Bonn and Berlin,

Ladies and Gentlemen,

1. Introduction

As a convinced European, I am particularly pleased to be able to contribute to the opening and funding of this conference on "Science, Training and Career – Changing Modes of Knowledge Production and Labour Markets" here at the Centre of Higher Education Policy Studies (CHEPS) of the University of Twente.

I have had project relations and fruitful discussions for many years with the Centre of Research on Higher Education and Work of the University of Kassel, where Professor Enders comes from. I was a co-founder of the Institute for Higher Education Research in Wittenberg, the city in East Germany where Martin Luther lived and worked.

And currently I am chairman of the Bologna Preparatory Group, a high-level group of civil servants and consulting observers which meets between the biennial ministers' conferences to prepare the establishment of the "European Higher Education Area" by 2010.

This European concept is reflected quite well by today's event: a German scholar holding a professorship at the Dutch University of Twente has organized an international conference on major trends of change in research training in Europe and elsewhere, the working language being English ...

I would like to welcome the many top-class participants and guests who are present here today. The fact that so many people take part in this conference shows that it deals with a topical issue at just the right time.

The higher education systems in many countries are being critically reviewed at present. The reasons for this include the increasing international networking and the emergence of a world education market – aspects which have led to the inclusion of education services in the next round of GATS negotiations – as well as European developments in an enlarged European Union (EU) and within the framework of the Bologna Process "Towards a European Higher Education Area (EHEA)".

The invitation to the conference refers to the lively debate conducted in recent years about research training and the career prospects of junior researchers. It is pointed out

that an increasing number of doctoral degrees have been awarded since the beginning of the 1980s and research training programmes are of growing importance. Nevertheless, critics increasingly complain that the research training programmes offered by universities lack structure and need to be modernized and institutionalised to a greater extent. Furthermore we should consider the development of requirements as regards the general labour market on the one hand and academic teaching and research on the other.

2. Development in Germany: Which pathways lead to a doctoral degree?

I have been asked to talk mainly about the current situation in Germany and the trends that are beginning to emerge. A central feature of universities which distinguishes them from other scientific institutions is the right to award doctorates.

Thesis 1: Awarding doctorates must remain a privilege of the universities. Doctoral studies at non-university institutions should continue to be possible only in co-operation with universities.

Thesis 2: The status of research students, as well as their rights and obligations, must in future be formally established by the universities. The university as a whole must assume responsibility for its doctoral students. The fifth amendment of the Framework Act for Higher Education (HRG) has therefore introduced a special research student status in Germany. This status distinguishes postgraduate students from undergraduate students and entails the special obligation for the university and its departments to provide supervision and support in research training.

In contrast to most European (and non-European) countries, research training in Germany is not only important for qualifying the next generation of young researchers for the science system but, in certain subjects, is also an established and recognised training pathway leading to careers outside science. The labour market has so far honoured people who have successfully completed research training with preferential treatment in recruitment and with higher salaries. This is the situation in many of the natural sciences (for example, chemistry, physics and biology), where large numbers of graduates engage in research training and earn a doctorate.

Relevant surveys show that holders of doctoral degrees do not face major problems on the labour market; most of them find adequate employment. The development in the number of doctorates awarded – that is, a high percentage in the longer term, with a decline in the short term mainly in the natural and engineering sciences – is no cause for concern. The situation on the labour market for highly qualified young people looking for jobs outside academia or non-university research does not indicate a major shortage in the supply of candidates with doctoral degrees. However, there is a general shortage of graduates, mainly in the natural and engineering sciences. On the other hand, it is to be expected that, due to the growing demand for university graduates, most holders of doctoral degrees will continue to be successful on the labour market and find adequate jobs for which they are not overqualified. However, in certain subjects, for example in linguistics and cultural science, it will remain difficult for graduates of research training to find adequate employment outside science, as demand for such qualifications is limited on the general labour market.

Postgraduate research training has to meet both the less specific requirements of the

general labour market and the requirements of a career in teaching and research at universities and non-university research institutions.

In some subjects, mainly medicine and law, a doctoral degree is required for earning a professional reputation, especially among potential clients. A large number of degrees are awarded in these subjects, where less stringent requirements have to be met by doctoral theses.

Thesis 3: Research training for non-science labour markets will not be readily abandoned in Germany, also in view of European harmonization (as long as such training is sufficiently honoured by labour markets). In those subjects where to date doctorates have largely been earned for reasons of social prestige, research training should be differentiated in keeping with the specific requirements of scientific research. In Germany we do not have specific doctoral programmes. Doctoral studies are therefore largely unstructured and supervision is often inadequate. Outside the research training groups, which we call *Graduiererkollegs*, there are no standard regulations setting out the rights and obligations of doctoral candidates and their supervisors. The German Science Council will shortly issue recommendations on doctoral training, which will include the obligation to provide structured research training programmes. Doctoral candidates who are employed by their university often have to assume assistant functions which are not related to their research.

Thesis 4: All doctoral candidates should be offered structured research training, also outside research training groups, so that they are able to study their research subject – and not only the subject of their doctoral thesis – on a broader scale and to deal with issues related to the research situation and with research management. The final examination should, however, be limited to defending the doctoral thesis.

The pathways to a doctorate in Germany

In Germany, a doctorate can be earned via different pathways, which are characterized by specific forms of funding and specific activities, such as project work or work on the staff assigned to a professor or in postgraduate research groups.

a) Work on the junior academic staff of a university department: Here doctoral candidates familiarise themselves with the various tasks of a professor; they gain teaching experience, supervise undergraduates and are involved in institutional self-government. All this can be an asset when applying for a junior professorship. The qualifications acquired, including project management and leadership skills, are also recognised outside higher education. When working as research assistants, doctoral candidates can count on regular support by their academic supervisor. They are involved in academic activities and supported by their colleagues, for example, by post-docs and academic assistants. The university teachers to which the research assistants preparing for a doctorate are assigned are not only their superiors, but usually also provide advice and support regarding the doctoral thesis.

b) Many of the staff members financed from external funds prepare for a doctorate. As project staff, doctoral candidates are involved in major research projects. As a rule, the research they do for their doctoral qualification is part of the project. There may be a conflict between project requirements on the one hand and the requirements of doctoral studies on the other.

c) Different types of fellowships are provided for research students: There are grants for participants in structured training programmes and grants which are not linked to specific requirements and programmes. Examples of these types of fellowships are the research training groups (*Graduiererkollegs*) of the *Deutsche Forschungsgemeinschaft* (DFG) and postgraduate funding by the Länder respectively. The gifted education funding organizations (Begabtenförderungswerke) take an intermediate position.

The Federal Government played a leading role in initiating the research training groups programme. Under this programme, model structures were established and tested which proved that it is possible to improve the quality and scope of qualifications while shortening the duration of training. The structured programmes of the DFG research training groups have become an important option in terms of quantity. Herr Königs will report in detail on this point. However, the *Graduiererkolleg* cannot probably serve as a model for postgraduate programmes on a national scale. It is not possible for all universities to provide the supervision and support needed by these groups. Throughout Germany, universities should provide structured programmes for doctoral candidates on a smaller scale (in terms of semester load and supervision required). These programmes would have to be established and funded by the universities themselves (part of the professors' teaching load will have to be assigned to these programmes). The Science Council is considering calling this type of graduate studies "*Promotionskolleg*".

d) Various universities already offer graduate programmes (for example, doctoral study courses), which are similar to those I have just mentioned but do not include funding arrangements for doctoral candidates. What all these programmes have in common is that they aim to provide optimum research training conditions for excellent young academics. Everywhere, doctoral studies should be completed within a reasonably short period of time.

e) Further support programmes for doctoral training have recently been launched by various authorities. All these programmes aim to establish prominent research training centres for graduates by concentrating financial and human resources. Cases in point are the doctoral studies support programme of *Land* Lower Saxony, the North Rhine-Westphalian Programme for Graduate Schools, and individual projects such as the Graduate School of Social Sciences established at the University of Bremen and supported by the Volkswagen Foundation. Other initiatives are emerging.

f) Providing support for junior scientists is the declared goal of many arrangements in the non-university sector. I would like to mention in particular the Max Planck Research Schools. They offer German and foreign students the opportunity to prepare for their doctoral examination at selected locations which combine the excellent research and training conditions of Max Planck institutes and neighbouring universities; the doctoral examinations are administered by the universities concerned. So far, 19 International Max Planck Research Schools have been established. They involve co-operation between 25 Max Planck institutes and more than 30 universities. Before their implementation, the research school projects were considered and approved by a commission of experts composed of representatives of the Max Planck Society and of the German Rectors' Conference.

These examples show that there are many different ways of organizing and funding the doctoral or research training phase. Doctoral candidates can work on the junior academic staff of universities; they either hold established posts linked to a professorship, or they work in externally funded research projects. They are usually paid

in accordance with the Collective Agreement for Federal Employees (BAT). These BAT IIa posts are often filled on a part-time basis (mainly half-time employment) but, with certain departments, subjects and external fund providers, may also involve three-quarter or full-time assignments. In almost all cases, fixed-term contracts of varying duration are concluded with the research students. In the natural sciences, the duration is usually three years. In the engineering sciences and in the case of established posts in many other subjects, the maximum duration of five years was usually taken advantage of, pursuant to the provisions of the Framework Act for Higher Education as valid until 2001.

Thesis 5: The existence of so many different forms of employment and support for doctoral candidates is indispensable. Programmes fostering scientific excellence such as the *Graduiertenkollegs* will be of great importance also in the future. A variety of individual support programmes, including support by private institutions, offers many different opportunities for a large number of candidates. Support for doctoral studies will continue to be provided to a great extent through employment of doctoral students as members of the junior academic staff, either holding established posts or working in externally funded research projects. It is up to the universities concerned to provide adequate supervision and support for these candidates too.

Despite this great variety, a new relevance has been given to doctoral training by the fifth amendment of the Framework Act for Higher Education (HRG), which introduced a new status for doctoral students as well as the junior professorship and reduced the significance of the post-doctoral habilitation procedure. Structures and programmes will have to be adapted to take this into account.

As a result of the reform of employment law in German higher education, a time-limited junior professorship was introduced. Young researchers are to be appointed junior professors soon after earning their doctorate. Work as a junior professor is to be the standard requirement for appointment to a university chair. The introduction of the junior professorship is meant to shorten training times and to facilitate earlier independent academic research and teaching. At the same time, the junior professorship is to improve the chances of women as professorial candidates. The departments will share in the university's responsibility for shorter and better structured training, and the habilitation procedure, which leaves much research potential untapped, will be abandoned.

As in the past, however, there will be alternative pathways to appointment as professors. In particular, these include support under the Emmy Noether Programme. This programme offers young qualified researchers an opportunity to do their own research at an early stage. Immediately after earning their doctorate, researchers receiving funding under this programme can qualify for appointment as university teachers within a maximum period of six consecutive years. This includes a period of research abroad, followed by research on their own responsibility in Germany, which involves leading their own junior research groups and teaching specific courses related to their qualification.

The German Science Council has set up a working group which is to deal with individual aspects of doctoral training.

3. Goals of the reorganization of academic qualification pathways

From the point of view of the BMBF, the reorganization of research training is to pursue the following goals:

- enabling junior scientists to start with their own research at a considerably earlier stage; improving the procedure for establishment of qualification,
- facilitating first appointment at an earlier age by shortening all phases of qualification, including undergraduate and doctoral studies,
- increasing the attractiveness of German universities for qualified German and foreign junior researchers.

Universities should offer a structured programme for research training. University departments are to assume greater responsibility, particularly for ensuring excellent supervision and support for doctoral candidates.

Overarching research efforts have to take into account that doctoral training is organised differently in different scientific disciplines and subjects. Reorganisation of doctoral training cannot mean following the abstract goal of introducing a standard procedure, thus doing away with the specific research training cultures that have developed in individual subjects. However, features that are common to all disciplines should be taken into account when formulating science policy goals. These common features include:

- the requirement of a clear and transparent structure with well-defined responsibilities,
- transparent procedures for quality assurance and selection of staff,
- placing a reasonable limit on the duration of doctoral studies,
- different pathways to gaining access, also taking into account two-cycle study programmes,
- definition of doctoral studies as an established phase of training, which means that the candidates' work load that is not related to preparation of the doctorate must be reduced.

4. International, in particular European development:

The following development trends are currently being discussed in Europe:

- Organising common European structures
- Agreement among the currently 33 Bologna member states on common structures for research training, maybe including funding of pilot projects for European doctoral studies by the EU Commission.
 - **Doctoral studies:** The planned common basic structure of higher education (that is, a system based on two main cycles) is to be complemented by agreement on a basic structure for doctoral training;
 - Plans are being made to establish systematic quality assurance procedures on the basis of mutual trust and general recognition of national quality assurance systems and to reach agreement on **general principles of quality assurance**. Under these general principles, specific agreements on mutual recognition could then be concluded on a bilateral or multilateral basis;
 - There are also special cases such as research training at the European University Institute (EUI) in Florence – which is recognized by law throughout all member states of the European Union – and doctoral training at the Franco-German

University in Saarbrücken; there is not enough time to deal with these cases in greater detail now. Nevertheless, they should be considered as models in further discussions.

I wish every success to this important and interesting conference at the Centre for Higher Education Policy Studies in Enschede.

Science Policy in the Dutch Context

**Emil Broesterhuizen, Deputy Director, Research and Science Policy,
Dutch Ministry of Education, Culture and Science**

I am asked to tell you something about Dutch science policy as the context for the issue of today's conference, which is on science, training and career. Before I start I would like to say that my views do not necessarily reflect those of the ministry.

Dutch science policy is developing between sets of conflicting policy goals. One of these is the following.

At the one side there is the notion that Europe's and our future will be largely determined by knowledge as a primary production factor, at the other there is the financial policy of Dutch government.

We know all about the ambition the heads of government of the European Union formulated at their summit in Lisbon in March 2000. They wanted Europe to be the most dynamic and competitive economy in the world in the year 2010. And much more explicitly, they formulated in Barcelona in March 2002 a quantitative goal for that: in the year 2010 the expenditure for R&D and innovation in Europe should reach to 3% of GDP, whilst 2/3 of the new investments should come from the private sector. The former Dutch cabinet, the second cabinet under prime minister Kok, I mean, stipulated after the Lisbon summit that our country should be at the forefront in Europe in 2010.

Three percent of GDP means, that Europe should expand its investments in R&D by two thirds. If we translate this goal to Dutch spending on R&D, then we should raise R&D-expenditure, which is now slightly above 2% of GDP, with almost 50%.

If asked if this is realistic, I have to say 'no, not very'. It would mean, for example, that the R&D-expenditure of the private sector should almost double. Dutch industry is investing amazingly small budgets in R&D, and whatever we do, private sector R&D-expenditure is not raised by government decree. This scepticism does not mean however, that we have to acquiesce in the, I hate to say, somewhat faint-hearted advice about the Barcelona targets given last June by the Advisory Council on Science and Technology. The declaration of Barcelona has to be seen as a powerful statement of the European heads of government who wanted to put science, technology and innovation high on the political agenda.

Since Barcelona the political scene in our country changed drastically. A new government came in and fell. We do not know of course what policies the cabinet to be formed this winter will like to promote. So, let us take the priorities set in the Strategic Agreement of the now defunct coalition as a starting point: reduction of the state debt is the first; security and reduction of bureaucracy are among the most prominent priorities. Although the direct funding of research organisations by the ministry of Education, Culture and Science was excluded from budget cuts, the budgets of universities and the programme and project funds of the ministry of Economic Affairs, and other ministries as well, were significantly reduced. The words 'science' and 'knowledge' are not found in the agreement, the word 'technology' is only sparsely used.

An important compensation for these cuts will, hopefully, be provided by the 805 mln. for the period 2003 – 2010, which, according to the plans, the cabinet in charge then will decide upon next summer on the basis of the proposals put forward in the so-called ICES-KIS procedure.

Our parliament seems to be worried. In the debate about the Strategic Agreement of the new coalition a motion was broadly accepted asking the government to devise policies that would support the development of the knowledge economy. In the debate about the government budget for the year 2003 a motion was presented to cancel the budget cuts on higher education; this motion was rejected. Another motion asked the government to develop proposals for the promotion of innovation, underlining the importance of scientific research for innovation. This motion will be discussed during the parliamentary debate on the budget proposal of the ministry of Education, Culture and Science.

At the opening of the Academic Year on the 2d of September, most of the university presidents complained bitterly about the new budget cuts, the umpteenth in at least 20 years. An organisation like TNO, the main Dutch public research contract organisation is facing a decline in government contracts, and other institutes have to fear similar problems.

Although I understand these complaints, I find this way of reasoning not very fruitful. The research system should try another approach. I think that the research system has a serious public relations problem. Although, under the second cabinet of mister Kok, there were signs of science gaining ground in political circles, we have to admit that we have to start all over again. I think that politics in general is not convinced of the social return of the public R&D expenditure. Politicians are not very much impressed by general statements about the importance of scientific research and technological innovation, not only for economic development but also for the advancement of public goals and services. The Dutch scientific world and other interested parties have quite a job to do to make them change their minds. That asks for very practical approaches that appeal to the feelings of politicians. The setting up of the large programme for genomics, the largest single programme for science in our country since the mid eighties, gives proof for that. And perhaps that the statements of the senior technology officer of Philips, about the transfer of Philips research to other countries, like Belgium, Ireland or Singapore, in connection to his criticism of government policies and the university system in our country, make some impression.

Science policy might have to face in the coming years a no-growth or even negative growth situation. We will have to try to spend the budgets available in a most efficient way, trying to get the best results possible. This means in my view:

- maintaining or even enhancing research quality, and, at least as important, making clear to the outside world that high quality research achievements are rewarded at the expense of research of a less high quality.
- showing in a very practical sense what science and technology have to offer to society and enhancing the societal return of the public funds spent on R&D.

There are five other, sometimes conflicting, factors, that form the context for the main lines of science policy for the coming years:

- The drive for more autonomy for the universities and research organisations will certainly keep on. This means that universities and research organisations will have ample room for devising their strategies and policies.
- Reduction of red tape is an important issue nowadays. We would like to reduce the administrative burden put on scientists as much as possible, so that they can use most of their time to do what they are good at: research and teaching.
- Accountability, supervision and control are becoming more and more important. This factor could easily go against more autonomy for the universities and research organisations and cause more red tape as well. The point is to make universities and research organisations really accountable for the fulfilment of their missions and the results of their strategies and policies.
- The demographic changes we have gone through and the changes in study and career choices, not only in our country but in the whole industrialised world, are causing serious problems with respect to the recruitment of young scientists (or broader: knowledge workers) in a number of important areas of science and technology, already now and the more so in the coming years.
- One of the most important aspects of the context of science policy is the internationalisation, or in any case Europeanisation, of science policy. The European Research Area will come much slower than Commissioner Busquin is striving at, but the trend is certainly there.

Against this background I would like to point to a number of policy issues, not an exhaustive list, that will have to be taken up soon.

The first is about budget and quality. I am sure in our country we need a mechanism that links budgets to research quality and research achievements, also in the universities. This mechanism must be simple and effective. Opinions on this matter in the academic world are divided, in the relevant outside world they are not. I think it is inevitable and necessary, not only to promote and protect the best research, but also for a better positioning of university research in the outside world.

A second point concerns priority setting. That will be left largely to the research system itself, preferably in close relation, when relevant, to partners in society. In my view the role of the government will be threefold:

- Government will see to it that universities and research organisations formulate their own policies, present these in four-yearly strategic plans and give account of the results achieved.
- When research investments for the sake of societal interests are planned, ICES-KIS being an example, government organises a bottom-up process for the formulation of priorities.
- In cases that priorities require actions that are beyond what individual institutions can handle, government has to take responsibility and give these priorities a push, on the basis of careful foresight and advice. In those cases a national strategy can be necessary, as is shown by the genomics initiative.

The third issue. It is necessary to protect and give room to basic research, at the one side, and to promote the flow of knowledge from basic research to practical application and back, at the other. Also these goals seem to be conflicting.

The OECD, an organisation that is very keen on harnessing science to innovation, is stressing the importance of basic research already for several years. In a recent OECD

document I saw to my surprise that the volume of basic research, as a percentage of GDP, in our country is now below OECD-average.

As university research is concerned, it must be clear that the scientists have to be in the driver's seat. But one may ask scientists to be open to the outside world and to let themselves be inspired by the challenges of society. That asks for the promotion of 'innovative networks'. Some, like Michael Porter in his last year's Technology Lecture, have said that university research is still in an ivory tower. We know all that that is absolutely a wrong and unfair picture. But improvements can be made – I refer for example to a study on university-industry relations in ICT-research, done by TNO. By 'innovative networks' I mean the fervent relationships the Advisory Council for Science and Technology meant in its foresight report on ICT, 'Longing for the endless sea'. These networks also contribute to the conditions necessary to attract and keep business R&D in our country.

We think that our research council NWO can play a very fruitful role in promoting the flow of knowledge. The large genomics initiative, organised in a separate entity within NWO and aimed at coherent steering of research over the entire innovation chain, could be a successful model. A comparable approach was chosen for the catalysis research programme ACTS, also with NWO. The merger of ZON (Health Care Research Netherlands), the agency for applied research of the ministry of Health, with NWO's Medical Sciences Board – hampered as it may be by budget cuts -, offers comparable opportunities.

It would certainly not be a crazy idea to bring together NWO and the so-called Sector Councils. The foresight and research programming activities of these Sector Councils could then be carried out in direct contact with responsible ministries at the one side and an organisation that really is good at promoting research quality. Such a structure could provide bridges between basic science and application.

The next issue is about accountability and diminishing of red tape. Many scientists complain about the administrative burden put upon them by a large array of policy instruments of the different ministries, the funding agencies as well as the universities. Many of the funding schemes have a rather low chance for success. Decision making procedures are not always felt to be transparent. In co-operation with universities and research organisations we would like to reduce bureaucracy. The number of policy instruments could be quite reduced. And would it not a good idea to have policy schemes that provide funding for longer periods and larger sums of money?

There is a clear tendency of stricter accounting of public funds and of the results of the activities and policies of public bodies, also in science. We have made agreements with a number of large research organisations about a small set of indicators they will use for accounting. That approach was based on the idea, that we should not ask more information than we really need for making up our mind on the way these organisations are functioning.

A fifth issue is internationalisation. It will take much more time to bring about the European Research area than Commissioner Busquin will like, but steps are made in that direction already in the 6th Framework programme. As a consequence of the introduction of new larger scale instruments we need to have our research establishments developing larger consortia in order to be able to effectively take part in the Framework programme. In the longer run that will lead to larger units, virtual or not, at the national level as well. National programmes will gradually be opened up to participation from other countries – when reciprocity is assured, of course. We intend to

promote the setting up of a real European research Council. Perhaps the Dutch presidency in the second half of 2004 will offer the opportunity to give that a boost.

All these issues may seem not to be too relevant for this symposium, which is about science, training and career.

However, if we want to realise the goals that I put forward, we will need human resources, a high quality scientific corps. In our view human resources is a crucial policy issue.

In this policy area universities occupy a very important place indeed. The primary function of the university is to educate and train people and to deliver highly qualified people to society. University research not only leads to new interesting knowledge, but also to well-trained scientists – the formation of scientists is a very important function of university research.

But there is another reason why the universities are important in this policy area. Year after year successive ministers stressed the importance of an effective human resource management for the universities and research organisations, and delivered ideas and suggestions for such a management. Ministers could not do much more, because the responsibility for human resources management is with the universities and research organisations, and rightly so. Only now the universities seem slowly to come in action.

When looking at the human resources for science, one can easily identify a number of – partly interrelated – problems:

- The influx of secondary school graduates in a number of scientific and engineering disciplines is declining all the time; the resulting influx in research, 5 to 6 years later, will be proportionally lower. It is remarkable that more than 40% of secondary school pupils choose their so-called profiles in science and technology, and science and health.
- Research does not seem to offer attractive career opportunities for university graduates. The influx of young graduates in research seems to be low. As a result there are growing shortages of candidates for AIO-positions, which brings universities to hire youngsters from other countries.
- The participation of women in research is rather low, at least in the higher ranks of the academic staff. So we are losing quite a lot of talent.
- Our country does not seem to have an alert and effective policy for the migration of scientists and engineers and those immigrating are confronted with tough bureaucracy locally.
- Within a few years we could be confronted with insufficient numbers of successors of the scientific leaders of today. That was a very important driving force behind the so-called 'Innovation Impulse', in Dutch '*Vernieuwingsimpuls*', a scheme to give young talented scientists room to develop their own research ideas into a research programme.

The consequences of these developments are very worrying. Not only do we already face shortages of trained scientists, but in the future these shortages will grow. These tendencies are not unique at all, the whole Western world is confronted with them. At the OECD this problem is high on the agenda, but successful solutions are yet to be found.

We feel we need a comprehensive policy for the issue of human resources for science and engineering. The ministry will prepare a so-called 'deltaplan for science and engineering', that in my view has to cover pupils' choices and curricula in primary and

secondary education, students' choices and the nature of the study programmes in the university and vocational education, as well as the attractiveness of research careers, including human resources policies in the science system. It has to pay attention to public awareness of science and technology, especially for the young.

Another important consequence is that universities feel that they have to reorganise and reduce the number of academic staff in those disciplines which for years have to cope with strongly declining student numbers. The University of Leiden decided last year to focus the departments of biology and chemistry on bio-molecular science, much to the distress of the ministry of the Environment that complained that valuable ecological research was stopped.

We think that the universities have to have the lead in formulating plans in such a way that on a national level a balanced portfolio is maintained. Three years ago the Advisory Council for Science and Technology advised to reduce the number of departments in such areas like physics and chemistry. The ministry then asked the universities to make up a plan for the natural sciences. Such a plan was proposed only recently, and we are not really convinced that it is a good one. These problems are not unique for the natural sciences. Also language and literature studies are confronted with these kind of problems. In 1996 a covenant was made by the universities, but the covenant could not be renewed thus far. It is difficult for the universities to come to an agreement in these issues, local interests conflict with the national interest.

The ministry puts quite a lot of pressure on the universities, but is not in the position to settle the problem by decree. This creates a dilemma for government. The more so, because these developments do not only affect the universities and research institutes, but also industry. Some leading industries, for example Philips, are complaining about government policies and the university system, warning that they will have to move their research to other countries. If these warnings are serious threats or not, is not very important. They are clear signs that the conditions for investing in business R&D in our country are really deteriorating. That is very worrying in the light of our own ambitions. For I am sure that that the well-being of our country is very much dependent on scientific and technological knowledge and thus on highly qualified scientists and engineers.

Strategic Research, Post-modern Universities and Research Training

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Introduction

In our present time of change, *research training* is an impossible challenge. We have to train students for the world of science and research – but for which world? Traditionally, that is in more or less stable situations, it could be defined as bringing students to the research frontier of the particular specialty. Derek de Solla Price once calculated that you need four years to do that, so that should be the time allocated to PhD training. In the present fluid and dynamic situation, research training has to prepare students for roles and skills which are not clearly articulated yet. And there is no assurance that their research career (if they will have one) will be located within a particular specialty. One may set goals for research training, but these are moving target posts.

There have been attempts to diagnose what is happening and project a probable future. The Gibbons et al. thesis about Mode 2 of knowledge production is well-known, and while it is simplistic in its projections, the diagnosis of ongoing changes appears to be right. The Triple Helix analysis of increasing interactions between universities, governments and firms is less ambitious. There is a link with changing roles of academics, who are becoming quasi-entrepreneurs, with the university as the equivalent of a holding company. The emergence of strategic research, and in particular its institutional location in Centres of Research Excellence and Relevance (my terminology), is an interesting development visible since the 1980s. Clearly, it is possible to identify some trends. My additional point is that lock-ins may occur, in which institutions and activities at different levels of the research system get aligned and a new regime emerges. As I will show below, there are good reasons to expect a regime of *strategic science* to stabilise.

Research training occurs on location, traditionally in research universities (where departments or chairs were in the business of reproducing their specialist scientific/scholarly community). These universities are also on the move, and may not remain the exclusive location for research training – which then raises the question whether the role of specialist communities will become correspondingly less, or at least heterogeneous and distributed. A kind of *post-modern university* might evolve which would accommodate the new requirements of research training.

Research training could, and often did, focus on requirements of the specialist community and thus remain isolated from society, in terms of the human capital it produced. The complaint about ‘ivory towers’ is well known, and the specialist/generalist debate is another take on the same issue.

In a recent ESF Policy Briefing, the notion of “T-shaped people” is introduced (in relation to needs of industry, but one can enlarge the analysis to the needs of society):

Industry seeks “T-shaped people,” in which the down-stroke represents depth and specialist knowledge in a discipline and the cross-stroke represents breadth and flexibility.¹

While industry may well focus on bachelor and master degree students, one could argue that research training nowadays is also about creating T-shaped people – a productive deformity! One could link this with Jürgen Enders’s remark, in the background note to this conference: “doctoral training is infected by a number of issues traditionally raised in the context of undergraduate employment and work.” By keeping the link with knowledge production visible, one can say something specific for research training.

In the first half of this paper I shall elaborate on the evolving conditions for research training (strategic science, post-modern universities). In the second half, I discuss new possibilities for research training.

Part I: Changing contexts and locations

Strategic science

The old division of labour between fundamental and applied or problem-oriented research has almost disappeared, and with it, the functional distinctions between universities, public labs and industrial and other private research. What has come in its place? The fluidity of a transitional stage, but also emerging new patterns.

Gibbons et al. (1994) and the recent sequel by Nowotny et al. (2001) emphasize a number of changes which in their view add up to a Mode 2 of knowledge production (in a Mode 2 society).² Mode 2 is characterised by fluidity, changing research teams, distributed research more generally; discovery in the context of application and transdisciplinarity (= the irrelevance of traditional disciplines); new forms of quality control (at least, the need for it); contested expertise and (social) robustness as the new ideal; and the needed recontextualization (in society) of science and the institutions of science.

One may be doubtful about the overall thesis (already because of its programmatic nature), but many of the changes that are identified are important to take into account. What Gibbons et al. neglect is the emergence of strategic research. While the term was used already in the 1970s, to denote applied research with a long-term perspective, it has now become a type of basic research. In some fields like biotechnology and chemistry, and some areas of social science, strategic research covers most or all of the research that is done.

Strategic research combines relevance (to specific contexts, possibly local) and excellence (the advancement of science as such), and may therefore bridge the eternal tension

¹ European Science Foundation Policy Briefing 17, July 2002: *Agents for change. Bringing industry and academia together to develop career opportunities for young researchers*, at p. 4. [Report of a meeting sponsored by ESF with Science Magazine Next Wave and the Karolinska Institute, Stockholm (Sweden), 24-25 March 2002.] Given the diagnosis of increasing heterogeneity, it is interesting to note the combination of sponsors: European Science Foundation, *Science Magazine*, and a higher education and research institute.

² Michael Gibbons, Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M., *The New Production of Knowledge. The dynamics of science and research in contemporary societies*, London: Sage, 1994. Helga Nowotny, Peter Scott and Michael Gibbons, *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press, 2001

between regional and global.³ But it does so in a specific way. The (by now) authoritative definition of Irvine and Martin brings this out well:

Strategic research [is] basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised current or future practical problems.⁴

Thus, a distance is created between ongoing research and the eventual uptake of its results by emphasising expectations, the production of a 'base of knowledge', and the provision of a background to problem solving rather than offering solutions. In this way, excellence and relevance can be combined.

Research results thus contribute to a reservoir of scientific knowledge and technological options, while others fish in the reservoir and create new combinations (which range from new understanding to new technological options, innovations and expert advice).⁵ The reservoirs are visible in the contents of scientific and trade journals, but just as important are professional networks. Hybrid communities, they could be called, and examples abound in fields like chemistry and biotechnology. Performance indicators for (academic) scientists increasingly include activities in such hybrid communities.

Institutionally, an important indicator of the increasing importance of strategic research is the spread of *centres of research excellence & relevance*. T-shaped centres, one could say. The USA Engineering Research Centers, the UK Interdisciplinary Research Centres, and the Australian Collaborative Research Centres all started in the 1980s, and by now, such centres are set up everywhere. For science policy makers, the key point is that they are time-limited in terms of funding (10, maximum 15 years). There are often other sponsors, and on that basis, a centre can survive after special funding has stopped. The centres are almost always a good context for PhD training; the USA Centers have PhDs as one performance indicator. They can also offer shorter stretches of on-the-job research training (which may contribute to a PhD), and postdoc training.

Do these new structures and patterns add up to a new regime? 'Science, The Endless Frontier' (after the title of Vannevar Bush's 1945 Report to the US President) characterises the earlier regime, which started to shift (to relevance) and break-down (as to assured roles of public laboratories and research universities). By now, one can see a new regime, 'Strategic Science', emerge, where strategic research is basic way of doing research.⁶ The characterisation of this regime overlaps with the changes highlighted in

³ The contrast between fundamental (and scientifically excellent) research on the one hand, and relevant research on the other hand is not a principled contrast. It has more to do with the institutional division of labour, than with the nature of scientific research. The combination of scientifically excellent and relevant research occurs again and again, in history and in present-day science. This combination is not present in all disciplines and scientific fields in the same way, but it occurs sufficiently often to justify the claim that a new category like strategic research that embraces both is a realistic option.

⁴ Irvine, J. and Martin, B. R. (1984) *Foresight in Science. Picking the Winners*, Frances Pinter, London.

⁵ The pattern of knowledge reservoirs and uptake by (scientific) users also occurs in traditional academic research areas, but then normally remains limited to the researchers in that area. One could see this as an extreme ('pure') case of the hybrid picture sketched in the main text. Historically, such 'pure' areas are in fact a recent phenomenon (from mid-nineteenth century on). Therefore, when Gibbons et al. speak of Mode 1, the academic-disciplinary mode, this is not the basic pattern of scientific research, but a historically contingent regime covering roughly a century, from 1870 to 1970. It is within this regime that PhD training, as we used to know it, was shaped.

⁶ I have argued this in a number of (overlapping) papers, including Arie Rip, 'A cognitive approach to relevance of science,' *Social Science Information* 36(4) (1997), 615-640; and Arie Rip, 'Fashions, Lock-Ins, and the Heterogeneity of Knowledge Production,' in Merle Jacob and Thomas Hellström (eds.),

the Mode 2 thesis (as it should: we are diagnosing the same world), but the processes of change and institutionalisation are now traced explicitly.

The lock-in into this regime was pushed by the interest, in the 1980s, in scientific technologies as motor of renewed economic growth. But there is a second component as well, the interest in long-term developments about which decisions must be made now, and which require new kinds of scientific input. Climate change is an obvious example, also in the sense that it has been embraced by policy makers and has become a growth industry for a number of scientific specialties.

Part of the regime of Strategic Science is a modified version of the division of labour between research and uptake of research (in innovation, in health care, in policy making). Scientists have internalised the pressure for relevance, but maintain the open-ended character of their research, with the attendant freedom to move to other, more promising lines of research.⁷ This applies to innovation-oriented research, but just as well to expertise and decision-oriented strategic research.

Instead of a linear model of innovation (and attendant policy measures and expectations of immediate benefits), one could speak of a *lateral* model of innovation, where innovations and their effects on wealth creation and quality of life are not limited to a linear innovation chain. Some of the more interesting innovations and their impacts derive from new, lateral combinations, and the social and intellectual mobility of key actors.

Life sciences and technologies are linked to innovation, as well as to insight and expertise, and thus straddle the two components of the regime. Environment and earth sciences, most social and behavioural sciences linked to the second component, strategic decision making

From this diagnosis, some immediate requirements for competencies in a scientific career can be derived. A mastery of a range of approaches and skills (some through own work), the ability to do (mixed) scanning of developments in scientific and societal environments, and some skill in the identification and exploitation of “leads”.

But this is only part of the story. The importance of scientific expertise for decision-making under uncertainty, and the resulting pressures for “sound science” -- whatever that may turn out to be -- require further skills, at least for some researchers. They must be able to provide expert narratives linked to (societally) robust evidence. The requirement of societal robustness, rather than just scientific robustness, has to do with the changing position of scientific expertise in society.

Society is now less fatalistic about impacts of science and attendant risks (as with molecular biology and genetic modification), and wants some technology assessment done (including ethical aspects) – this will modify innovation-oriented research, for example by having an ELSI component in stimulation programs of genomics and nanotechnology.⁸ Society wants expertise (up to “sound science”) even in the face of large

The Future of Knowledge Production in the Academy. Buckingham: Open University Press (2000), 28-39.

⁷ For legitimation purposes, typical stories about strategic research have the hero as the source of one or more ‘innovation chains’ leading to a fabulous new material or a wonder drug. In practice, there are gaps in the chain, to be bridged by others than the hero. But scientists remain horizontally mobile because of the gap in the innovation chain – that is how they can remain linked with the global.

⁸ ELSI stands for Ethical, Legal and Social Issues, a small part of the Human Genome Initiative program in the US. Almost all recent genomics programs have such a component, if only for legitimation purposes. Nanotechnology programs similarly want to have attention paid to technology assessment. See for a discussion, Arie Rip, *A co-evolutionary perspective on ELSI, CTA and other attempts at re-contextualization of science and technology in society*, paper presented to the Bi-annual Conference of the European Association for the Study of Science and Technology, York (UK), 31 July – 3 August 2002.

uncertainties. Expertise is not limited to what regular science provides. New stakeholders are becoming important (at all levels of the research system). Public scrutiny of science is now a fact of life. It has to do with public understanding of science, but more importantly, with new interactions in the risk society, including a critical appreciation of experts and expertise. But also continuing trust in science even if specific developments are being criticised.

A researcher need not be involved in all of these broader issues, but some sensitivity to them is important, as well as exposure to examples how to handle them.⁹

Obviously, not all of the requirements linked to life under the regime of Strategic Science can be trained in a period of three or four years. Nor should one expect all of them to be present in one person. But all of them should be present, or at least made visible, in the group or centre in which the PhD is done (or better, given the mobility of PhD students: all of them should be encountered during the PhD journey).

There is increasing recognition of the need for broader training, even if its realization is not always easy. As an example, take the rationale for training at the French *École des Mines*. While the *École des Mines* is not a regular university but a *Grande École*, it does educate an élite of technocrats (although not much research training). In its brochure, the mission is set out as “A close alliance between research, training and industry” where the engineer is “prepared for tomorrow’s tasks”. The diagnosis is remarkable: “Tomorrow’s engineer will change jobs several times during his career and may even change his field of expertise in various locations, often abroad. In order to cope with these upheavals, the *École des Mines* graduate is given a sound basic training, ranging from the fundamental sciences to the applied sciences, while including economics and social science, with strong emphasis on development of personal initiative and appreciation of international issues. In this way he combines his technical skills with expertise in economic and social forecasting. He is not only competent in traditional spheres but also in those which will undoubtedly be required in the future: the multi-media, communications, design engineering, etc.”¹⁰

Post-modern universities

For research universities, the key challenge is to diversify and recombine its components, both cognitively and institutionally, into what I call a post-modern university. Such a university will include overlaps and alliances with Centres (of excellence and relevance), public laboratories of various kinds (themselves on the move!) and various private organisations managing and performing research. The boundaries between the university and the outside world are porous, and such ‘porosity’ is sought explicitly.¹¹ Partial examples are visible already, as in the close collaboration with public

⁹ One example is how to take societal impact of expert advice into account in the scientific choices made in constructing the advice, and thus showing pragmatic rather than utopian rationality (Arie Rip, ‘Expert Advice and Pragmatic Rationality’, in Nico Stehr and Richard V. Ericson (eds.), *The Culture and Power of Knowledge* (Berlin and New York: De Gruyter, 1992) 357-373). Nowotny et al. (2001) also emphasize social robustness, but appear to limit it to interaction with stakeholders.

¹⁰ The original French text is slightly different, and more convincing. For example, the final sentence reads: “.. les ingénieurs sortent de l’École non seulement formés aux métiers traditionnels, mais prêt à saisir, voire à inventer, les emplois de demain: multimédia, communications, ingénierie de la conception ...”

¹¹ In their review report, De Boer et al. identify notions like ‘unbundling of the university’, ‘porous institutions’, ‘permeable boundaries’ and ‘post-modern university’. Harry de Boer, Jeroen Huisman, Anne Klemperer, Barend van der Meulen, Guy Neave, Henno Theisens, Marijk van der Wende, *Academia in the 21st Century. An analysis of trends and perspectives in higher education and research*. The Hague: AWT (Adviesraad voor het Wetenschaps- en Technologiebeleid), Sept. 2002.

research organisations of some universities in France and South-Africa, or even a merger, as in Wageningen University and Research Centre.¹²

Traditional disciplinary faculties may well disappear in the end, but that is not necessary. They can remain as part of the heterogeneous set-up. (As I will further argue below, disciplines as we know them may not be of major importance, but interdisciplinarity as such is not the answer.)

In such a university, a doctoral student can wend his or her way through the various types of locations that are present, just as s/he is expected to do in his or her later career.

The question of credentialling and accreditation has to be solved. Clearly, governments at various levels will have a responsibility, even if only at arms' length. There have been proposals for portfolio diplomas, where students collect teaching and training, and there are degree-granting bodies checking the portfolio.¹³

So everything will be OK in this best of all possible worlds? No, there are problems and barriers of various kinds. Universities do not change easily. *Doktorvaders* are out on reproducing their specialty, also with an eye to their position within it. PhD students provide cheap research labour.

But there are ongoing changes. I see the (T-shaped) Centres of Excellence and Relevance in the universities as one of the bridgeheads for the postmodern university. For research training, such institutional arrangements are important. For the content of the training, one has to look more closely at the cognitive and professional changes. For engineering, we have shown how university training at first followed changes (including cognitive changes) in the profession, but from the 1950s onward focused on becoming a regular part of the (research) university.¹⁴ This distance to the professions is still visible, but if one wants to overcome it, one should think about their future, rather than their present needs.

¹² For a case-study of the University of Twente, in relation to the regime of strategic science and to regional innovation systems, see Arie Rip, 'Regional Innovation Systems and the Advent of Strategic Science,' *Journal of Technology Transfer* 27 (2002) 123-131.

¹³ For Brown and Duguid, such degree-granting bodies (DGB) should be separate from universities (John Seely Brown and Paul Duguid, 'Universities in the Digital Age' *Change (The Magazine of Higher Learning)* July/August 1996, 11-19). The traditional university might well survive, but as one package-deal among others. "Despite the loss of a tied academic administration and faculty, concrete facilities under [the new] arrangement would no doubt look very much like the campus of today." (p. 19) Their vision of the future emphasizes distributedness: "In this way, a distributed system might allow much greater flexibility, employing local sites of professional excellence – research labs, hospitals, architects' offices, law firms, engineering offices, and the like – to offer mentoring programs that give students practical experience and course credits simultaneously. Regions that lack conventional academic facilities might start to attract students through the quality of mentors in the work force. Students in forestry, viticulture, mining, conservation, or ocean science would, for instance, be able to get credit for working with experts in the field, however far this might be from conventional academic centers. Essentially, a student's university career in such a system would no longer be through a particular place, time or pre-selected body of academics, but through a network principally of students' own making, yet shaped by a DGB and its faculty. (..)" (p. 19)

¹⁴ C. Disco, A. Rip, B. van der Meulen, 'Technical Innovation and the Universities: Divisions of Labor in Cosmopolitan Technical Regimes', *Social Science Information* 31(3) (1992) 465-507. E. Homburg, A. Rip and J.S. Small, 'Chemici, hun kennis en de industrie,' in Schot et al., *Techniek in Nederland in de twintigste eeuw, deel II* (2000), 299-316.

Part II: Research training – what and how?

Knowledge transfer from academia to society goes through people (graduates). Both general competencies and specific knowledge are important (cf. T-shaped people), but in different ways. Some specific training is necessary (to acquire the craft skills, and to obtain some competencies useful in a first job), not just general problem solving,¹⁵ or interdisciplinary or other ‘liberal’ education. But training in a scientific/scholarly specialty as traditionally defined is not relevant anymore. There are new clusters of knowledge production, transfer and utilisation which should structure training. In other words, we need a cognitive diagnosis of developments, not just new institutional arrangements.

Based on such a diagnosis, I see two new developments which must transform university education (undergraduate as well as graduate): changing knowledge production in relation to professional practices, and the rise of ‘new natural history’ approaches.

(1) *Professional practices* with a knowledge-production component change, require other combinations of knowledge and skills (in researchers) and other types of research.

Let me take the situation of engineering as a starting point. Traditional sectoral-defined competencies (oil, sugar, paint, electricity generation) and partly overlapping professional classifications (mechanical engineering, electrical engineering, chemical technology etc) were relevant during the main part of the 20th century, but not anymore. They are now reduced to labels for training classifications (with little relevance to graduate research). In their stead, one can identify two main clusters of professional knowledge practices:

- sociotechnical systems engineering
 - advanced technologies (materials, mechatronics, optics, bio, nano, ...)
- Actual undergraduate and graduate training already follows one or the other of these clusters.¹⁶ Note that each of these clusters have their own mix of excellence and relevance; it is not a matter of general versus specialized training.

Having seen this, one can look for similar developments in other areas. In medical & health, there is integrated health care research, and advanced biomedical research (with clinical research sitting uneasily between them).¹⁷ In agriculture, there is the broad spectrum ranging from agriculture research to rural development and nature conservation (or nature care), as well as dedicated laboratory and field research often related to molecular sciences.

In education, social care, and psychology, the separation between the two such clusters is perhaps less emphatic, but the difference in emphasis can be seen, for example between designing a communication campaign and studying foundations of communication.

¹⁵ Jürgen Enders, in his April 22 Note, identifies emphasis on problem solving, but I don’t see that. Below, I identify new tasks in terms of knowledge production in professional practices and in natural-history type expertise.

¹⁶ The recent reshuffling of technical schools in the University of Twente actually arrived at a similar clustering, with a School of Constructive Technical Sciences and a School of Applied Natural Sciences (plus a School of Information Sciences).

¹⁷ Interestingly, in the Netherlands research in these two areas was funded by different organizations (the national funding agency NWO and the dedicated organization ZON, Health Care Research Netherlands), but the Medical Council of NWO recently merged with ZON to exploit overlap and synergy.

In policy & regulation studies, political science and law, there is a foundational component linked with the development of normative theory, as about a 'constitution', about rights, about 'good' policy.

One can continue this exercise further, for example in the domain of economics. But it does not cover everything. In particular, knowledge production has an epistemic dynamic of its own, somewhat independent of the professional dynamics.

(2) *Epistemic dynamics: evolving mix of modes of knowledge production.* Three main modalities of knowledge production can be distinguished, which require different skills and approaches to produce robust results, so there are implications for research training. Briefly (but drawing on a broader diagnosis):¹⁸

The first modality or mode of knowledge production is based on circulation of embodied knowledge and partial articulations and codifications between local practices. This is the main mode of knowledge production in traditional knowledge, in the crafts, and in professional communities, also today, even when there is also strong input from other kinds of knowledge. The importance of clinical judgement in medical practice would be one example.

The second modality can be called "natural history", to honour a venerable tradition. Circulation remains important, but may be more extended, and consciously sought after, as when Aristotle collected and refined observations and traveler's tales, or 17th and 18th century amateurs collected specimens, museums and gardens were established and scholars were hired to study the collections. The key element is the attempt to recognise patterns which extend over time and place. Since the 19th century, collection, refinement and pattern recognition have become quite sophisticated; geographical information systems (GIS) are a recent achievement and stepping stone to further developments. In fact, there are good reasons to speak of the rise of a 'new' natural history.

The third modality is the production of knowledge under controlled circumstances, in a laboratory and in experimental situations more generally. This starts out as a local practice, and its reproduction in another local practice, say, a laboratory attempting to also build a new kind of laser, is fraught with difficulties which can often only be resolved by visiting the original location and learning relevant skills. The idea is that the phenomena created under such restricted circumstances allow access to background regularities which are valid more generally – at the very least as long as one can recreate the relevant circumstances.¹⁹

The tradition of 'natural history' has been revitalised through the increasing importance of the sciences of the environment. Measuring, mapping and modelling the world becomes a scientific challenge in its own right – one might speak of the "3M" sciences -- , and is pursued with the help of new information and communication technology. One can put this more strongly: The experimental approach of high science (especially of physics) is facing its limitations, and new natural history is on the rise. Including modified ideals of explanation, and new ways of forecasting (through models and scenarios rather than predictions based on regularities).

¹⁸ Arie Rip, 'Science for the 21st Century', in Peter Tindemans, Alexander Verrijn-Stuart and Rob Visser (eds.), *The Future of the Sciences and Humanities. Four analytical essays and a critical debate on the future of scholastic endeavour*, Amsterdam: Amsterdam University Press, 2002. pp. 99-148.

¹⁹ Since the 19th century, the disciplinary hierarchy in the sciences is based on the claim that lab sciences (and work under controlled conditions more generally) are better in producing valid knowledge than work under non-controlled conditions. "Low" sciences, on the other hand, were open to whatever appeared to be interesting and useful to practitioners in relation to a variety of audiences, from the fairs and markets to the newly emerging industries.

What does this diagnosis imply for research training? Field work (including data mining and other navigating of data basis and other collections of information) and recognition of patterns are the new challenges, but do not always get sufficient attention because of lack of status compared with high-science (physics-like) approaches.

The other important change is the spread of modelling approaches. Graduate students become accustomed to working with models, they are part of the cognitive infrastructure. Competence in handling the software brings better performance than understanding what it is all about. This point applies to the whole range of sciences, from physics and chemistry, to engineering and the social sciences. For the new natural history, there is synergy between monitoring and modelling (up to modeling sometimes replacing actual experiments). Expertise centres for environmental research, but also for economic monitoring and modelling (in the Netherlands, these would be RIVM and CPB) could be included as regular locations for research training. The International Institute for Applied Systems Analysis (IIASA) is another interesting location (and its history is illuminating for its mix of cognitive, professional and political aspects).

The shape of research training: transdisciplinarity

How to actually arrange research training so that developments (1) and (2) are taken into account?

In form and content, the training must link up with, and to some extent anticipate on, cognitive developments and distributed locations. I will call training which embodies such double anticipations 'transdisciplinary'.²⁰ The term is evocative, but exactly for that reason I have first to say what it should not refer to.

Three ways how not to do transdisciplinary research training:

- Training for interdisciplinarity and/or problem solving: this is too general and thus too empty, and becomes just a trick if done with students who are too young and inexperienced to be able to profit. A sandwich curriculum can partially compensate for this.²¹
- Create a general initiation which allows graduates to function in a variety of jobs and careers. (as did the famous Cambridge Tripos in the 19th century). There are indeed broad bachelors of science, beta/gamma curricula, all at undergraduate level. It would be interesting to develop similar integrated approaches for graduate training, but there should be a clear structure, including a component of specialist training.
- While polytechnics, technikons (in South Africa), HBO (in the Netherlands have some transdisciplinarity in their training, through links with the world-of-work, these tend to remain vocational, that is, oriented towards specific careers. So there is a lock-in. Research training is about what underpins and contributes to work practices, not the work competencies themselves.

Practically, the first step towards transdisciplinary research training is the inclusion of Centres of Research Excellence and Relevance (CRER) as key locations for research training. When these are linked to a university, this happens already but too often with

²⁰ The term has been pushed by Gibbons and Nowotny (cf. note 2), but I use it here programmatically, to capture the shape of future research training. I was inspired to do so by the way the South-African Peninsula Technikon has interpreted the Gibbons/Nowotny concept to apply it to transform their undergraduate training.

²¹ There is a large literature on interdisciplinary research. Some aspects of interdisciplinarity in research training were studied by Duncker, in particular the mutual translations and partial integrations across chemistry, physics and electronical engineering in a shared research program. See Duncker-Gassen, Elke L., *Multi-Disciplinary Research at the University of Twente. The Challenges of Heterogeneous Cooperation*, PhD Thesis, University of Twente, defended 23 April 1998.

too much deference to degree-granting departments. These Centres should have their own responsibility to certify packages of research training, and be recognised as such. If that is realised (and governments could play a role there), Centres which are not, at the moment, linked to a university, could then also become accepted as certifying a package of research training.

Clearly, this scenario assumes that a portfolio of certified elements of research training will be acceptable for a PhD. The question then is who will be responsible for awarding the PhD. In Europe, this has been the prerogative of a professor with *ius promovendi*, who has been appointed to a chair by a university. There is no reason to limit this right to university professors, provided there is some credentialling (directly or indirectly overseen by government).²²

If arrangements for a portfolio PhD are in place, further locations for knowledge production can be included. These could include environmental consultancies and some patient associations. Obviously, supervision and reporting has to be arranged to have some quality control, but that can be done if one sets one's mind to it. Professional scientific societies could play a role here as well.

By then, there will also be pressure to redefine PhD. A full dissertation will become less important. A portfolio of certified research training packages and their products, training courses concluded successfully etc., with a stamp of approval by some authority, may become the equivalent of a PhD dissertation. Perhaps a PhD degree will become just one possibility in a range of research training certificates.²³

In conclusion: requirements for research training in the brave new world of the 21st century

I have outlined a number of requirements for PhD training related to the changing landscape of knowledge production and knowledge professionals. While I would strongly argue for the importance of most of them, the basic point I want to convey is that one should anticipate on the new (and fluid) situations, rather than maintain existing arrangements and the interests that are linked to them. If such anticipations would lead to another set of requirements, that is acceptable, as long as there are good, and articulated, arguments for them.

In my diagnosis of the situation, but in almost all diagnoses that are offered, “unbundling the university” (De Boer et al 2002) is the key element. Unbundling, however, is an open-ended suggestion. What sort of re-bundling can be envisaged? A stronger voice from the demand side can be useful – but the demand side is often short-sighted. That is why I offered a background analysis of professional and epistemic changes, in which specific demands can be located. It is the combination of long-term diagnosis and responsiveness to (possibly) short-term concerns which should carry the articulation and implementation of requirements for research training in the 21st century.

²² Brown and Duguid (cf. note 13) envisage a system where degree granting bodies can compete, and will be successful depending on the quality of the degrees they grant.

²³ The PhD dissertation is a type of product that will never be required in the later career, so why train students how to do it? It is an initiation rite, but even that will become less important because the “tribes” are less clear (“porous”) and of varying composition.

Current Science Policies and their Implications for the Concept of Academic Identity

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Introduction

Towards the end of the 20th century the concept of identity came under intense scrutiny by social theorists. The character of change in late modernity was seen as generating degrees of fragmentation, dislocation and discontinuity in social institutions and patterns of life that challenged the central meaning of identity (Harvey 1989; Giddens 1991; Laclau 1990; Hall 1992). At the same time, new expressions of collective identity were seen as strong and important counter forces to the onward march of globalisation and cosmopolitanism (Castells 1997).

It can be argued that debates about identity are particularly pertinent for studies of higher education and science. The concept of identity has been of central symbolic and instrumental significance in the lives of individual academics and in the workings of the academic profession. Not only has academic work provided the conditions for strong identities, but also the building of individual identities that are, nevertheless, embedded in defined communities, has been central to the dynamic of academic life in the Western world. Traditional academic reward systems, centred on reputation, reflect the cultivation of an institutionalised individualism within a self regulating community of peers. Advancement is a matter of acquiring a public identity in the community, sustaining and enhancing it. Public identity feeds into the sense of an individual professional identity and self-esteem, and for successful academics a virtuous, if often fragile, circle is created between reputation and self esteem. This connection between the concepts of individual identity and public reputation is largely centred on research.

One of the foundations of academic identity is to be found in postgraduate education that has been shaped by, and for the primary purpose of reproducing, the academic profession.

The paper will first briefly outline a theory of identity in which the traditional strength and stability of academic identities can be understood. It will suggest that they are strongly associated with the notion of inhabiting a bounded world. Key boundaries are conceptual and normative, as well as organisational. They serve to reinforce identification by highlighting differences from other groups, as well as by strengthening internal connections.

Secondly, the paper will consider the implications for these boundaries of various aspects of current science policies and some contemporary theories of knowledge

production by which they are influenced. They include the emphasis on strategic or exploitable research and innovation; the replacement of linear-rational models of the relationship between science, technology and innovation by models stressing heterogeneity and interaction; the growing importance of interdisciplinarity; the commodification of knowledge and challenges to the idea of science as a public good. It will then consider what weakening of various boundaries might mean for academic identities, with particular reference to the natural sciences. Lastly it will look briefly at how far developments in postgraduate education, traditionally a key context for the formation of academic identities, are taking account of such changes.

A communitarian perspective on academic identity

While academics have in many ways seen themselves as the epitome of the enlightenment subject (Hall 1992), rational, self-directed individuals, the traditional concept of academic identity may be better understood within the framework of communitarian philosophy. At its heart are the paradoxical but mutually reinforcing ideas of individuals as distinctive and embedded. Identities are shaped and reinforced in and by communities. At the same time, communities provide a bounded and defining space within which individuals make their choices, construct their identities and in so doing make their own contribution to those communities.

For MacIntyre (1981) the individual is embedded in and emerges from communities, each with its own traditions. 'What I am is in key part what I inherit.... I find myself part of a history and whether I like it or not,..... one of the bearers of a tradition.' (p. 206) 'A living tradition is an historically extended, socially embodied argument.....in part about the goods which constitute that tradition.'

Taylor (1989) emphasises the importance of 'a defining community' in the formation of identity. One function of such a community is that it provides the language in which individuals understand themselves and interpret their world. Being initiated into a language entails 'entering into ongoing conversations between people with a particular role or status in the web of relationships that make up [the] community' (Mulhall and Swift 1992, p. 111; Taylor *ibid.*). Through such conversations individuals learn not only a language but a way of understanding the world, through the ideas, cognitive structures and experience expressed in that language. They are also introduced to the myths through which deeply held values and beliefs of the community are expressed (Bailey 1977; Vabø 1999).

Values are central to identity. 'To know who you are is to be oriented in moral space, a space in which questions arise about what is good or bad ... what has meaning and importance to you and what is trivial and secondary.' (Taylor (*ibid.*) p. 28). Selfhood and the good are thus inextricably intertwined themes. For Taylor the moral framework within which they are worked out has three dimensions: obligation to others, fulfilment or meaningfulness and a range of notions concerned with dignity, respect and self-esteem.

Identity in this mode of thought is not fixed and it may undergo substantial shifts. But the possibilities for reconstructing identity are limited. Stability, coherence and continuity are implied in the institutions or communities through which identities are built.

This paper follows Burton Clark (1983) in defining, first, the discipline and, second, the enterprise or higher education institution as the key communities in which individual academics build their identities. Both are centred in the production and transmission of knowledge. However, they form an asymmetrical and incommensurate framework of influences. The dominant community has been that of the discipline. Its cosmopolitan but diffuse power is substantiated in part in the system of peer review, through which epistemological and evaluative criteria are set and rewards allocated. It is embodied in local and tangible form in the department that derives from an institutional and, indeed, a national context. Membership of a department can influence individual orientations to the discipline, through the media of collective responsibilities and day to day dialogue. At the same time, departments are constructs of the enterprise, as well as being critical to its well being. Departmental needs for both tangible assets and symbolic significance are in part met by the enterprise, for example, in the built environment, the location and the history or saga (Clark 1970) of the university or college, collective goods over and above anything a department can provide for itself.

Membership of these interconnected communities has enabled academics to see themselves as belonging to a distinctive and bounded world, the normative power of which has been sustained to a remarkable degree by a nexus of myths, socialisation processes and regulatory practices. However, it has also depended in part upon external factors. They include the status enjoyed by academics in the nation states that support them; the continued dependence of those states upon academics as definers, producers, transmitters and arbiters of advanced knowledge and widespread acceptance that the fulfilment of these roles depends, in turn, on boundaries that have been drawn round the academic world.

Current science policies and the challenge to traditional boundaries

Challenges to these boundaries have come from social scientists, most radically but far from exclusively from sociologists of science, and from national and international policies. They have been building up over a substantial period of time, since the late 1960s. However, the process of change they have set in motion has been gradual, disorderly and ambiguous.

Empirical study (Kogan et al. 2000; Henkel 2000; Henkel et al. 2000) supports the view that myths and the values and beliefs they represent can survive long after social science analysis has highlighted the contestable nature of the picture they present and/or policy and structural changes in conflict with them have been put in place. Ivar Bleiklie has spoken of how 'new structures and values imposed by reforms are grafted onto established arrangements in a process of meandering and sedimentation that gives policies and institutions their character of complexity and ambiguity' (Bleiklie and Marton 1998; Bleiklie and Kogan 2000).

Perhaps a particularly important example of a myth shared across disciplinary communities and academic institutions is that of academic autonomy. Academic autonomy represents a shared value and a condition of the nature and quality of academic knowledge and thus of the value of academia to society. The idea of a strong boundary between academia and external influences is integral to it. This boundary

between academia and other social institutions, notably those of industry, commerce and government, has been of critical normative and political significance.

Definitions of, and changes in, academic autonomy have been the subject of extensive scholarly analysis, to which I cannot hope to do justice here. I will focus on two dimension of autonomy: the power of academic communities to control the direction, substance and evaluation of their research agendas and the importance attached by individual academics to their freedom and capacity to exert that same kind of control at the level of their individual agenda. Such a value is strongly linked to the idea of academic identity and it continues to be a major driving force of academics (Bauer et al. 1999; Henkel 2000; Kogan et al. 2000), even if the constraints, internal and external, upon it, particularly for those working in 'restricted' and experimental sciences, are substantial.

Science policies, national and international have, in different degrees, been eroding academic autonomy since the early 1970s. The landmark here is the Brooks Report for OECD (1971) which laid down the principles that governments rather than scientists must set over-riding research priorities and that the key driver of science policies must be the achievement of social and economic goals.

Another question mark was put against academic autonomy through the adoption by policy makers at the beginning of the 1980s of the concept of strategic research as the basis of public funding policies. While this represented an acknowledgement by policy makers of the continuing importance of research that advances knowledge and understanding, at the same time it put limits on the right to undertake such 'basic research'. Support for it would be given on condition that it could reasonably be expected to generate knowledge that could be exploited by society (Irvine and Martin 1984).

The boundary between basic and applied research is another that has been of functional and political importance to academics. Here, too, the realities and meanings of these categories have been challenged and by practitioners as well as by social theorists. Distinctions based on differences between the motivations of scientists or between the substance of the research have long been shown to be oversimplified (Mulkey 1977). The linear-rational model of the relationship between science, technology and innovation that assumed a progression from a foundation of basic research to applied research has been largely abandoned in favour of one generated in the framework of evolutionary economic theory. It is now understood as much more variable, complex, uncertain and interactive. The pathway to innovation often begins in industry rather than the university (Nelson and Winter 1982; Martin and Nightingale 2000).

However, until recently the distinction between basic and applied research has continued to represent a boundary that had meaning, based upon the *social contexts* in which research is carried out. In one set of contexts researchers are expected to pursue research agendas 'on the basis of their scientific significance' for a peer audience; in another researchers are expected to produce results that have useful practical consequences (Mulkey op. cit.). This distinction has been important in the construction and maintenance of academic identities, in terms of the meaning of academic careers, self-esteem and the reinforcement of the value of academic autonomy. The divide is normative as well as organisational, carrying with it for academics connotations of the superiority of contexts concerned with scientific significance.

It, too, has become blurred partly by international, national and institutional level policy drives to encourage closer collaboration and exchange between academic scientists and industry and partly by the embracing of the function of basic (or, at least, strategic) research by some industries. Greater emphasis on the role of 'tacit knowledge' in the exploitation of advanced knowledge to create technological change has persuaded some firms that they must give their researchers opportunities to engage in more fundamental research (Rosenberg 1990; Pavitt 1991), either alone or, increasingly, in co-operation with others, notably academic researchers.

The promotion of different forms of collaboration has led to growing interest on the part of both social theorists and policy makers in research or innovation networks, flexible structures with permeable boundaries. Network membership is likely to have some fluidity and cross a number of divides: disciplinary, departmental, institutional, sectoral and national. In some cases, collaborative research has meant a modification of the distinctions between research producers and research users.

Contentions by Gibbons and his colleagues (Gibbons et al. 1994; Nowotny et al. 2001) about new modes of knowledge production in the form of a radical shift from Mode 1 (knowledge 'generated within a disciplinary, primarily cognitive, context', in which problems, rules and evaluative criteria are internally determined) to Mode 2 are now well embedded in the discourse of higher education and science policy. Mode 2, as defined in 1994 (ibid.), entails a broader conception of 'transdisciplinary' knowledge, generated 'within a context of application'. It addresses problems identified through a process of continual negotiation between actors from a variety of settings.

Critics of Gibbons, Nowotny and their colleagues argue that a polarised framework, in which two modes of knowledge production are set against each other is too simplistic. It radically underestimates the importance of contexts of application in the past (Godin 1998; Rip 2000). It ignores analyses that have highlighted the variety of functions played by disciplinary knowledge and discipline-based research training in the advance of research and technology and the complex interplay between theory development and the possibilities of its exploitation identified in, for example, finalisation theories (Van den Daele et al. 1977). As Rip (op.cit.) argues, the concept of Mode 1 can be seen as a 'lock-in' that exaggerates the rigidity of boundaries in which academic research practices are pursued and so threatens the heterogeneity required for advancement of knowledge that can tackle social as well as scientific problems of the future. Moreover, while it may be true that in some fields such as biological sciences interdisciplinary collaboration has proliferated and is an important driver of innovation, it has even there been concentrated within a relatively limited framework. It is most obviously explained by reference to the striking changes in these sciences themselves, triggered by the discovery of DNA and all that has followed from that. Again, such developments and the increased policy emphasis on inter-disciplinarity have not prevented many academics from continuing to see their discipline as having a critical role in their normative and epistemic identities.

By 2001, the framework developed by Gibbons et al. had been substantially expanded as a vehicle for 'rethinking science' within a postmodern perspective (Nowotny et al. 2001). Now science and society are depicted as involved in a co-evolutionary process, through which significant changes are occurring in both. 'The categorisations of modernity into discrete domains', such as state, society, market, culture and science itself, are

dissolving. The boundaries and differentiation between institutions such as universities, government and industrial or business organisations are breaking down.

As part of this process, a new kind of 'contextualised' science is said to be emerging. Mode 2 science is practised not simply in a context of application, but also in a more elusive, and, again, unbounded context of social implications. In these circumstances, science becomes open to the involvement of increasingly heterogeneous populations. A better educated society more able to organise the articulation of its multiplicity of interests 'speaks back' to science, now operating in the *agora*. Science is no longer mediated and regulated through a limited number of bureaucratic or professional institutions, although some of these persist, but also engages in collaborations, negotiations, debates and conflicts with all sorts of actors.

The degree of category collapse implied in this thesis is contentious. However, it is not necessary to subscribe wholesale to a postmodern perspective to perceive a variety of ways in which the boundaries between academic and other worlds are being blurred and to conclude that this is a growing trend.

The last decades of the 20th century have seen challenges to the self-regulative ideal of a number of professions, including academics. Increasingly, policy makers have sought to introduce non-academic evaluative criteria, such as social relevance and social, economic and environmental impact upon science, so heightening concerns about the 'drift of epistemic criteria' (Elzinga 1985). Research users have been incorporated into ex ante and ex post evaluative systems of funding bodies as well as, in some cases into the research process itself.

While the knowledge society is increasingly dependent upon science and upon expert scientific advice, it is at the same time less trustful of it. The foundations of the authority of expertise are less secure, the privileged status accorded to scientific knowledge and those who produce it has become more precarious and epistemological and value pluralism has increasingly to be taken for granted. Attempts by governments and scientists to restore confidence in science through programmes to enhance the public understanding of science have met with limited success. Indeed, there is growing evidence that enhanced understanding tends to diminish rather than increase public confidence (Wynne 1995; Bauer et al. 1997).

Meanwhile, the impacts of scientific and technological developments upon every policy sector and, indeed, every aspect of human experience and its environment have become ever more evident. The potential of research agendas, activities and outputs in, e.g., genetics, forms of energy, materials and information and communication technologies to revolutionise conceptions of life and the limits of nature, together with deep seated normative assumptions is now embedded in national and international political agendas. There is a growing interest in the development of political mechanisms through which participation in the management of the ensuing problems can be widened well beyond a dialogue between scientific experts and governments (Weale 2001).

Finally, if the tenor of the above account has tended to emphasise the degree of external intrusion into the world of science, science, too, has extended its interests in quite radical ways. Academic scientists and the institutions in which they work have become more or less willing actors in a range of markets and so in the commodification of scientific knowledge. Changes in the law on intellectual property in some countries,

together with increasing pre-occupation with the problems of funding research and higher education, have encouraged individuals to identify the commercial potential of their work. Academics have found themselves playing new roles in new arenas, for example as individual entrepreneurs and negotiators about intellectual property. Capacity for profit making sits alongside intellectual reputation as high value currency in an increasingly competitive academic labour market.

The implications for academic identities and career trajectories

Assessing the implications for academic identities of these developments involves thinking about the nature and extent of change in the structural context, social, epistemological and normative, in which identities are built and maintained and how these have affected the values, sources of meaning and self esteem of academics. It is important also to reiterate that, while there have been significant and even radical changes, they have taken place over time. The academics, the actors involved, have been responding to, managing and to some extent shaping those changes during that period.

We will first look more closely at the institutional or social structural context and in particular the dynamic between individuals, disciplinary communities, departments and institutions. We begin with the department or basic unit in which discipline and enterprise are seen as coming together in Clark's classic formulation (Clark 1983). One consequence of the growing dependence of nations, businesses and higher education institutions on scientific and technological research and innovation has been restructuring by universities. Internal structures have become more complex, more flexible and more open to external interests. Incentives have increased for the establishment of units that can be focal points of attraction for external research funding, research collaborations and technology transfer. Research centres or institutes have proliferated in universities, sometimes as specialised off shoots of departments, sometimes cross-cutting the discipline-based departmental organisation, to bring together researchers from a number of disciplines in an emergent or growing research domain. The department as the point at which not only discipline and enterprise come together but also the research and teaching functions are integrated comes under question.

The network is another example of a structural form with increasing visibility and importance for policy makers, researchers and higher education institutions. Academics, at least the most active and successful, have always developed their own networks, largely within the invisible colleges of the discipline. The differences now lie in the variety of network membership and in the drives by various policy and institutional actors to formalise research networks and to give them increasing administrative or financial significance. Recent EU policies regard the creation of more extensive international networks as a means of rationalising the research effort, realising the concept of a European Research Area and strengthening EU competitiveness. At the same time, universities are increasingly developing their strategic and integrative functions and developing networks of their own to support or encourage their members in making connections that will be of value to their institution: an instance of the coincident growth of international and local expectations and pressures.

It seems, then, that academics have exchanged membership of a bounded world for involvement in multiple worlds. The dynamic between individual, discipline and institution has been replaced by a looser and more fragmented set of relationships. In other words, the conditions for consolidating stable, coherent identities in academic life have been replaced by conditions more in tune with those of other modern contexts, in which individuals pursue what Giddens (1990) calls the 'project' of identity. These include expanding fields of operation, more variegated, less permanent and more permeable institutional structures and multiplying roles and relationships. Individuals may have to make more choices about the combinations of structures and relationships that constitute their environment and what kind of identity(ies) they are constructing in that context.

The blurring and loosening of various boundaries may mean that scientists at the beginning of their careers have to make a less stark choice between academia and industry. Equally, however, they mean that their career trajectories are less straightforward.

Values and conceptions of knowledge: stability and change

MacIntyre's assertion that 'What I am is in key part what I inherit' is less compelling in this context. Cherished conceptions of academic life and work such as the integration of teaching and research have to be reappraised in the light of the multiplicity of demands upon academic researchers, many of them pulling them away from the institution. Increasingly, at least for natural scientists, it has meaning only at postgraduate levels of education and even there it is often an ideal rather than a reality (Becher et al. 1994).

However, the extent of change in assumptions required is not clear. It is worth spending a little time considering some areas of stability alongside those of change. It may be true that some of the complexities of the relationship between research and other forms of knowledge production are now better understood and that they increasingly entail collaboration between multiple kinds of actors. However, we still do not know enough about what the implications are for the patterns of individual lives and the value and conceptual frameworks in which they are worked out. This is an area in which more empirical research is needed, although we do know that it is dangerous to make too many generalisations. The thrust of much of the research on knowledge production emphasises heterogeneity. Academics in different fields with different research interests will have different degrees and kinds of external relationships from one another at different stages in their research and individuals may make different connections with different firms or different research groups.

While academics may have had problems with the concept of strategic research, it does mark an acceptance on the part of governments and substantial elements of the private sector that the creation of new knowledge, knowledge at the leading edge of scientific fields, is a priority for them. This means that values and conceptions of knowledge that have been central in academic identity development continue to have public support, even if their limits have been more tightly defined. Many academics are, therefore, embarking upon new roles and relationships within a relatively stable epistemological and value framework.

Even in fields such as pharmaceuticals, where firms have invested heavily in their own research, what many industries want from their connections with universities is early

access to scientific advance. Relationships are developed within an assumption that the academic research agenda will be sustained and that it will be pursued largely in the research group or centre in the university. It is built on rigorous training and specialisation in a discipline or community of inquirers, within which the focus, theoretical base, methodologies and epistemic criteria have been developed. The substantive and methodological knowledge, understanding and skill to develop that kind of research take years to acquire. The implication is that that kind of continuity and the foundations on which it is based are always going to be required, although not necessarily within a single disciplinary framework. If that is the case, it follows that advances in fundamental understanding will always require scientists whose careers are characterised by continuity and coherence in their research agendas. While scientists may change fields during their careers, the degrees and frequency of change are going to be limited, if they are going to be involved in work at the leading edge.

However, coherent research agendas do not require research to be conducted in isolation. There are already multiple models of the academic-external relationships within which it is clear that coherence is being sustained (Henkel 2000; Henkel et al. 2000; cf., in the context of social science, Shove 2000). The agenda is not fundamentally altered in the relationship. In one model the relationship may be largely *instrumental*: academics develop relationships with external organisations and actors, primarily to secure the financial and other support they need to sustain their own research agenda. They may be developed with a more genuine commitment to *scientific collaboration*, a belief that the agenda needs more than one set of scientific perspectives, disciplines or methodologies. In some cases, such scientific collaboration is between actors located in industries and universities. A variation on this is a more *hybrid collaborative model*, in which practitioner or other professional perspectives are incorporated and/ or those of research users or interest groups. An example of this is where the goals of an industrial firm provide part of the framework for the conduct of the research so that the implications of the research and its connections with the development work of the firm can be discussed at regular intervals. Although this may not fundamentally alter the research agenda, it may affect the direction it takes and the speed with which particular aspects are pursued, how they are understood and how they connect with current and future product development.

Individuals who are perceived to have a clear research agenda that is generating knowledge wanted by users may develop a variety of relationships and roles without detriment to their public reputation or private sense of identity. Indeed, these may well be enhanced, even if they are more complex and entail some reappraisal of values.

The discussion here borders on the question of academic autonomy in the current policy environment, its connection with academic identity and the quality of knowledge. It suggests that maintaining the power to control research agendas depends most importantly on the scientific community's and the individual's success in developing the theoretical imagination and vision, the scientific understanding, technical expertise and long term perspectives through which to generate and realise those agendas. It further suggests that, if those conditions are met, the exclusion of external influence or perspectives is not essential to ensure the integrity of knowledge production and that there may advantages in active and open engagement in that process with alternative perspectives.

This is an alternative strategy to one commonly adopted by scientists and their communities at present: a strategy of ritualistic compliance with requirements of public funding bodies or the perceived needs of potential industrial sponsors, combined with minimum sufficient communication. The aim can be understood in terms of accommodation, the incorporation of external agendas into those of the scientists, so that they can pursue their own objectives relatively undisturbed. It entails processes of interpretation akin to Latour's concept of 'translation' (Latour 1987). An actor with one agenda persuades another with a different agenda that their interests, 'what lie[s] in between actors and their goals' (ibid.), are the same.

The idea underlying the latter strategy is that scientists and their communities must preserve their own space of action and their power to choose their own paths of scientific inquiry as undisturbed (or bounded) as possible. It can be linked with the strong beliefs expressed by scientists in our research on the impacts of the UK Foresight programme in the serendipity of knowledge development and its applicability and the argument it represents for the unfettered freedom of academics to determine their own research agendas. Since outcomes of inquiry are often wholly unpredictable, imposing limits in terms of future relevance or applicability is likely to reduce rather than enhance the social or economic benefits it may generate.

Two comments might be relevant here. First, it is possible that an alternative strategy of regular and open dialogue between scientists and other actors could make some inroads into the unpredictability of scientific outcomes or, if not, into the length of time before which ideas about their applicability are formulated.

Second, it is worth reminding ourselves that there is a real question how far exclusive control of research agendas by the scientific community guarantees freedom of choice, particularly as scientific research becomes an increasingly collective form of activity and resources are limited. Individual choices within this context are inevitably strongly structured by dominant definitions of research fields.

Changes in Research education and Identity Formation

The picture drawn so far is of a shift for academic scientists from a bounded world to involvement in multiple worlds; to the demand to manage a more varied institutional environment, more flexible and open structures, less predictable career trajectories. There is a less strong basis for a distinctive *academic* identity, in particular for one linked with rigid hierarchies of esteem and reinforced by perceived or constructed differences from scientists working in different contexts. More generally, this suggests a greater emphasis on the importance of individual choices of values and aspirations in the construction of identities and less upon the 'givens' of life in strongly defined communities.

There is a greater variety of roles and roles are less tied to particular contexts. Possibilities include moving between the state and the market, between roles of academic researcher and entrepreneur. There are opportunities for involvement in different aspects of knowledge and technology transfer.

There is a demand for university-based scientists to make more varied connections and to collaborate and communicate more widely in the process of knowledge production.

The analysis so far has focused primarily upon communication within a collaborative framework. However, changes in the political environment, together with the increasingly contestable nature and impacts of science, mean that scientists will increasingly be required to explain and justify their work more fully and to more varied constituencies in a context of conflict. Many will be required to negotiate their agendas with multiple stakeholders.

The fundamental epistemic requirements remain: for rigorous, resourceful and productive practitioners of scientific research. These practitioners will be judged by the reputations they build up. However, existing evaluative bodies have expanded membership, new ones have emerged and evaluative criteria have proliferated beyond scientific merit. Nowotny et al.(2001) speak of the need for criteria that are 'socially robust'. How such issues are resolved depends partly on the capacity of scientists to make their case in multiple arenas for the maintenance of scientific goals and values. .

Research education has traditionally played a significant role in academic identity formation. How likely is recent thinking about research education to enable it to continue to play such a role as the contexts of identity formation are being enlarged and less well defined?

First, it appears that in policy terms it is being 'decoupled' from its strong association with academic careers and the reproduction of the academic profession (Blume 1995). As research or systematic inquiry is promoted as an aspect of a wide range of occupations in the knowledge society, the functions of research education have been reviewed. One question raised by this development is whether a broadening of objectives will mean dilution of scientific education or an expansion of choices for participants. The shift of emphasis from the requirement for a doctoral candidate to make an original contribution to knowledge to the concept of research training suggests the former (although it probably also reflects what is possible for many, perhaps most, doctoral students in the natural sciences). However, research training is itself a concept contested by different stakeholders (Pearson and Brew 2002). It may mean a concern with competence in research design and research techniques. It may mean the enlarging of what competence in research means, to include, for example, communication and presentation skills, collaborative skills, understanding and management of intellectual property rights; in other words transferable skills.

Second, there has been some convergence in recent years towards more clearly structured systems of higher education, including the establishment of graduate schools. More graduated progressive structures make it possible to supplement the apprenticeship model of research education with a pedagogical approach. This means not only more emphasis on formally taught components but more collective thinking about the aims of research education or training programmes and the development of means by which they can be met. Programmes have the option to incorporate a stronger generic element in research training at a Master's level before students embark on the more specialised stage of the doctorate. This would mean a wider variety of students working together in the development of research capabilities: not all will progress to the doctoral level. It may be at this stage that key general principles and concepts can be reinforced, such as the identification and definition of problems, developing research designs through which they can be tackled, the role of analysis in these tasks and so on. Many broader transferable skills can be integrated into such activities.

Such programmes might be developed on a variety of principles. As I see it, there is a strong case for such programmes to continue to be devised within the framework of a discipline. This enables them to be implemented within relatively well-defined theoretical and conceptual frameworks, methodological approaches, definitions of researchable problems. It also gives students the opportunity to connect with each other within a particular tradition of inquiry, an epistemological community. If this experience could be supplemented by some opportunities to introduce the perspectives of another adjacent discipline on their work, this would mean that a disciplined heterogeneity of knowledge production was being promoted, along with a propensity to look outwards beyond the boundaries of one scientific tradition.

The movement towards more structured frameworks has been accompanied by a shift towards greater variety in the location and funding base of doctoral education. Students may be working on their thesis in very different contexts, including research groups in university departments, specialist and/ or interdisciplinary research institutes in or outside the university and a variety of organisations in the private and charitable sectors.

Lave and Wenger (1991) conceptualise this as participation in 'communities of practice' that provides a greater variety of opportunities for learning than the conventional apprenticeship model (that embodies a strongly asymmetrical relationship). In a sense they are stating what has long been tacitly understood, that doctoral students learn substantially from peers at different stages and, particularly from post-doctoral researchers. However, they are also suggesting not only that this is a rich and positive source of learning (as distinct from simply compensation for the inadequacies of supervision) but also that it is worth examining and articulating the range of skills and knowledge that are acquired in this way.

In the current environment, such 'communities of practice' would be expected to be part of a range of networks and other forms of connection to which students would have access. Even so, each community may have a rather particular focus and represent a relatively narrow conception of research work. The value to students of a common base in a university, where the experience of different contexts could be shared, would again be high as preparation for careers likely to entail contact with number of worlds and as enabling students to make more informed choices.

At this point some contradictions in policy developments need to be addressed. First, and probably most seriously, large university graduate schools that can bring together numbers of students to exchange research experiences and progress can find the free exchange of experience and ideas to be obstructed in the new normative environment. Now that the boundaries between academia and the private sector have become more permeable and universities, students may be based in or have links with firms in competition with each other. Academics themselves may be in the business of protecting intellectual property rights. The concept of science as public knowledge has become more precarious and contestable, in the context of academic embracing of the commodification of knowledge .

Second, however valuable 'communities of practice' are, the role of the supervisor remains a key one. Indeed, here, too, there are arguments for reconceptualising this in terms of responsibilities for the whole experience of students, as distinct from that focused upon a particular piece of research and the production of the thesis. This is part

of a more general trend towards understanding research education in more systemic terms. It therefore requires those involved to perceive research education as more distinct from research practice than has been the case in the past, just at the time when that research practice is making so many extra demands. The climate is not conducive for supervisors to rethink and extend their educational roles.

It would seem that in theory there is some synergy between changing policies for science and for research education. In consequence, research education could provide support for the development of identities in a changing environment. In particular, it might provide a strong core of discipline-based research training, as a foundation for the production of an individual thesis in a particular research setting, but also for a grounded sense of a research identity. Second, it might give access, direct or vicarious, to a variety of research settings, in which the goals and rewards of research also vary. Third it might provide opportunities to develop capacities for presentation and exchange of ideas and argument between peers and other practitioners for researchers who are going to have to manage collaboration and conflict in a variety of career trajectories.

As ever, in practice it is more complicated and the policy environment is ambiguous.

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The Doctorate in Transition: Current Trends in German Doctoral Education

Robert Paul Königs, Deutsche Forschungsgemeinschaft (DFG)

Doctorates in Germany

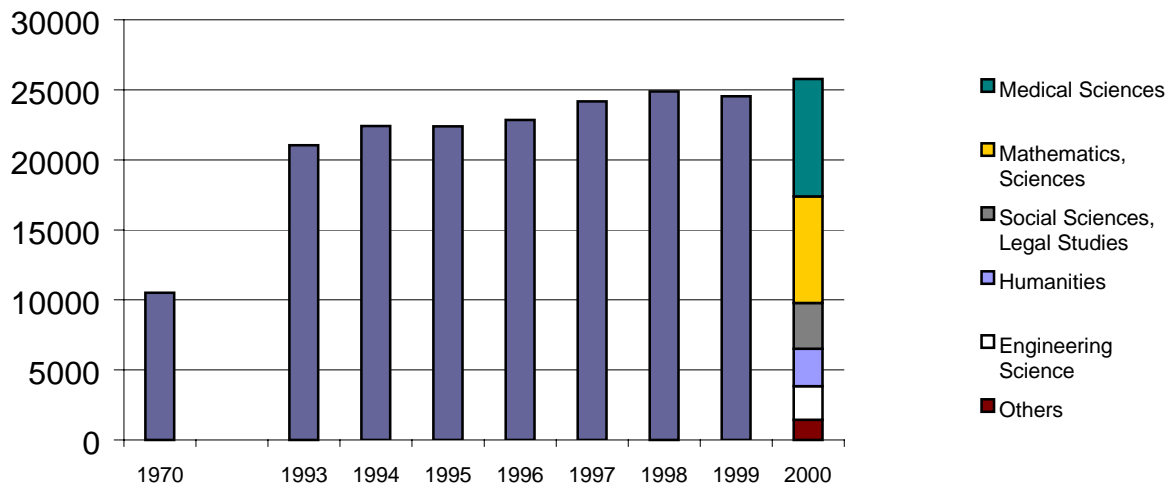


Diagram 1: Number of doctorates conferred in Germany (1970: West Germany only)

After a long period of time, the perception and character of the doctorate in Germany is changing noticeably. Although a large part of the 18.000 doctorates outside the medical sciences are still in the traditional mode – one student, one thesis, one advisor – structured doctoral programmes are gaining ground.

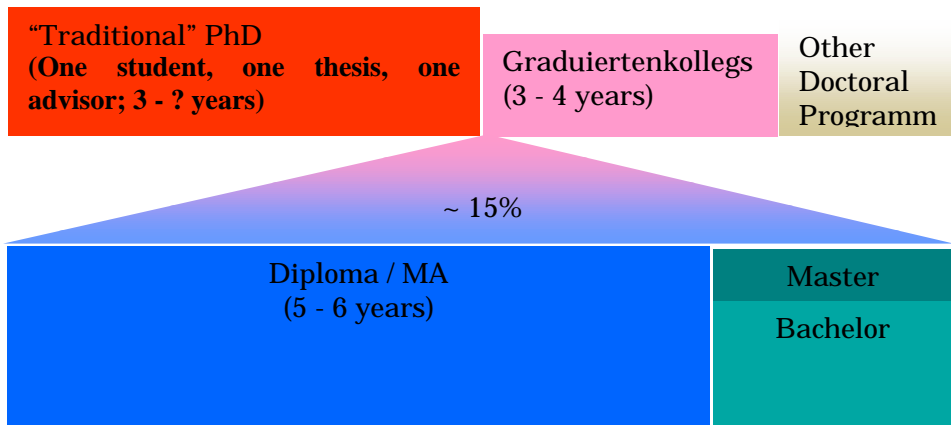


Diagram 2: Paths to a doctorate in Germany

Pioneers in this respect are the Graduiertenkollegs, which have inspired a number of new programmes, notably by the Max Planck Society (International Research Schools) and some of the German *Länder*.

Some of the factors contributing to this change are:

- Increased awareness of the need to make research careers attractive, triggered in part by severe recruiting problems in key disciplines.
- „Early independence“: Success and attractiveness of research careers have been linked to opportunities for younger researchers to work independently and follow their own ideas at as early a stage as possible. Pursuing this idea has implications for the PhD phase that structured programmes are better placed to fulfil.
- Job market expectations (varying according to discipline): Success in the non-academic job market increasingly depends on additional skills which are more readily provided and acquired in structured programmes.
- Increasing acceptance of the „training“ aspect of research training. Traditionally, PhD candidates in Germany are not seen – and do not see themselves – as „students“, but as employees, either as teaching or research assistants. This view is changing, the „training“ component of the doctorate, emphasized in structured programmes, is increasingly in focus.

Pressure towards change stems from the following factors:

- International competition
 - Scarcity of PhD students in key disciplines
Good students leave Germany - good students from elsewhere go elsewhere
 - Bologna Process
- New career structure at universities („Juniorprofessor“)
Weakening „Habilitation“ increases the importance of the PhD for a research career
- Perceived weaknesses of the system
 - High age of PhDs – long completion times
 - Lack of suitable training for a modern job market (High degree of specialisation, no job-qualifying skills)
 - High dropout rate, due to a lack of structure and guidance
- Impact of Graduiertenkollegs.

Pressures working against change are the result of

- High professorial workload and little incentive towards reform
- Essential role of PhD students as research workforce
- Non-perception of problems
- Federalism (the responsibility for doctoral studies lies with the *Länder*, for whom reform has low priority)
- Cost of change.

Changes in Policy

- Provision for Graduate Studies in new Federal Higher Education Act
- New recommendations by Science Council

Three prominent examples of changing structures will be touched upon here.

1. Variety of Structured Doctoral Programmes

- 19 International Max Planck Research Schools
- 6 Graduate Schools in Nordrhein-Westfalen
- 9 International Graduate Schools in Niedersachsen
- 42 Internationale Promotionsprogramme (DAAD/DFG)
- An increasing number of other models - local initiatives, *Länder* and Federal (incentive) Programmes; some private Foundations

Characteristics of these programmes are

- Their integration with Masters Degree Courses, making it possible to recruit students at the Bachelor level
- Broader subject area than Graduiertenkollegs
- Indefinite duration
- External funding based on peer-review procedures
- Excellence-based and selective
- Professional training („soft skills“) included
- Particular regard to foreign students (courses in English).

2. International Graduiertenkollegs (Research Training Groups)

A Graduiertenkolleg (Research Training Group) is a university graduate training programme established at a centre of scientific excellence in a specific field. It is designed for 15-25 PhD students by 8-12 faculty members at a single university or, in a few cases, a small group of neighbouring universities. The students work on their theses within the framework of a coherent and often interdisciplinary research programme with a focussed topic; they participate in an accompanying training programme organised by the faculty members and to a considerable extent by the students themselves.

Proposals for new Graduiertenkollegs are initiated by faculty members and endorsed by their university. They are evaluated and selected in a competitive central peer review procedure and have a maximum duration of nine years.

Graduiertenkollegs have proven a successful approach to new forms of cooperation in PhD training: between disciplines in Graduiertenkollegs on interdisciplinary subjects, between dispersed locations in a „virtual“ Graduiertenkolleg, and between university and industry. They have also developed into a flexible and dynamic instrument of international cooperation in research training.

The communicative and absorbing research environment in a Graduiertenkolleg encourages early independence in research. This is enhanced by special funding for the PhD students' activities and initiatives. In addition, the participation of a larger number of faculty ensures competent advice and guidance on a broad scale. Employers in industry and business appreciate the transferable skills acquired. Graduiertenkollegs also significantly reduce the average time of completion of a dissertation and lower the average age of PhDs

International Graduiertenkollegs extend this concept to a cooperation between a German university and a partner university abroad. They feature

- A joint (interdisciplinary) research programme & study programme
- 6-12 month mobility periods for students of both sides at the partner university
- Encouragement of joint degrees

The DFG provides funding for the German share of the collaboration; complementary national funding is required to cover the international partner's participation. There are presently 25 International Graduiertenkollegs with partner universities in the following countries:

Denmark	2
France	3
France / UK	1
UK	2
UK / Belgium	1
Netherlands	7
Italy	1
Poland	1
Poland / Czech Republic	1
Sweden	2
Spain	1
Switzerland	2
Hungary	1

3. Graduiertenkollegs - New Profile

In 2002, the DFG decided to modify the Graduiertenkollegs programme, taking the abovementioned developments into account. Key features of the Kollegs now are:

- *Excellence*
As structured programmes proliferate, Graduiertenkollegs can concentrate on excellence in research and training.

- *Model for reform of the PhD system („experimental“ programme)*
The programme aims to remain a motor of innovation and reform.
- *International dimension*
The International Graduiertenkollegs as well as international links between regular Graduiertenkollegs and foreign partners will receive additional strong emphasis.

Accreditation of Research Schools in the Netherlands

Prof. Dr. John A. Michon

chairman of the Accreditation Committee for the Research Schools
(Erkenningscommissie Onderzoekscholen) of the Royal Netherlands Academy of
Sciences and Arts²⁴

Position and task of the ECOS

Since 1992 most university-based scientific research in the Netherlands has taken place in the context of research schools, integrated environments for research and PhD-training. Now, in 2002, there are approximately 120 such schools. Although they cannot be compared with the graduate schools as they exist in the Anglo-Saxon tradition, they nevertheless share a number of characteristics with these institutions.

The structure and role of the research school are prescribed by law and the Royal Netherlands Academy of Arts and sciences (KNAW) is responsible for their accreditation. For this purpose the Academy has established an independent committee, indicated with the acronym ECOS, which stands for *Erkenningscommissie voor de Onderzoekscholen*. The committee is charged with the task of evaluating the performance of all research schools in a 5-year cycle (soon to be changed into a 6-year cycle). A decision of the committee whether or not to recognize a school is primarily based on a statement, provided by each school, concerning its goals, means, operations and results. In addition each school must submit the report of an independent international peer review and interviews with the management of the school and PhD-students and postdocs associated with the school provide further information.

Mode of operation of the ECOS

The ECOS consists of an independent chair and vice-chair, plus seven members, each of whom presides over a sub-committee of experts in the major domains of science and humanities—natural sciences, life sciences, medical sciences, technical sciences, agricultural sciences, behavioural and social sciences, and humanities. The decisions of the committee are reached on the basis of the recommendations of one, occasionally more, of the subcommittees and following a detailed plenary discussion. When in doubt, the committee may postpone a definitive judgement for a period of up to six months, during which additional information concerning a school's performance will be obtained and evaluated. Appeals against a decision by the ECOS may be filed with the Presidency of the Academy.

²⁴ The opinions expressed in this contribution do not necessarily reflect the opinion of the committee, nor that of the Academy.

The ECOS follows a strict protocol that has been established by the Academy in consultation with the Netherlands Organization for Scientific Research (NWO) and the Association of Netherlands Universities (VSNU). Specifically this protocol defines the criteria applied by the committee when evaluating a school's performance. The following criteria apply:

- clarity of the scientific mission
- quality and transparency of curriculum and supervision
- the level of jurisdiction (autonomy) of board and scientific director
- attractiveness, capacity and 'throughput' of the school
- national and international 'connectivity'
- appropriateness of accountability and internal auditing procedures

Some observations

The protocol on which the accreditation of the research schools is based has been in operation for more than 10 years. During this period only modest changes have been introduced, the most important one being the independent international peer-review, which has become mandatory only very recently.

From the point of view of the ECOS it may be said that most schools are very serious about their application and about their recognition. This should be considered as a clear sign of the usefulness of the recognition procedure, since recognition (or non-recognition) by the ECOS has no direct consequences, favourable or unfavourable. As part of a more comprehensive system of accreditation of universities and other institutions of higher education, now being established in the Netherlands, the recognition of the research schools by the ECOS may eventually lead to more immediate consequences in terms of continuity or funding. This may also apply to a small number of research schools that explicitly do not apply for recognition. Invariably these schools argue that their work is beyond reproach and that preparing an application (or even inviting an external international peer-review) is therefore a waste of time. The real motive, however, may well be that they are arguing from a relatively safe position based on their excellent past performance.

Even with the loyal cooperation of the vast majority of research schools in mind, the ECOS cannot close its eyes for some soft spots in many of the applications. Some of these would seem to derive directly from the weakness of human nature, while some important others derive from the ambivalence of the university system—notably the faculties—towards the (partial) independence of the research schools.

- In the applications it is not uncommon to observe a tendency towards window dressing of a rather elementary kind, such as overstating the innovative character of certain projects, the intensity of relations with colleagues elsewhere on our planet, and exaggerating the coherence of the curriculum.
- The jurisdiction (administrative independence) of the management of the schools, both in terms of policy decisions and budgetary discretion is frequently inadequate. In these cases it appears to be impossible for the director and the board of the school to act in accordance with the best interests of the school. This is a very general complaint and the ECOS considers most of these complaints justified. Presently, however, the legal status of the research schools (as described in the Higher Education Act) does not stimulate the universities to grant the research schools

sufficient independence in this respect. It should be noted, on the other hand, that a considerable number of schools do indeed operate with an adequate mandate.

- Too many schools do not yet define the objectives of their PhD-curriculum in a sufficiently straightforward way. This may well be related to the ill-defined status of a PhD-degree in contemporary Dutch society. Whereas previously a PhD-level degree would carry some public weight in terms of social status and remuneration, as in the case of high school teachers for instance, no such effect seems to be left. The PhD-degree has largely become a matter of intrinsic motivation of the candidate and even a job in university teaching or research appears no longer to be a desirable career track. Apart from the need to maximize the value of the PhD-curriculum in terms of scientific education, there should also be more explicit attention for the student's later professional career, for instance by explicit training in relevant aspects of science management.
- The position of the research schools in the academic setting should be reconsidered with an eye on the primary tasks of the university as such. Over the past 40 years, the Dutch system of higher education has slowly moved from a continental European model towards a (half-baked) Anglo-Saxon model. The introduction of the Bachelor-Master structure is the most recent step in this process. An important further step, that so far was never considered explicitly, is the establishment of the graduate school as the core entity in a university system that indeed wants to offer the most advanced education possible. Not the undergraduate curriculum (that should be offered by the colleges within and outside the university as such), nor the specialized research institutes without statutory commitments to (graduate) teaching should occupy the central position in the universities. Ultimately it is the graduate schools that make the academic world go round!

The PhD in the US: Criticisms, Facts and Remedies

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The US PhD is a much sought after degree both nationally and internationally. US doctoral education serves as a model throughout much of the world. However, within the US, the doctoral education is not without its critics. During the past ten years the criticism of doctoral education has generated national attention and resulted in a call to reevaluate whether this education measures up in content, structure, and process to prepare scholars and researchers for present and future societal needs.

In this paper I will first contextualize the debates, criticisms, and initiatives, with some basic data on US doctoral production; ²⁵ second, present the criticisms voiced, examine whether they can be substantiated by empirical findings; third, describe the intentions and focus of five programmatic national initiatives, and fourth, end with a critical analysis of the likelihood of successful impact of these initiatives and a focus on the active participation of doctoral students in bringing about change in their education.

Presently over 40,000 PhDs are awarded annually in the US. **[GRAPH 1]**.

During the 1960s, the time of the Vietnam War, doctoral enrollment experienced a sharp increase—many men deferred the draft by going to graduate school—and thus the early 1970s show a dramatic increase in doctorate awards. This PhD production rate leveled off over the 1980s and began to increase again in the 1990s **[GRAPH 2]**. This recent increase stems from higher enrollments in the life sciences, physical sciences, engineering, and humanities doctoral programs and includes an increase in the influx of international students in natural science and engineering fields **[GRAPH 3]**. (Roughly 50% of the international PhD students remain in the US after degree completion.) Among other factors, the increase in PhDs, particularly in humanities and arts, is a result of a widely publicized, but false prediction of a shortage of PhD recipients in the late 1980s (see Bowen and Sosa 1989 for the humanities, and Atkinson for science and engineering in 1990).

Women's participation in the doctoral degree steadily increased since WWII. **[GRAPH 4]** Women's PhD acquisition surpassed men in Education, the social sciences, and since the year 2000 is equal to that of men in the humanities. **[GRAPH 5]** Overall, time to doctoral degree in all fields has increased between 1 and 2 years. **[GRAPH 6]**

The ratio of PhDs to bachelor degrees has stayed fairly stable between 3.5-4.3% during the last 20 years, at 3% when we count only degree awarded to US citizen and

²⁵ In this paper I am using the term PhD, that is the strict academic doctoral degree, interchangeably with the generic term, doctoral education, that also includes professional doctoral degrees such as the EdD, Dr. of Engineering or Dr. in Public Health, but NOT the doctorate of law, the JD, nor the medical doctorate, the MD, which are strictly professional degree with no research dissertation.

permanent residents. **[GRAPH 7]** About 25% of the US population hold a bachelor degree and 1.5 % a doctoral degree including MDs and JDs **[Table 1]**.

406 institutions award doctoral degrees. 50 of these 406 institutions award about 50% of all doctoral degrees. **[Table 2]** This means doctoral education is concentrated in a few institutions, mainly the major research universities, and the majority of which are members of the American Association of Universities.

The largest “PhD mills” are the major public universities led by University of California in Berkeley, which awards roughly 750-800 PhDs annually. The top private universities follow in PhD production these major state universities.

Although the number of faculty at US college and universities has steadily increased during the last 30years, the number of tenure-track faculty has not increased in relation to the increase in the undergraduate students population **[GRAPH 8]**. The number of “other faculty” referring to the non-tenure track, annually appointed lecturers, instructors, affiliates, is steadily increasing.

Against this background of these present dimensions of doctoral education in the US, the major points of criticism of doctoral education have to be understood as they have emerged nationally over the last 15 years. Who is voicing these criticisms? What are counter-positions of these criticisms (often voiced by faculty)? What empirical research confirms these criticisms? How do former PhD students on the basis of having applied their doctoral degrees, assessed their doctoral education?

Three recent national student surveys exist that voices a number of criticisms: The Golde and Dore study (2001), the National Associate of Graduate and Professional Students study (2001), and the Nerad and Cerny (1999, 2002) The Golde/Dore study, “At Cross Purposes: What the Experiences about Today’s Doctoral Students Reveal about Doctoral Education,” was initiated by the Pew Charitable Trusts, a private foundation, that until recently has included a focus on higher education. This study administered in 1999, surveyed doctoral from eleven disciplines at twenty-seven major research universities—in all, 4000 students in their third year or beyond. This study focused on their “current” experience in their programs, and on whether they regarded themselves prepared for their subsequent careers. This study had a 42.3% response rate.

The National Associate of Graduate and Professional Students study (2001), “The 2000 National Doctoral Program Survey,” was funded by the Sloan Foundation. It sought to survey every student who has been enrolled at least for one semester since 1995. The study focused on students’ learning environment, faculty/student mentoring and advising relationships, clarity and transparency of program structure, whether the program fostered diversity, and it assessed the implementation of recommendations given by the National Research Council (COSEPUP 1995) and the Association of Graduate Schools within American Association of Universities (1991). The study received responses from 32,000 current and recent doctoral students from 5,000 doctoral programs and 400 universities across the US and Canada. The response rate cannot be calculated because the basic survey population cannot be assessed as the survey and the call for completion was posted on the web. This method had no way of knowing how many students heard about the survey and chose to complete it.

The Nerad and Cerny study, “PhDs Ten-Years Later” **[GRAPH 10]** study, funded by the Mellon Foundation and the National Science Foundation, surveyed roughly 6000 PhD recipients from 61 research universities ten to fourteen years after degree completion, in six disciplines: biochemistry, computer science, electrical engineering, English, mathematics, and political science. The response rate of this study was 66% of the domestic PhD recipients and 52% of international PhD recipients. The study focused the career paths from the time the respondents received their PhD to 1996/97 to 10-14 years later and the retrospective evaluation of the quality and usefulness of their doctoral education, information about their job search, and job satisfaction.

The major criticisms are:

- Doctoral students are educated and trained too narrowly.
- They lack key professional skills, such as collaborating effectively and working in teams, have no organizational and managerial skills.
- They are ill prepared to teach.
- They are taking too long to complete their doctoral studies and in some field many do not complete their degrees at all.
- Doctoral students are ill informed about employment outside academia.
- I would add to this list- doctoral students have a too-long transition period from PhD completion to stable employment.

The first two criticisms come from the employment sectors outside academia, that is, industry, business, government, and nonprofits that employ PhD recipients. A widely publicized report by the National Academy of Science, *Reshaping the Graduate Education of Scientists and Engineers* (1995) brought national attention to these criticisms.

These two criticisms reflect the traditional notion that the PhD is the entrance ticket to a faculty career path alone. The criticism that PhD recipients are educated and trained too narrowly is difficult to substantiate, in other words we don't really know by what criteria industry is determining this assessment. In contrast faculty currently training graduate students argue that a primary objective in educating their students is to train researchers and scholars, which, by definition, equals a broad education. When we ask PhD recipients themselves about their education and professional skills acquisition we find that overall they tend to agree with industry. They explicitly recommend that doctoral programs have increased breadth and interdisciplinary in their curriculum. **[GRAPH 11]** They also recommend that doctoral programs offer greater opportunities for developing professional skills by fostering collaborative and teamwork environments and by teaching organizational and managerial skills. **[GRAPH 12]**

The third criticism, that students are ill prepared to teach, comes from those higher education institutions that are mainly teaching institutions (4-year institutions, liberal arts college, and 2-year colleges) and from students themselves. Unlike the first two criticisms this third criticism has no obvious counter positions, except from the English and foreign language faculty and their doctoral students. These doctoral programs offer plentiful teaching opportunities and some training in how to teach because these programs serve a large undergraduate student body and because they have few funding sources for their doctoral students. The teaching assistantships are the main financial means of doctoral students to fund their education in these fields. All three recent national studies found insufficient training of how to teach despite recent claims by graduate deans that the lack of pedagogical training has been adequately addressed.

Moreover, the respondents of these studies cite a desire for a component of their doctoral study that introduces and prepares for all facets of a faculty position: teaching, writing grants, participating in committee work, administrating departments. In short, they want an introduction to the politics of the academic workplace.

The fourth criticism, that doctoral students take too long and don't complete, comes from a variety of sources. Such as, state and national policy makers who are concerned about the cost of a drawn-out doctoral education and the filling of needed positions in R&D job sectors. (Interestingly, the age of a PhD graduate is not of great concern to policy makers in the US.) **[GRAPH 14]** This criticism also comes from graduate deans who are concerned with resources for funding graduate students and the flow of incoming talented graduates to their programs. An argument that graduate deans and department chairs often make is that PhD recipients with a long time to degree are at a disadvantage when job searching. However, the "PhDs: Ten-Years Later" study could not substantiate this concern. It showed minor correlation between the length of a doctoral degree and job type.

In contrast, many professors in the humanities and the social sciences argue that over the past decades, the volume of knowledge has increased and students need to be proficient with a greater number of methodological approaches. Consequently, degree completion necessarily takes a longer time. In the sciences, where the time to doctoral degree stayed fairly even, around 5-6 years, the acquisition of additional methodological tools takes place after the PhD has been completed, in the postdoctoral years. (When we consider not time-to-degree, but time to first professional job, PhD recipients in the humanities, social sciences, and sciences are about the same.) **[GRAPH 14]**

While the empirical studies do not inquire about student attitudes toward time-to-degree, we surmise that long time to doctoral degree is a factor for some students. Students in the sciences and engineering are well funded and have reasonable time-to-degree. Those in the humanities and social sciences have the double burden of limited funding resources and long courses of study. Given the limited funding, many doctoral students need to take on additional work, unrelated to their thesis and in turn take longer to complete. Many PhD recipients in humanities and social science accumulate debt on average \$20,000- \$30,000 of accumulated debt. (SED)

The fifth criticism that doctoral students are ill informed about employment outside academia comes from the current and former students and private funding agencies. University administrators and department chairs, except in engineering and the biotechnology fields, do not see this criticism as valid. For them the main purpose of doctoral training is still to produce the next generation of faculty. And yet, all three studies found that students want information about jobs outside academia. In fact, contrary to university administrators and department chairs assumption, that all students aspire to a faculty career, overall only about 50% of the survey respondents aspired to faculty positions as shown in the "PhDs-Ten Years Later" study. **[GRAPH 15]** This percentage varies by field: more students in the humanities and social sciences wanted to become faculty and fewer students in the sciences. Despite the fact that only about half of the PhD students sought faculty positions, they experienced apprehension in articulating their actual career goals. Students told vivid stories, even ten years later, about encountering unsupportive climates in their programs toward students who had career goals other than the professoriate. The NAGS study showed that students want

curricula that are broad enough to give them a choice of careers, and there want that the choices they make are respected.

So where are the PhDs employed?

The “PhDs-Ten Year Later” study found that ten to fourteen years after degree completion 2/3 of English, mathematics, and political science PhD recipients were found to be in professorial positions. Half of all biochemistry and roughly 1/3 in computer science and electrical engineering PhD recipients were in faculty positions. Clearly a large proportion of PhD recipients are employed in positions outside the academic sector. **[GRAPH 16]**

This fifth criticism is highly intriguing because it gets at a key current tension in US doctoral education. What we see with this criticism is the effects of an increasingly limited academic job market. Although this limited academic job market for tenure-track faculty positions is well known and documented among university administrators, faculty, and students, it is only the students who must face the reality of a job search. It is only the students who are forced to broaden their job search in order to find adequate employment. University administrators tend to mediate this job market (in fact benefit from it) by hiring non-tenure track temporary lectures (primarily women) to teach the increasing undergraduate student population and do not establish an adequate number of tenure-track faculty positions.

For faculty several different factors come into play. First, given the tight academic job market and recognizing their own good fortune, faculty feel helpless and become aloof toward their students in their search for employment. After all, they themselves do not have experience outside academia, which means they do not have contacts, they do not know the various job opportunities, and they do not know the nature of the application process. Second, the academic value system tends to reward faculty for placing their graduates in faculty positions preferable at the top research universities. Despite genuine commitment to their individual advisees, professors end up upholding the traditional value systems at the expense of their students. Faculty unwillingness to act upon providing their students information about careers outside academia is a function of their own fear that they themselves will be viewed by their peers as unsuccessful because their students are not seeking faculty positions.

In the United States, campus career centers offer some workshops for career placement for doctoral students. These centers, which operate independently of departments and which aim to provide students with information of careers outside academia, undermine the well-intended support, by referring to nonacademic careers euphemistically as “alternative” or “other” careers, thus reproducing the academic norm.

Students of all fields are aware that people with engineering and life science PhDs have excellent job opportunities outside academia. In fact, these highly paid industry and business jobs resulted in an increase in engineering faculty salaries in order to retain some engineering PhD recipients in academia. Overall students are beginning to recognize that a PhD in our present knowledge-based society has value outside academia and they want to learn about those opportunities.

The last criticism I wish to add is not one voiced by former students or by other parties. This criticism refers to the long and arduous transition period from degree completion to stable employment for roughly half of the PhD recipients **[GRAPH 17]**. The “PhDs-Ten

Years Later” study found that those PhD recipients, who did end up in a faculty position, did not follow a smooth linear path from PhD completion to assistant, associate, and full professor. In the English, political science, and mathematics it took PhD recipients up to four years to land a tenure-track position because of the limited job market. Many ended up spending these interim years in year-to-year, low paying, teaching position without benefits while building their publication records. The added publications, not the extended teaching experience, increased their likelihood of being a successful academic job candidate.

In the life sciences, in the case of the “PhD 10 Years Later” study, biochemistry PhD recipients also took four years after degree completion to find more stable employment. Most of life science PhDs (80%) spent on the average 4 years in low-paying postdoctoral positions, with minimal benefits. **[GRAPH -18]** During these postdoctoral years they build their publication records but also acquire additional experience in research methodologies and grant writing, thus making them stronger candidates for faculty positions. Therefore, the postdoctoral position works as a stepping-stone to an academic career. However, for women the postdoctoral years do not necessarily have that stepping-stone function to a research career as it does for men. Given the biological clock, more women than men opt for postdoctoral positions in order to combine the family and career building. So while the family might grow, women’s careers stagnate.

These criticisms have not fallen on deaf ears. Private and national foundations, which provide a substantial number of graduate fellowships, have responded to these criticisms because they have a clear financial interest in ensuring that their money invested fulfills foundation missions.

Currently in the US there are several initiatives to address various aspects of the criticism of doctoral education. Private foundations, reflecting the particular US higher education system, fund all but one of the initiatives.

- National Science Foundation: The Integrative Graduate Education Research and Traineeship program (IGERT)
- Council of Graduate Schools: Preparing the Future Faculty/Preparing the Future Professional
- The Carnegie Foundation for the Advancement of Teaching: Carnegie Initiative on the Doctorate
- The Woodrow Wilson National Fellowship Foundation: The Responsive PhD, including the Humanities at work program
- The Sloan Foundation/Council of Graduate Schools/Ford Foundation: Professional Master’s Programs

Not reporting here are initiatives that are mainly web-based information dissemination projects and that do not have a major program associated with them, such as the “Re-envisioning the PhD” also initiated by the Pew Charitable Trusts, and the “Next Wave” and Postdoctoral Network by the American Association for the Advancement of Science and Science Magazine.

The National Foundation **IGERT** initiative proposes the creation of doctoral programs that are centered on theme-based research. This initiative is very similar to German Research Council funded Graduiertenkollegs. The goals are:

- a) To provide funding for doctoral students that is more independent of the faculty advisor by tying the funding to the doctoral program and not the faculty advisor
- b) To build doctoral programs that are interdisciplinary
- c) To educate and train doctoral students in problem-oriented and theme-based research programs
- d) To provide access for doctoral students to professionals in their field who work outside academia
- e) To organize the structure of the program so students learn the maximum range of professional skills, from learning how to teach, to working in teams, publishing, presentation skills and learning organizational skills
- f) To bring diversity to doctoral programs

This initiative does not provide funding for faculty. It mainly provides funding for students. There is some administrative program support and some curriculum development support. With the shifting of funding away from faculty to students and an emphasis on the learning conditions, NSF hopes to reduce time to doctoral degree and create the next generation of scholars who are better prepared to address the large-scale problems of industrialized societies that cannot be solved by a single disciplinary focus or by a single researcher. NSF has allocated 64 million dollars over five years to this initiative and currently there are 70 IGERT programs at 55 universities.

The second initiative, **Preparing the Future Faculty**, was originally initiated and funded by the Pew Charitable Trusts Foundation and coordinated by the Association of American Colleges and Universities and Council of Graduate Schools in 1993. Currently the Council of Graduate Schools runs this program via private donors. The initiative goals are:

- a) To prepare present doctoral students for their role as future faculty
- b) At some campuses this has been extended to prepare students for their role as professionals in their field.

Today about 295 institutions participate. The majority are Master's and Bachelor's institutions, and 43 doctoral granting universities. The initiative sponsors seminars and workshops to introduce doctoral students to the different types of institutes of higher education, their responsibilities as teachers, researchers, and in providing service to the academic community. It places students into internship at these various institutions where they teach under the mentorship of an established professor. Thus doctoral students have multiple mentors. It also offers pedagogical workshops. Since 1998, the PFF works together with disciplinary associations. These associations select the participating doctoral programs.

The third initiative, **Carnegie Initiative on the Doctorate**, by the Carnegie Foundation for the Advancement of Teaching is a multi-year research and action project to support departmental efforts to more purposefully structure their doctoral programs. This initiative exists since summer 2002 and addresses the disciplinary communities of six fields: chemistry, education, English, history, mathematics, and neurosciences. It fosters discipline-based conceptual work. Departments that apply and are selected to participate in this initiative receive advice and funding for two of their members to attend meetings with their counterparts in other participating programs where they share experiences and information about restructuring their programs. They do this work in collaboration with their professional associations. In short, this initiative tries to stimulate a debate about the structure of doctoral programs by engaging the national

association of a discipline in such a conversation, just as the Preparing the Future Faculty initiatives did.

The fourth initiative, **The Responsive PhD**, by the Woodrow Wilson National Fellowship Foundation is an initiative that focuses not directly on students or departments, it intends to support the initiator of change at a university, that is, department deans, divisional deans, and department chairs. It provides information on best practices in graduate education, by bringing participating members together to share their experiences with their own best practices, particularly on the implementation process. The Foundation funds the information-sharing meetings and provides some financial support to institutions that wish to implement one of the best practices. The Woodrow Wilson Foundation also created the Humanities at Work project that consists of a 2-year postdoctoral fellowship program, practicum grants of \$1,500 for graduate students, and a public scholarship grant for faculty,

The fifth initiative, **the Professional Science Master's Program**, by Sloan Foundation/Council of Graduate Schools/Ford Foundation is an initiative that proposes a better match between the career options and the career opportunities of graduate students in the sciences and social sciences. This program responds to the criticism of doctoral education of time-to-degree, high attrition rate, the limited academic job market, and student desire for non-faculty positions by providing an alternative route to a substantiated professional terminal science master's degree. This initiative funds institutions to develop a new type of science master's degree that equips people to work outside of academia. It targets flagship research universities to develop a two-year master's programs that are heavily oriented toward interdisciplinary course work. This terminal degree is opposed to the traditional one-year master's degree in the sciences that is really simply a stepping-stone to the PhD and that is considered a conciliatory degree for those who do not make it to the PhD.

These initiatives address different aspects of the criticism, they have different opinions about strategies that will bring about change, and therefore target different groups: students, departments, deans, and universities. They are, however, uneven in their scope; some function more as a bandage to the problem than as a cure. The Woodrow Wilson initiative acknowledges the critiques, however has insufficient financial means and is limited in its programmatic structure. While it is absolutely useful to have an exchange of best practices, and encourage contact of humanities students with non-academic work places, the initiative at present offers minimal incentives for implementing these best practices. It appeals to a moral imperative of the necessity of change and the good will of top campus administrators.

The Carnegie initiative, while more of a grass-root level approach, provides basically no financial incentive. The incentive it provides is one of advice and the promise of national visibility, thus a raising of status to the participating departments. Since it was only launched in summer of 2002, little can be said about it.

Council of Graduate Schools' Preparing the Future the Future Professoriate addresses the criticism that PhD recipients are ill prepared for their faculty positions. It keeps in place a fairly traditional notion of what PhD recipients are trained to do: enter the academic faculty positions.

The Sloan and the CGS/Ford Foundation initiatives are the most pragmatic of the initiatives. It addresses particularly the limited academic job market situation and proposes to strengthen the master's degree. Yet, it too keeps in place the idea that the doctorate is solely for preparing the next generation of faculty.

The IGERT initiative is the most comprehensive approach. It addresses all of the critiques and it follows through with a truly innovative approach to changing doctoral education. While this initiative is not found in the elite institutions because they have sufficient funds for their doctoral students, it is likely to have a far-reaching impact on change and innovation in doctoral education, because the major public state universities, which educate the largest number of PhD students, have embraced it.

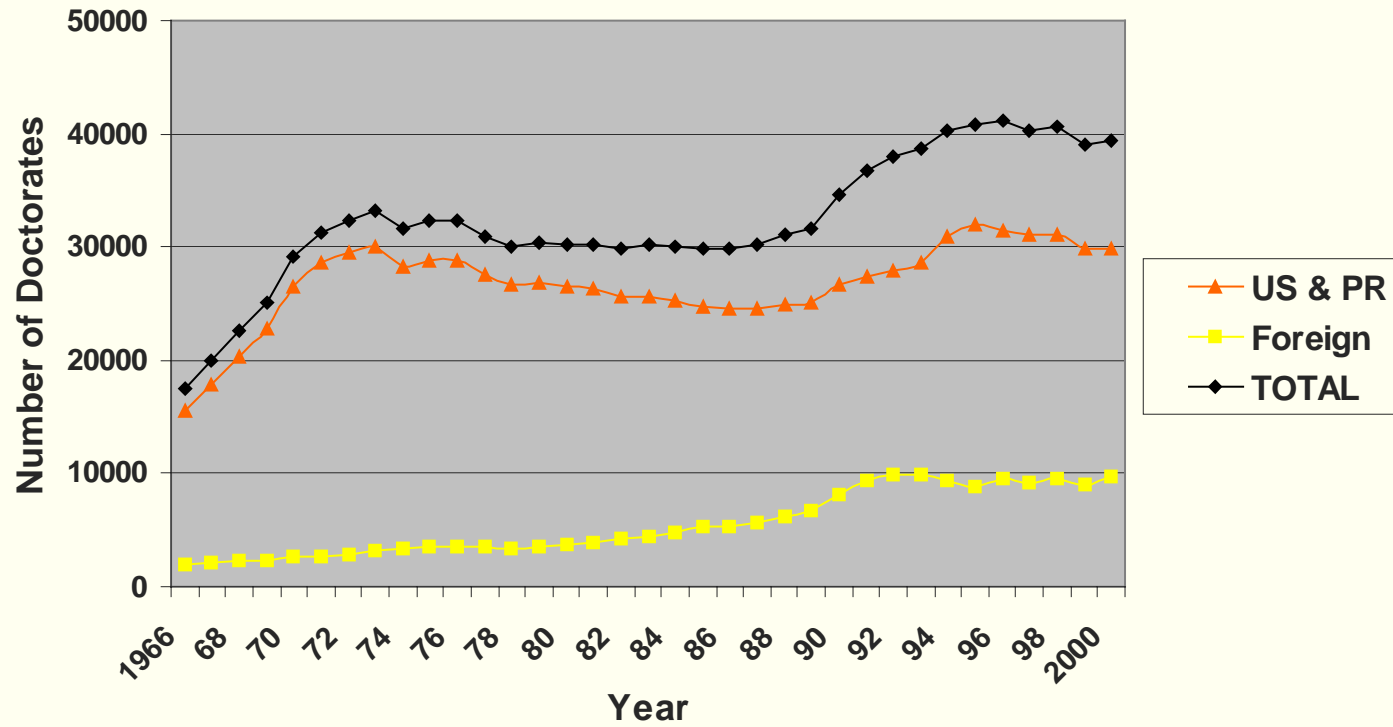
As we saw, doctoral students play an active role in criticizing US doctoral education. Their criticism addresses both the content of the education, the structure, and the process of doctoral education. They ask for a more interdisciplinary approach in their programs and for a closer relationship with the "real" world. But mostly their criticism focuses on the process of their education, the interaction with faculty, their peers, the acquisition of knowledge and skills that turns them into scholars who can function both inside and outside academia. They are interested in using their PhD to find employment. This does not mean they are solely vocational oriented. They want intellectually challenging employment, with a high degree of autonomy, as the "PhDs--10 Years Later" study found. They want to apply their scholarly training for work that solves real problems in the world. They look for employment that fulfills these criteria both inside **and** outside academia. (In the US, people with PhDs are not mainly interested to getting an education in order to find work that pays the most. People with such goals stop after the Bachelor's degree or enroll in MBA programs or go to Law School specializing in the lucrative sides of a law career, or attend medical school.) Current PhD recipients still ascribe to a value of the education that surpassed purely economic purposes, **and** they are also realistic.

In order to make the university listen to their concerns mostly about their conditions as teaching assistants, doctoral students launched national surveys to hold up a mirror to departments and universities, and they formed graduate student unions linked to large US union organizations such as the American Automobile and Transportation Union (UCB, NYU, Yale, UCSD, U Wisconsin, UW have formed unions). They know that university administrators fear negative publicity about their institution. They used the media publicity in their strategies. In fact, the fear of increased union activity and the fear of a negative press has pressured a number of universities into revisiting their doctoral education and making improvements in the educational learning and working environment. Moreover, the values of a consumer society, where the client has some influence on the product and the production, and the culture of a client-service orientation has penetrated the universities (see the increase of student services, including food and sports facilities). This increasing culture of consumer orientation, combined with the above described fear of further unionization, and fear of a negative image in the public eye are pressuring universities to consider changes in doctoral education. The likelihood that doctoral students' criticism are heard and acted upon is presently great.

Whether, however, the renewed focus on and activities in doctoral education will be fruitful and not be bypassed by the present US anti-terrorist politics and accompanying isolationist tendencies since 9/11, remains to be seen. US doctoral education has a

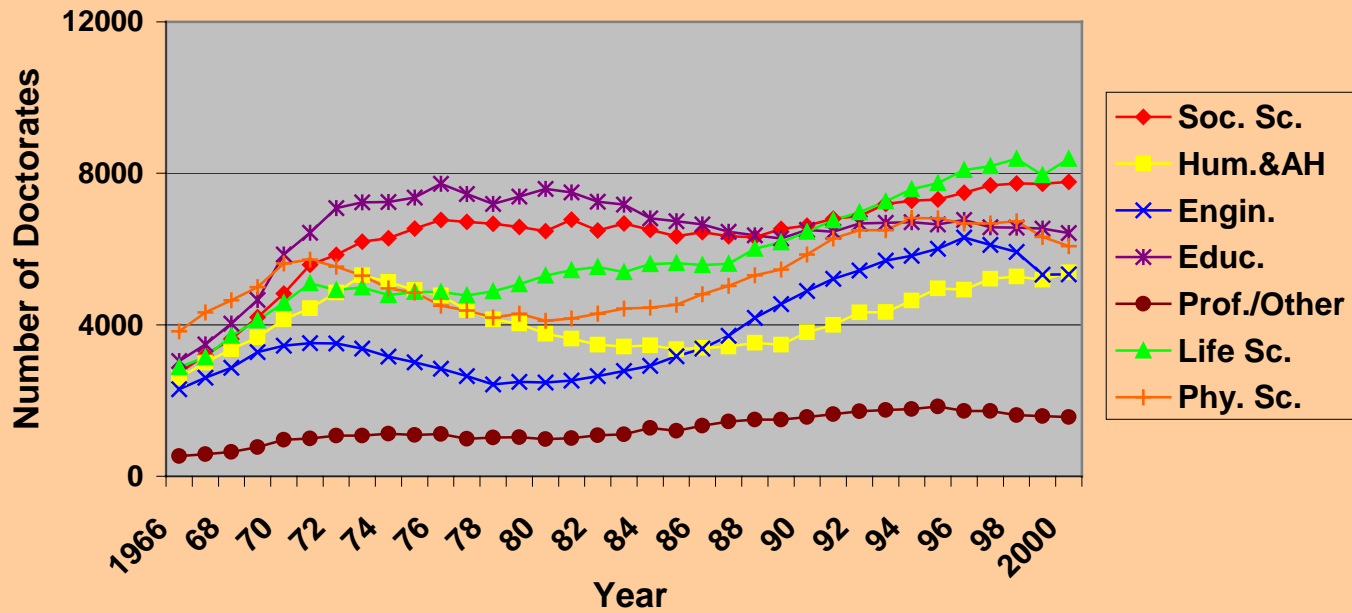
historical precedence, where similar criticisms were voiced and a beginning focus on doctoral education emerged, in the early 1960s. However, these beginning were overtaken by the events of the civil rights movement, the anti-Vietnam protest, and a resulting student movement, that puts criticism and reform of doctoral education on the backburner on US campuses. The six present initiatives, in their own limited way, address the criticism and are a beginning. In five years from now, we will hopefully report on more evidence of change in US doctoral education that truly educates students for the 21st century and to operate as global citizens.

Graph 1: US Doctoral Degrees by Citizenship 1966-2000



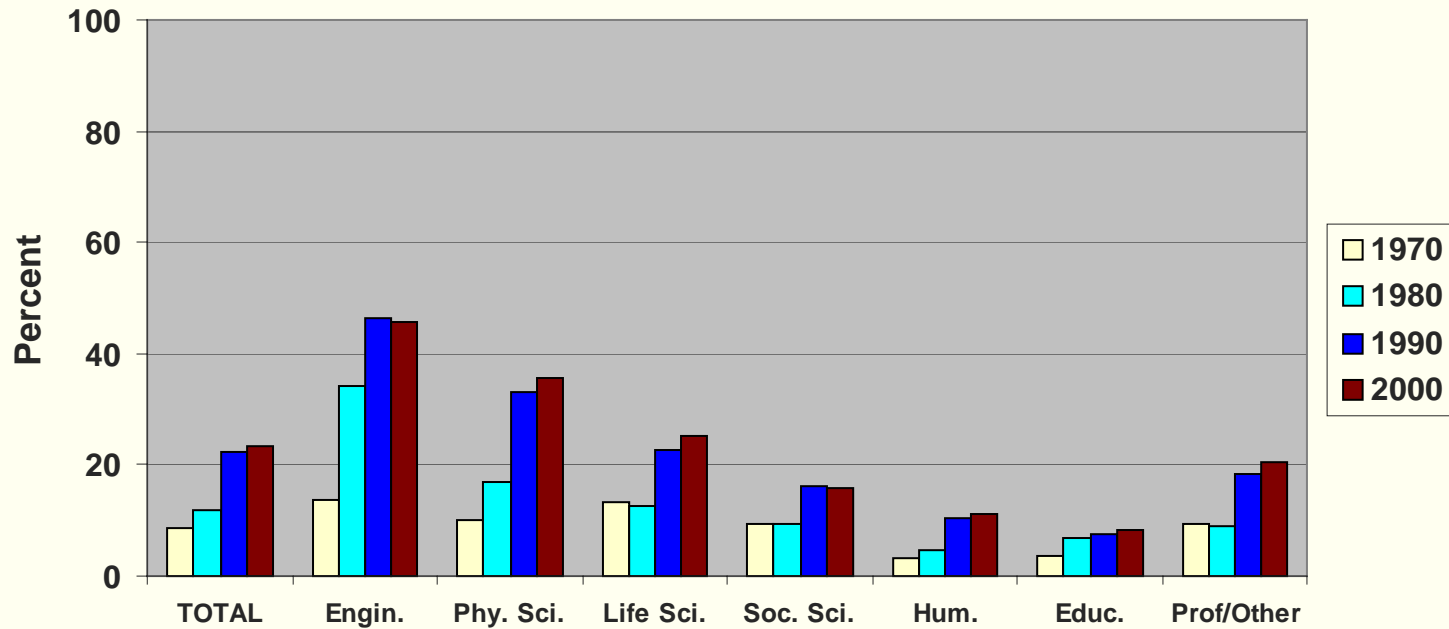
Source: CIRGE, UW Seattle, 10-21-02, NSF Web CASPAR, Doctoral Record File

**Graph 2: US Doctoral Degrees by Major Field of Study
1966-2000**



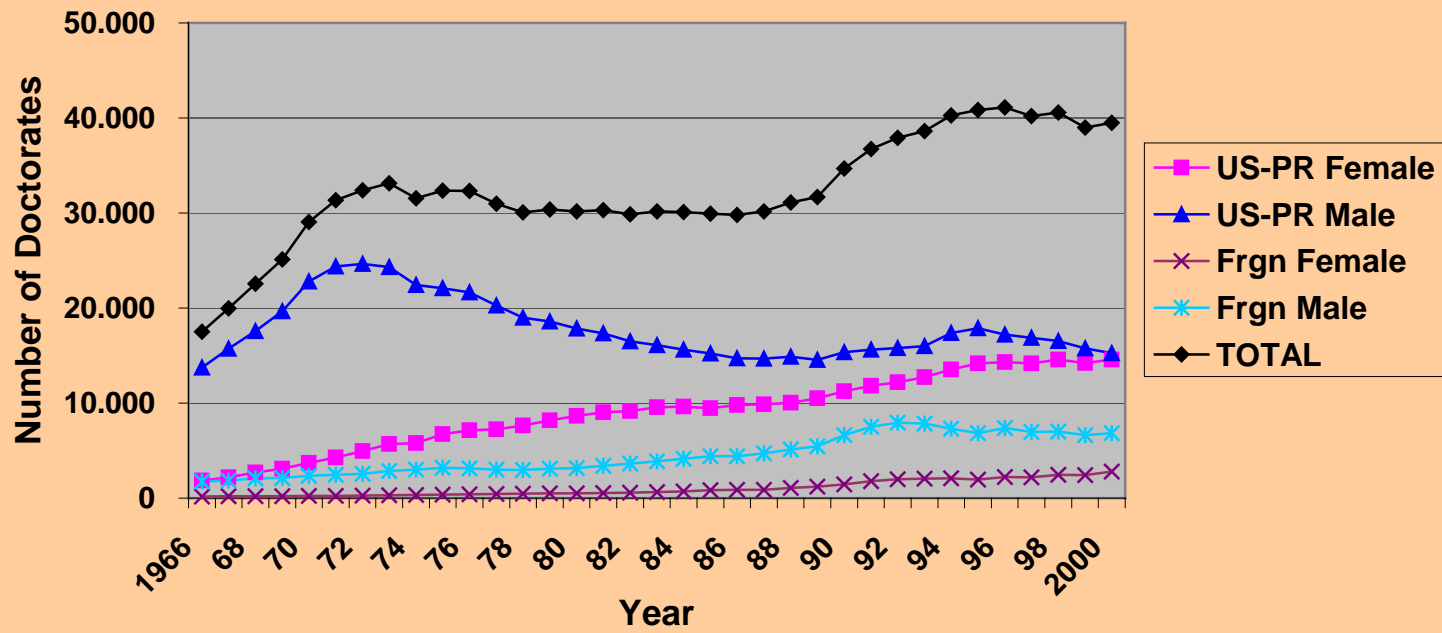
Source: CIRGE, UW Seattle, 10-21-02, NSF Web CASPAR, Doctoral Record File

Graph 3: Percent of Foreign Doctorates Awarded in US by Major Field of Study: 1970-2000



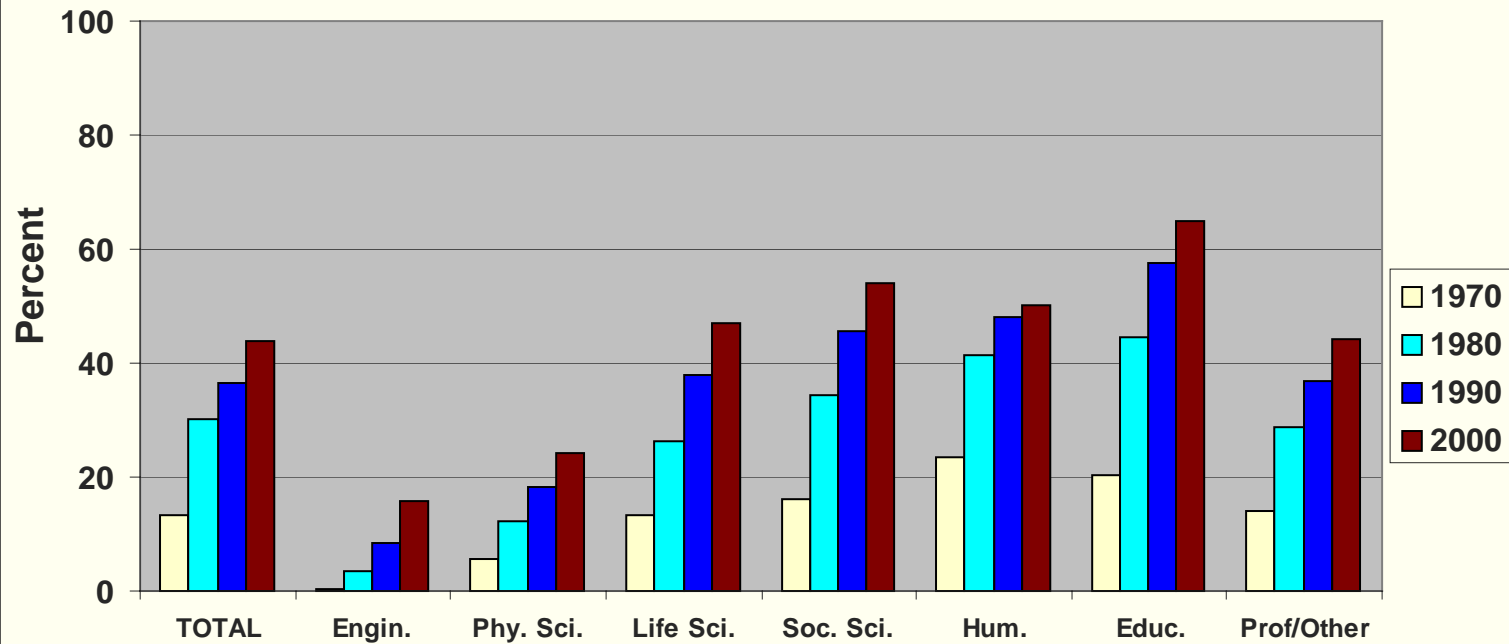
Source: CIRGE, UW Seattle, NSF Web CASPAR, Doctoral Record File, "figures for 10/21-citiTemp%."

**Graph 4: US Doctoral Degrees by Gender and Citizenship
1966-2000**



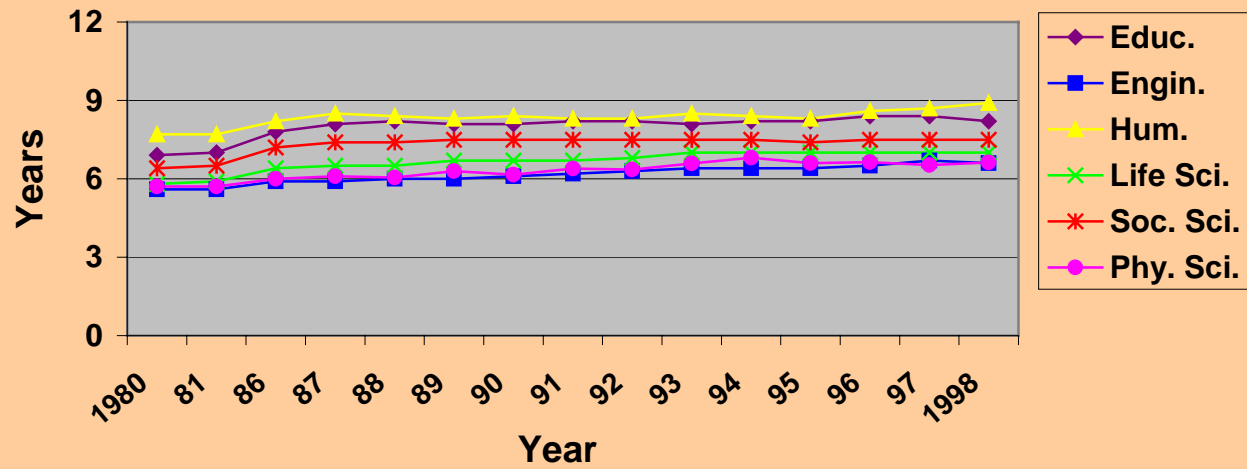
Source: CIRGE, UW Seattle, 10-21-02, NSF Web CASPAR, Doctoral Record File

Graph 5: Percent of US Women Doctorates by Major Field of Study:1970-2000



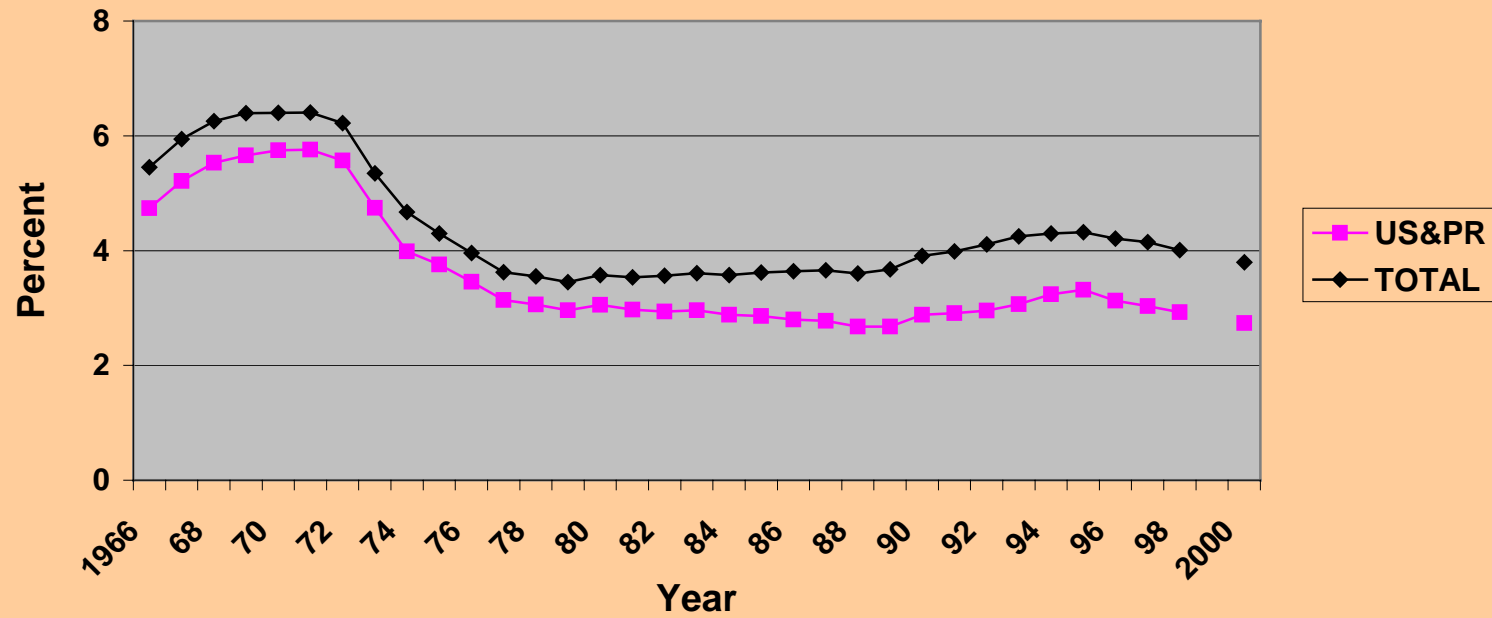
Source: CIRGE, UW Seattle, NSF Web CASPAR, Doctoral Record File, "figures for 10/21-women&field."

Graph 6: Median Time to Doctorates by Major Field: Registered Time



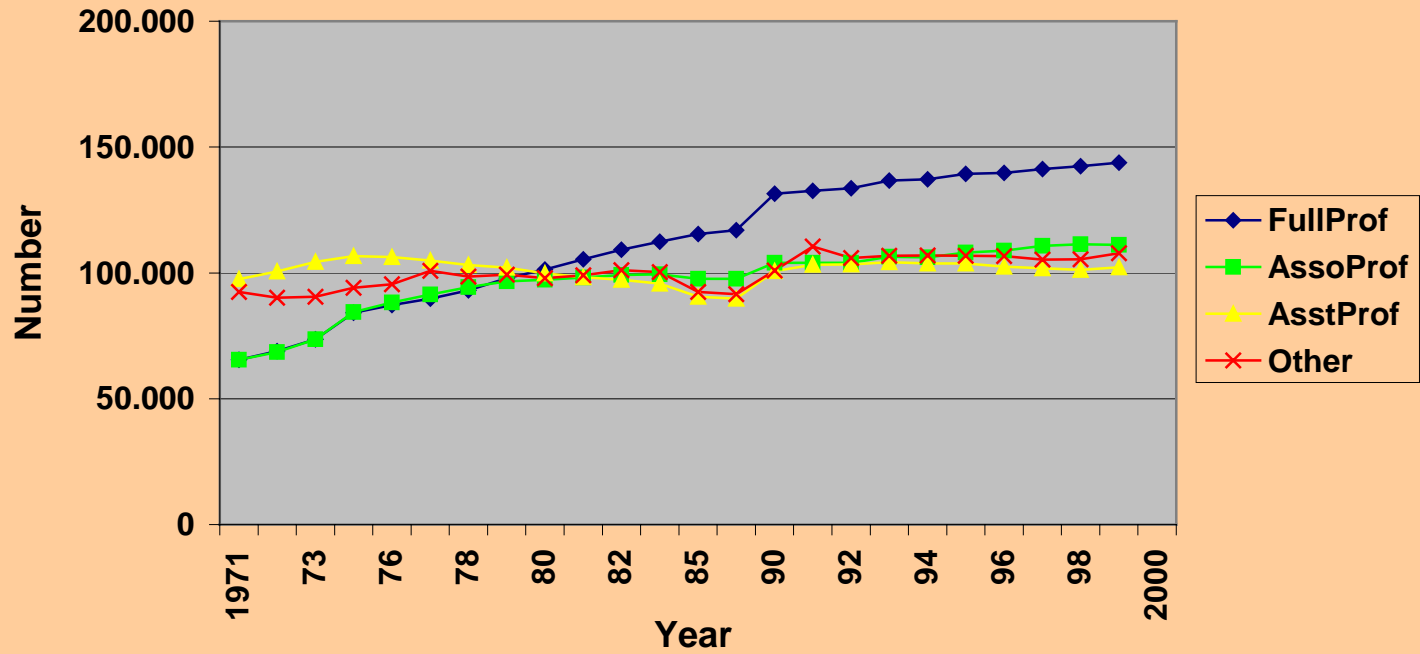
Source: CIRGE, UW Seattle, Digest of Educational Statistics 2001, "figures for 10/21-timePhD".

**Graph 7: Ratio of Doctoral to Bachelor's Degrees Awarded
1966-2000**



Source: CIRGE, UW Seattle, 10-21-02, NSF Web CASPAR, Doctoral Record File

Graph 8: Faculty in the US: 1971-2000



Source: CIRGE, UW Seattle, NSF Web CASPAR, Doctoral Record File, "figures for 10/21-faculty."

**Table 1: Higher Education
Attainment in US (age >25)
in 2000**

<i>Level of Education</i>	<i>% of Population</i>
Some college or more	51.0%
Bachelor or more	25.6%
Master's	5.9%
Professional	1.5%
Doctoral	1.2%

Source: CIRGE, UW Seattle, 10-21-2002, Digest of Educational Statistics, 2001

**Table 2: US Doctorate
Production by Type of
Institution in 2000**

<i>Institution Type</i>	<i>N of Institution</i>	<i>N of PhDs</i>	<i>% total PhD</i>
All	406	41,368	100%
Research I	89	27,168	66%
AAU	61	21,748	53%
Largest	50	21,228	51%
Largest	25	13,351	32%
Largest	10	6,442	15%

Source: CIRGE, UW Seattle, 10-21-2002, NSF Web CASPAR, Doctoral Record File

Graph 10

**PhD Recipients in 6 Fields at 61 Universities:
01/07, 1982 -30/06, 1985**

Size of Surveyed Population and Response Rates




Major Field	G	E	Intern.	Total	% Response Rate	
					Domest.	Intern.
Biochemistry	694	268	97	962	70	50
Computer Sc.	583	69	209	652	65	51
Elec. Eng.	966	36	417	1,002	57	48
English	567	650	72	1,217	67	65
Mathematics	1,005	187	395	1,192	67	57
Political Sc.	630	199	144	829	68	47
aTotl	4,445	1,409	1,334	5,854*	66	52

* Excluded : _deceased (63)

Source: --Ten Years LaterÓ Study, Graduate Division, of December .

Graph 11

Recommendations for Doctoral Programs Open-Ended Questions: 3 Most Cited

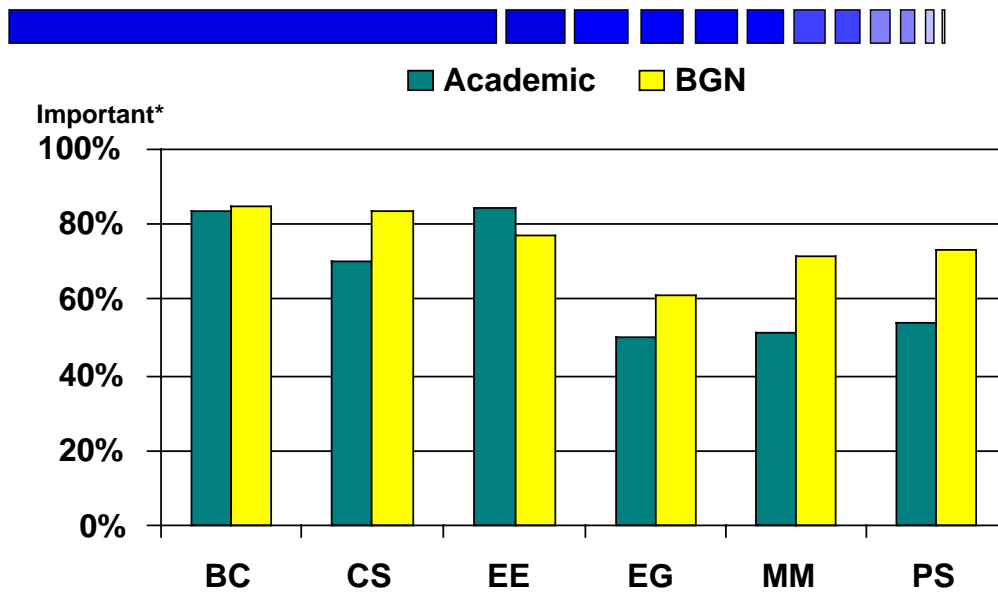


	BC	CS	EE	EG	MM	PS
Provide Breadth/Interdisc.	-	2	3	3	1	1
Stay Current/Marketable	2	1	1	-	2	3
Teach How to Teach	-	-	-	1	3	2
Downsize	1	-	-	2	-	-
Provide Hands-On Experience	-	3	2	-	-	-
Provide Info. on BGN	3	-	-	-	-	-

Source: ÖPhDÖs-Ten Years LaterÖ Study, Graduate Division, UC Berkeley, data as of December 1, 1999 .

Graph 12

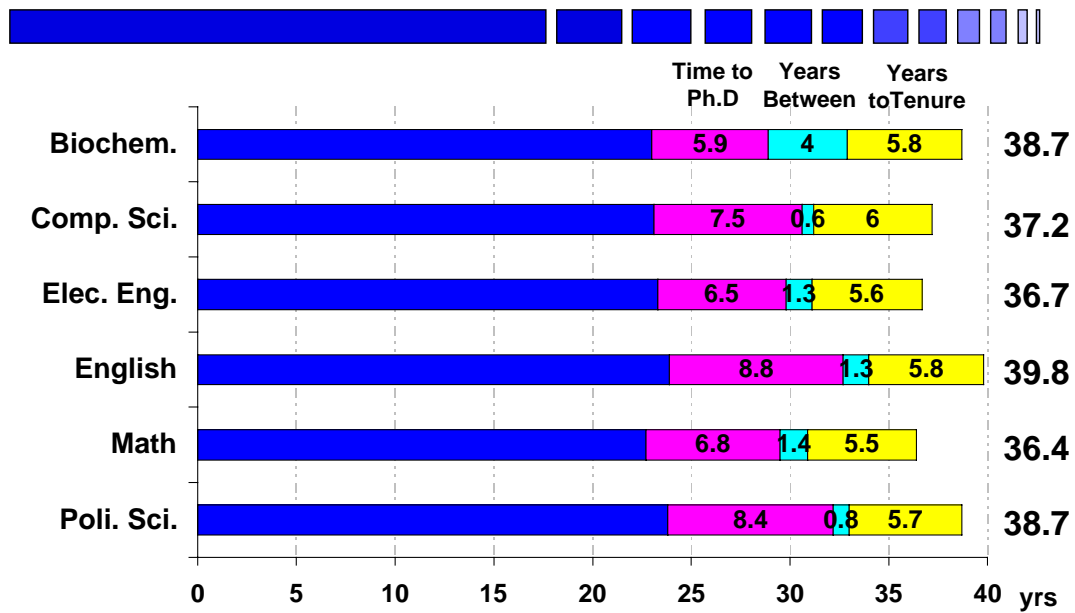
Assessment by PhDs of Importance of Learning Teamwork During PhD Education by Sector



*Important= ÒVery ImportantÓ + ÒImportantÓ

Source: ÒPhDÓsTen Years LaterÓ Study, Graduate Division, UC Berkeley, data as of December 1, 1999.

Graph 14 Age at Tenure By Field



Data as of February 26, 1998
 Source: OPh.D. OTen Years Later O Study, Graduate Division, UC Berkeley

CGS97-24

Graph 15: Career Goal at Doctorate Completion by Field (1983-85)

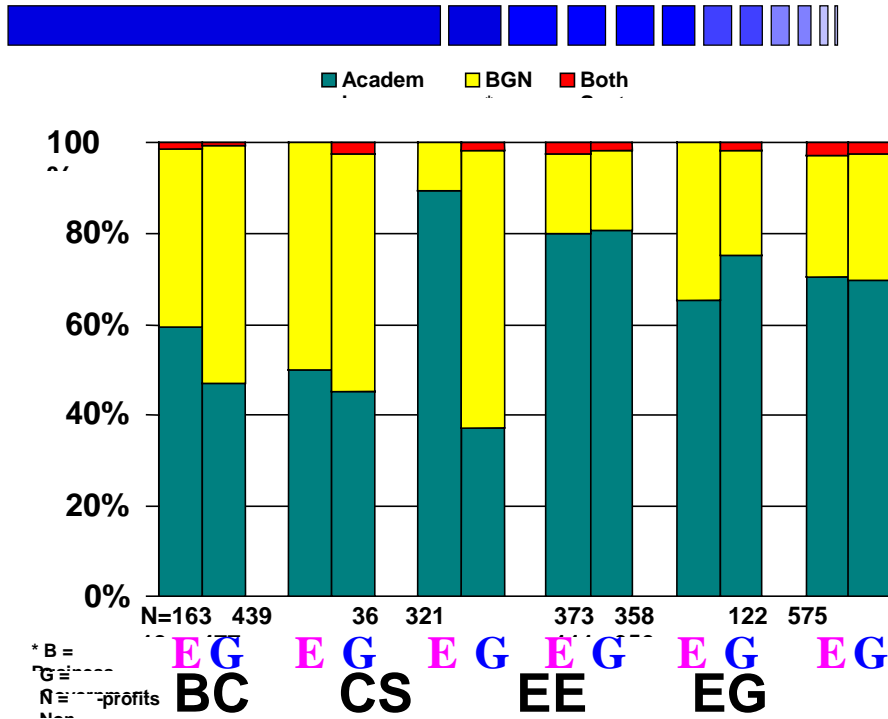
<i>Field</i>	<i>Become Professor</i>
Biochemistry	32%
Computer Science	45%
Elec. Engineering	25%
English	81%
Mathematics	54%
Political Science	72%

Source: CIRGE, UW Seattle, 10-21-2002, NSF Web CASPAR, Doctoral Record File

Graph 16 (E=male, G=female)

Employment Sector, Dec. 1995

by Gender

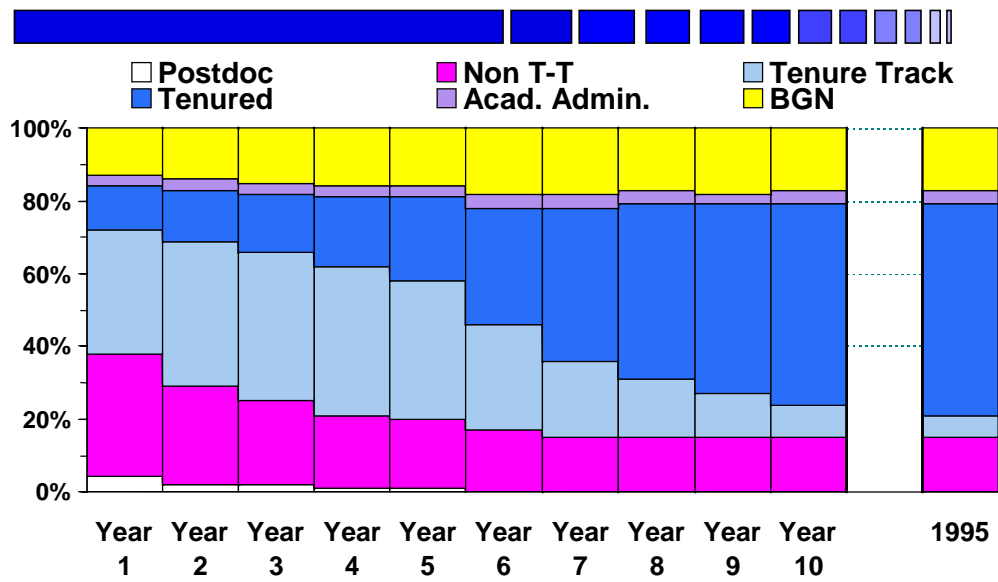


* B = profits
 G = non-profits
 N = sample size

Source: Ten Years Later Study, Graduate Division, UC Berkeley, December 1, 1995

Graph 17: Career Paths of English PhDs

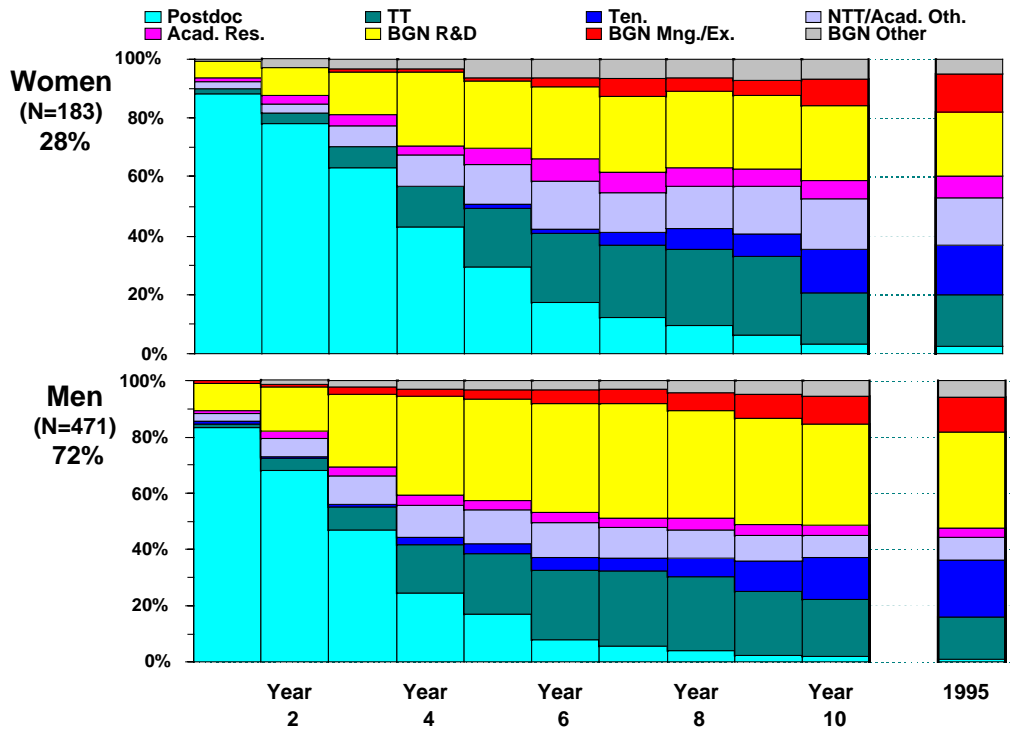
(N=740)



Data as of June 27, 1999
 Source: "PhD's -- Ten Years Later" Study, Graduate Division, UC Berkeley

Graph 18

Career Paths of Biochemistry PhDs by Gender



Source: OPhD's Ten Years Later Study, Graduate Division, UC Berkeley, data as of December 1, 1999.

The Double face of PhD students. The Example of Life Sciences in France*

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Introduction

Like the Roman god Janus, PhD students²⁶ have two faces. First, during their PhD they are involved in the scientific production of the research team²⁷, in teaching and, in certain cases, to relations with the laboratory's partners. As researchers in a team, they are remunerated. In the life sciences (biology, medicine, health), PhD students account for close to 30% of the qualified manpower²⁸ that laboratories mobilise in their scientific and technical production. Second, after graduating, PhDs leave the research team in which they were trained and spread the knowledge acquired during their training towards other academic or private organisations. PhDs are in a sense one of the laboratory's products, for they embody the skills and know-how acquired during their professional experience as trainee researchers. The study of their career paths enables us to highlight PhDs' role as one of the vehicles of knowledge transfers between academia and the corporate world. They are thus one of the components of new forms of knowledge production often referred to as the Triple Helix (H. Etzkowitz and L. Leydesdorff, 2000). Knowledge is produced and simultaneously utilised within the academic and commercial sectors. The production and use of that knowledge are characterised by numerous inter-relations in which junior researchers participate during and after their PhD.

During the 1990s recruitment prospects for permanent positions in academic teams in the life sciences remained stable while the number of PhDs increased substantially. The National Academy of Sciences (NCR, 1998) in the USA and the OST (OST, 2000) in France noted this evolution which was resulting in a high level of job insecurity for this qualified manpower. The lack of job security for life science PhDs reduced the attractiveness of scientific careers, thus dissuading young brilliant people from doing a PhD. However, as the baby-boom generation retires and the life sciences – and especially biotechnology – became one of the main thrusts of European research policy, the demand for skilled manpower (PhD level) is increasing, especially in the private sector. If the current trend towards a decrease in the number of people embarking on a PhD continues, the number of PhD candidates is likely to decline sharply. Thus, both academic teams and firms will be confronted with a lack of

* We wish to thank Philippe Laredo and E. Verdier as well as the participants of the "*Journées d'études sur les Cadres*", Aix en Provence, , 9-10 December 1999, for their comments on earlier versions of this paper. We are of course responsible for any mistakes.

²⁶ Throughout the rest of this paper, the terms PhD student, PhD candidate and junior researcher are used synonymously.

²⁷ Throughout the rest of this paper, the terms academic team, research team, research group and laboratory are used synonymously.

²⁸ This figure comes from the comparison of two sources, one on the number of scientists in academic team in life sciences (OST, 2000) and the other on the number of PhDs students in the same disciplines DGRT. (2000). "Rapport sur les études doctorales 1999." Paris: Ministère de l'Education nationale, de l'enseignement supérieur et de la recherche..

skilled manpower. The scientific production of the country may be affected by the quantitative and partly qualitative decrease in manpower. In the medium term, the reduction of the number of PhDs may also hinder the dissemination of knowledge. The aim of this article is to analyse the role of life science PhDs in the production and diffusion of scientific knowledge and know-how. It highlights their importance in the triple helix process. In the first part, the role of PhDs in scientific production is studied in relation to the organisation of the scientific community. In the second part the characterisation of recent trends enables us to highlight the consequences, on the diffusion of knowledge, of the recent job insecurity for young PhD graduates. Data which supports this analysis is presented in box. They were collected from PhD who are graduated in plant and animal sciences (sample of 652 who were trained at INRA, the National Institute for Agronomic Research). Data covers individual information (gender, age, initial training), information about the PhD process (grant, collaboration with a firm during the PhD, type of team in which the research is performed), information about the results (patents, publications), information about their current job position and information about the management practice of young researchers in their PhD team. All information was collected through questionnaire on 652 PhDs.

Box : Characteristics of the survey

The survey on 652 PhDs of (animal and plant) life sciences who were trained in one of the INRA** research teams and graduated between 1988 and 1998, focused on the respondents' career intentions at the beginning of their PhD, on the way they performed their research and valorised the results (publication, patents, training courses, innovations, etc.), and on the way in which teams took their aspirations into account. The survey was conducted in 1999 by postal questionnaire. The questionnaire was structured to reveal the way in which PhD students' career plans, their subsequent jobs and their career management fitted together. It comprised seven parts:

- Individual information (gender, age, initial training, etc.);
- Background information on the PhD (nature and duration of funding; PhD supported by a private partner – industry – or not; type of academic team in which the student performed doctoral research; relations with industry; academic situation; mode of valorising results; teaching activities or not during PhD);
- Information on modes of valorising PhD (publications, patents, etc.);
- Information on career plans;
- Information on type and nature of first job immediately after graduation (temporary or permanent post, in the academic community or not);
- Information on the type and nature of the job in December 1998, when the questionnaires were sent (temporary or permanent post, in the academic community or not).

Table 1 presents the characteristics of PhDs in the sample.

** *Institut National de la Recherche Agronomique* : French Agronomic Research Institute

Table 1: Characteristics of each population

N=652	Life sciences
Characteristics of PhD student	
% of women	50.2 %
Average age at time of completion	29.5 years
Graduated from <i>grandes écoles</i> or medical or veterinary departments	42 %
Characteristics of the PhD research	
Average time taken to complete the PhD	3,5 years
Mode	3 years
% of PhDs completed after 4 years	90 %
Characteristics of the funding of the PhD student	
Grants or research assistance given to the PhD student by the Institute	50 %
Grants by the Ministry of Research	25 %
Grants by industry	7 %
Other grants	18%
Relation with a private firm during the PhD	22.4%
Collaboration with a private firm during the PhD research	77.6%
No collaboration with a private firm	
Distinction of the thesis	
Highest distinction "Congratulations"	57 %
Other	43 %
Average number of publications during PhD research and before the first job after completion	2,9 (min 0, max 16)
Professional trajectories	
Permanent position in Academia	51.5%
Permanent position in research in a private firm	5.5%
Permanent position as professionals	11.2%
Short term position and unemployment	32.3%
Professional expectations at the beginning of the PhD	
To become an academic	70.7%
To get a job in the private sector	9.2%
No <i>a priori</i> choice	20.1%

Three important characteristics are thus revealed:

1) In life sciences, only a small proportion of PhDs works in private firms after their PhD. Less than 6% have a permanent position in private firms and 11.2% have a permanent position in firms in other functions than research (marketing, quality management, etc.). However, as the mobility of researchers who have a permanent position in academia to private firms is really rare, most of the mobility from academia to firms bears on the mobility of researchers. At the global level (DGRT, 2000), the figures are the same and the proportion of PhDs who have a permanent position in firms after the PhD is under 15%. The main difference between life sciences PhDs in general and those who did their doctoral research at INRA is that INRA's PhDs have greater chance of success in academic careers than the other does. More than 50% of INRA's PhDs have a job in academia while the national figure is under 25%.

2) PhDs are hired by the scientific team to do their research. PhDs done in the Institute are generally of a better quality (large proportion of highest distinction and average number of publications) than the average in life sciences PhDs (DGRT, 2000). Other characteristics

(average age at graduation, duration of PhD, etc.) are similar to those of all life sciences PhDs.

3) Over 70% of PhDs say they would like to have an academic position after graduating. Yet only 55% of them actually do so, in France or abroad.

Role of PhDs in scientific production

The role of PhD students in scientific production depends both on the individual or collective nature of scientific production and on the management of the individuals who occupy research posts.

1.1. Individual or collective production?

What are the relations between research teams and individuals? The economics of science is based on two different representations of scientific activity (V. Mangematin, 2001). A first model, proposed by Merton, offers a representation of scientific activity dominated by competition between individual researchers. Different economists refer explicitly to this model, in particular Dasgupta and David (P. Dasgupta and P. David, 1994) and Stephan (P. Stephan, 1996). Scientific activity is thus comparable to situations of competition: when several researchers compete for the same discovery, only the winner is rewarded. The results obtained by researchers are published in scientific journals which are subjected to a peer review system. In a system of perfect information, the prestige of the journal²⁹ is proportional to the importance and quality of the results obtained. Researchers themselves are evaluated by their peers who use various criteria including the number and quality of publications. These evaluations are used both for career advancement and to obtain resources (scientific research contracts) for developing new research (J. Glaser, 2001; P. E. Stephan and S. G. Levin, 2001). In this model, the individual is at the heart of the competition and the pyramidal selection model predominates. Individuals manage their careers alone and are rewarded individually. Collaboration is not directly analysed in this model.

The second model describes research as a collective activity in which work is shared between several researchers within the same team and between several teams, both academic and private. There are several indications of the collective nature of scientific production. Stephan (P. Stephan, 1996) shows that the average number of authors of an article in a journal indexed by the Science Citation Index increased from 2.52 in 1979 to 3.50 in 1993. She also notes that scientists who collaborate produce more, and of a better quality, than those who produce alone. In this conception of collective work, the work of young researchers is crucial because it offers a degree of complementarity with that of their seniors. Their research, often largely empirical, is used to test a large number of hypotheses and thus to accelerate cumulative processes. Based on the example of physics in the USA, S. Gruner *et al.* (S. Gruner, J. S. Langer *et al.*, 1995) show that the dynamics of scientific production depend not only on the resources allocated to a few star scientists but also on the average age of researchers in the discipline and hence on possibilities of recruitment.

T. Shinn (T. Shinn, 1988) accounts for the particular contribution of junior researchers. Based on a Popperian conception of science, he emphasises the cognitive division of labour. The author uses this term to denote the different and complementary roles of juniors, seniors and professors (or directors) in the scientific community. While juniors pay particular attention to anomalies likely to undermine the explanatory model, seniors work directly on the selection of models and the insertion of data into explanatory models. Professors focus on generalisation by working on fundamental and frequent phenomena. Lastly, models are produced by a few researchers of the "professor at the Collège de France" type. Scientific production is thus seen as a whole, with the presence of all the different components – junior scientists, senior researchers and professors – being necessary for its dynamics.

²⁹ Generally measured by the "impact factor" established on the basis of the average number of citations received by articles published in the review under consideration, over a given period.

Although careers and fame are individual, various indications point to a situation in which science has become collective production and where the division of labour enhances its effectiveness. From this point of view, PhD students are an essential component of laboratories and one that has to be managed by taking account of its specific characteristics, that is, temporary inclusion in a research team and the objective of training through research.

The longevity of the collective character of scientific production depends on the modes of managing scientific manpower in universities. Do research teams and universities have the means to manage manpower, suited to each category of researcher? If the system allows the majority of participants to be rewarded, it can last. If, however, the majority of actors in scientific production have no individual interest in collaboration, the entire structure is undermined.

1.2. Modes of managing scientists and propensity to collaborate

The study of the role of PhD students in scientific production is not independent of the modalities of management of research staff in both the academic and private sectors.

1.2.1 Academic careers and implicit contract

In all developed countries the management of academic careers is grounded in two basic principles: tenure and peer review for recruitment and career advancement.

Tenure: an incentive to specialise

The role of universities in developed countries (US, Europe, Japan) is to train students by teaching them new knowledge, at the cutting edge of scientific progress. This random nature of the advancement of knowledge demands a particular organisation of the academic and research job market. Several authors, primarily in the English-speaking world, have proposed theoretical justifications for tenure.

A first type of explanation is based on the need to *insure* researchers against risks inherent in *specialisation*. Given the fact that the frontiers of knowledge are constantly being pushed back, no academic can maintain her/his knowledge up-to-date in an entire discipline. Academics are therefore forced to specialise, as shown by A. Siow (A. Siow, 1998). At an individual level, specialisation increases risks of obsolescence of knowledge, and academics, who are considered to be averse to risk, need specific incentives to specialise. McPherson and Winston (M. S. McPherson and G. C. Winston, 1983) show that the role of *tenure* is to give academics a guarantee so that they can specialise. From the point of view of the university, the specialisation allowed by *tenure* enables researchers to teach the most recent discoveries. Carmichael (L. H. Carmichael, 1988) puts forward a further explanation for the tenure system: only this type of management allows the injection of new blood into the academic system. The tenure system, by enabling lecturers to have permanent posts, guarantees them life-employment. They can thus recruit brilliant young colleagues without the risk of being driven by them from the world of research. Carmichael shows that the tenure system is attended by various organisational devices to regulate an internal job market: taking into account of outside offers (especially in the determination of salary increases), early retirement scheme, etc.

Thus, the academic job market appears to be highly structured and managed by peers. However, this structure only applies for those who are in the tenure track (assistant, associate or full professor). It guarantees career opportunities within the academic system, whether within the same organisation or in another university. Professors also recruit junior researchers and their future colleagues.

The PhD supervisor / PhD candidate relationship: an implicit contract

The careers of researchers who have tenure are managed by peers, in so far as recruitment, evaluation and promotion are concerned.

In this respect, PhD supervisors have considerable influence in encouraging their students to cooperate. Doing a PhD involves an implicit contract between the supervisor and the candidate. PhD candidates undertake to participate in the collective production of the laboratory; in exchange, as a reward for their efforts, their supervisor supports their candidature for a post in the academic community. If this promise is to be credible, students have to be sure of having a good chance of obtaining a stable position after their PhD (a permanent position in France, the prospect of tenure in the US). These chances will be higher if candidates present a sound application. The quality of their application depends primarily on published work, and PhD students' propensity to publish is related to their immediate scientific environment, as shown by D. Hicks and P. Stephan (D. Hicks, 1996; P. Stephan, 1996): the greater the academic reputation of the laboratory in which students do their PhD, the more likely they (and other researchers) will be to have a large number of high quality publications.

When the prospects of posts in academic research diminish, the credibility of the PhD supervisor's promise falls apart. P. Stephan *et al.* (P. Stephan and S. Everahrt, 1995; P. Stephan and V. Mangematin, 1997; P. E. Stephan and S. G. Levin, 1997) have shown that the implicit contract is currently undermined by more intense competition between PhDs to obtain jobs and by the growing divide between the status of researchers with permanent positions and that of temporary research staff. This is reflected in students' behaviour as regards the PhD (training through research): either they try to find an individual way out, which results in opportunistic types of behaviour such as "free-riding", or they give up the idea of training through research. Incentives to collaborate are thus reduced as students choose PhD subjects whose rewards in terms of publications are likely to be immediate even if the long-term scientific interest is limited.

It is therefore not only the implicit contract between PhD supervisors and their students that is threatened but the entire system of collective investment formed around PhDs. Until the early 1990s the system tended to be self-regulated: "good" laboratories attracted good students who found jobs in the academic sector, while the "bad" laboratories, destined to disappear, were not chosen. From the mid-1990s competition between promising candidates intensified and the choice of recruitment became difficult, with an element of randomness, so that incentives disappeared. Freeman and De Meulemeester (R. B. Freeman, 1980) (J. L. De Meulemeester, 1994) have highlighted a cycle in choices of post-graduate studies in relation to job opportunities. Facts tend to confirm their argument: when job opportunities in the academic sector are rare, fewer students embark on a PhD. This could eventually cause scientific production to slow down. In the short term, we witness a rupture in the implicit contract linking students to PhD supervisors. This rupture is set in a paradoxical situation in which the collective nature of scientific production is reinforced whereas the individual nature of rewards creates tensions in laboratories, in a context of exacerbated competition between candidates. These tensions are, moreover, compounded by unemployment in the sector which increases inequality between insiders (with tenure) and outsiders (who would like stable employment).

1.2.2. The private sector: careers that are not well known

Until now, most of works done of career mobility from academia to private firms have been done on star scientists (P. E. Stephan and S. G. Levin, 2001; L. G. Zucker, M. R. Darby *et al.*, 1997). Thus, implicit contracts have concerned only the academic sector. This is due as much to the career aspirations of PhD students as to the competencies of PhD supervisors. Our study on PhD graduates who did their PhD in a plant or animal life science research laboratory (see Box for general information on the survey) shows that only 20% of PhDs have a job in firms after their PhD while 51.5% in academia find a job in academia. Several factors

can explained this situation : first of all, 70% of PhD students wanted a position in academic research; second, most of them express a preference rather than a real career plan as it has been shown by an in-depth analysis of the data (F. Dany and V. Mangematin, 2000). Only a minority of them has a clear idea of the modes of functioning and recruitment criteria in the academic sector. (Over 50% of PhD students do not know whether the members of their team are referees for academic journals or if they are on an editorial committee.) Their career plans evolve during their PhD. By contrast, only 10% of all PhD students express their wish to work in the private sector. In all cases, the vagueness of their career plans reveals a profound lack of knowledge on recruitment criteria in both the private and academic sectors. Moreover, as PhDs are performing science in academic team, the learning by doing concerns only the academic world and they acquire no learning by doing about the corporate world during their PhD. The only exception concerns those who have a collaborative project with industry during the doctoral research.

With few exceptions, PhD supervisors are ill-informed on career opportunities in the private sector. An analysis of the collective competencies of the research group (considered here as a proxy of the group leader) shows that over 50% of all research teams are considered by PhD students as having a weak or no involvement in private sector firms. As the mobility between academia and private firms are rare, academics' knowledge of the private sector is based on collaboration between academic teams and firms (P. B. Joly and V. Mangematin, 1996; P. Laredo, P. Mustar *et al.*, 1992). In other words, involvement in industry, identified by research contracts between an academic team and a firm (consultancy, expert missions by members of the team to firms, and PhD students funded by firms) is weak as shown in table 2.

Table 2: Characteristics of research team in which the PhD research has been done³⁰

		Involvement in academia		Total
		Weak	Strong	
Involvement in Industry	Weak	257 (44%)	195 (33%)	452 (77%)
	Strong	56 (10%)	79 (13%)	135 (23%)
Total		313 (53%)	274 (47%)	587 (100%)

We deduce that academics have little knowledge about the corporate world. Table 3 compares the professional trajectory of the PhD to the involvement in industry of the lab. It shows that the competencies of the research team have a strong influence on PhD students' jobs and professional trajectories. The more the research team is involved in industry, the more the PhD acquires knowledge and information about the corporate world and the more he is able to be recruited in that world.

Table 3 : Involvement of research team and jobs after the PhD

Involvement in Industry	Job in 2000 (when interviewed)					Total
	Permanent position in academia	Permanent position in private research	Permanent position in firm (non research)	Short term contract (temporary job)	Others	
Weak	238 (40%)	14 (2%)	48 (8%)	139 (23%)	17 (3%)	456 (76%)
Strong	69 (12%)	19 (3%)	19 (3%)	31 (5%)	2 (1%)	140 (24%)
Total	307 (51%)	33 (6%)	67 (11%)	170 (29%)	19 (3%)	596 (100%)

Chi-square DF:4, value : 26.7; prob: 0.001

³⁰ The other important dimension is involvement in the academic community, identified by the team's number of academic publications and the participation of each of its members in academic life (membership of scientific journal editorial committees, evaluation committees, etc.). Only 50% of research teams have a strong involvement within academia.

The hypothesis of independence of variables is rejected by a significant Chi-2 at the threshold of 1%. PhDs done in laboratories with strong involvement in firms lead in significantly large proportions to jobs in the private sector (both in and outside research). By contrast, students who do their PhDs in laboratories with strong involvement in the academic community are recruited to positions that do not differ significantly from the average.

Thus, the competencies developed by researchers about the functioning of careers in private firms and more generally their knowledge about the corporate world seem to be a key point to encourage the mobility of PhDs from academia to private firms.

With an average of three articles published at the end of their PhD (see Table 4 in Box), junior researchers play an essential part in scientific production. Until now the main incentive for their active participation in the laboratory's collective production has been their PhD supervisors' promises of helping them to embark on an academic career. This mechanism is now disintegrating as the number of PhD candidates far exceeds the number of posts offered. PhD supervisors have far too little knowledge of the private sector to make realistic promises of employment in it (See (F. Dany and V. Mangematin, 2000). Thus, mechanisms of regulation of the scientific community seem to be jammed, with the resulting risk of eventually undermining scientific production as well as the diffusion of knowledge and know-how.

2. PhD students: an excellent vehicle for the circulation of knowledge

The life sciences have undergone profound changes in recent years (A. Danchin, 1998; M. Morange, 1994; P. Rabinow, 1996). The seminal work of Watson and Cricks in the 1950s on the DNA double helix, followed by the possibility of amplifying segments of DNA (PCR), allowed DNA sequencing and the systematisation of research on genes. These three major scientific breakthroughs profoundly transformed molecular biology. Although the technologies used in biotechnology – DNA synthesis, sequencing, methods of cellular fusion to produce hybrids and bio-informatics – are less than 25 years old, some observers go so far as to forecast that they will eventually replace physics as the dominant scientific domain. Like physics in the early twentieth century, the life sciences generate a huge technological potential. Modes of scientific production have also evolved, with the progressive shift to what Weinberg (A. Weinberg, 1970) calls "big science", that is, like physics, an organisation of scientific production around technology platforms, as witnessed in the development of genopoles in France and the rest of Europe.

The implementation of increasingly complex and expensive equipment requires specific know-how in laboratories. This know-how is most often embodied in researchers who carry out experiments and especially in PhD students who are actively involved in laboratory work. The circulation of junior scientists from one organisation to the next, especially after their PhD, allows the circulation of knowledge on instruments and that embodied in PhD graduates.

2.1. Inter-organisational circulation of tacit knowledge

Although academic research invests heavily in the codification of knowledge in publications, a part of the knowledge produced remains tacit. Since Polanyi's famous expression "We know more than we can tell", the tacit dimension of knowledge has been the object of numerous theoretical developments. There is no lack of empirical examples: each of us has experienced the importance of tacit knowledge when faced with new technical equipment. Hatchuel and Weil (A. Hatchuel and B. Weil, 1995) define different types of know-how (doing know-how, understanding know-how and combining know-how) and show that modes of acquisition of

these different types of know-how vary. "Doing know-how" is transmitted primarily via interpersonal interactions, as is "understanding know-how". "Combining know-how" is, however, more the fruit of experience and the acquisition of a very broad culture.

The contribution of P. Saviotti, when he characterises knowledge in terms of its degree of contextuality (P. Saviotti, 1994), is consistent with this definition. The more knowledge is related to a context, the more reduced its scope will be. Consequently, knowledge outside this initial context cannot be identified and understood. More fundamental knowledge has a wider scope and allows the assimilation of diverse know-how. This explanation is consistent with those of Rosenberg (N. Rosenberg, 1990) on investments by firms in basic research. Having abstract knowledge is one of the conditions for being able to develop extensive competitive intelligence. Thus, the more basic the knowledge developed in-house, the more able the firm will be to absorb a wide variety of knowledge. Conversely, if the firm has a weak absorptive capacity, it will be able to assimilate only a small variety of knowledge. Mangematin and Nesta (V. Mangematin and L. Nesta, 1999) show that the circulation of men and women is an essential dimension in collaboration between organisations. It is especially important when the partners have capacities to absorb different scientific knowledge.

In firms, as in university laboratories, work by PhD students and junior researchers produces very specific, specialised and localised knowledge. Young researchers implement new methods to explore precise points that have remained in the dark. Even if they result in publications, these studies are largely contextual, as shown by T. Shinn (Shinn, 1988). In these conditions, the circulation of this new knowledge and even more so of related know how is largely based on the circulation of researchers. Because of their age, young researchers are more mobile than others. Numerically, they account for the vast majority of researchers who go from the academic to the private sector. Even with the support of specific measures such as the possibilities for academics to have both position in *high tech* SMEs and in academia³¹, the number of researchers with tenure who switch to the private sector remains marginal, while close to 300 young life science PhDs³² join the private sector each year. They are thus vehicles for the circulation of tacit knowledge, in three dimensions: inter-temporal, inter-individual and inter-organisational. The study of researchers' career paths enables us to identify more clearly their role in the circulation of knowledge.

The shift from individual research to research carried out collectively reflects the necessary accumulation of knowledge within research groups, related to the increasing need to use instruments. Weinberg (A. Weinberg, 1970), taking the example of the physical sciences³³, has shown that the more the sophistication of instruments increases, the more research communities are formalised (large laboratories, cooperative agreements between research teams, etc.). Within these communities, the circulation of the most recent knowledge as well as the training of researchers in new techniques is a role often given to post-docs and young PhDs recruited within the community. These junior researchers account for a substantial and particularly mobile part of the research staff. Since they master state-of-the-art technology and other specific know-how learned during their PhD, they can transmit that knowledge and know-how to senior researchers who thus keep their technical knowledge up-to-date. Owing to their experience and hindsight, senior researchers have a global view of the discipline. They can incorporate new and highly contextual knowledge, brought in by young PhDs, into a coherent research programme with a far broader scope.

³¹ In 1999, a new law in France encourages technology transfer through the mobility (part time or full time) of academics who have a permanent position to firms.

³² The population of Life sciences PhD is around 2000 individuals each year.

³³ The advent of *Big Science* has since spread to the life sciences, with programmes such as that aimed at deciphering the human genome. Such programmes necessitate substantial financial resources and logistics.

So that everyone can valorise their contribution, co-publication is an indispensable tool to perpetuate the circulation of knowledge when the number of temporary jobs (especially post-doc) increases. In the absence of co-publication, senior researchers would derive all the benefits from collaboration: updating of technical know-how (offering new prospects to verify their theories) and enhancement of their reputation via scientific publications. In this type of context, young researchers would be less inclined to disseminate their knowledge and know-how. By contrast, co-publication enables them to benefit from cooperation in so far as it helps to enhance their reputation (by signing an article with a well-known researcher) and simultaneously their chances of obtaining a stable job after their post-doc.

The collective nature of scientific production has another consequence: human resource management practices evolve, within academic laboratories, towards a constant trade-off between the circulation of persons and the maintenance of competencies. The functioning of laboratories is increasingly based on the use of temporary manpower. In order to retain the competencies needed for the pursuit of their scientific activity, research teams with a high staff turnover have to organise in-house capitalisation of the experience gained by temporary researchers. In the long run this type of situation could lead to problems in the running of experimental research. A reduction in the number of PhDs present in laboratories could accentuate this phenomenon if the transmission of knowledge is no longer possible in laboratories.

Thus, within a research group, the transfer of tacit knowledge related to instrumentation, in particular, implies a balance between permanent researchers and temporary researchers. This balance will maintain and develop the contextual know-how that constitutes the originality of the research produced.

The circulation of tacit knowledge between organisations is based on a logic similar to the one prevailing within research groups. The acquisition of tacit knowledge that allows the development of skills involves not only the replication of experiments carried out elsewhere but also the temporary or permanent employment of a researcher. Almedia and Kogut (P. Almedia and B. Kogut, 1997; P. Almedia and B. Kogut, 1999) have similar results when analysing invention done by engineers. Through the identity of inventor in patent, they show that the inter-organisation circulation of knowledge is based on the circulation of engineers from one firm to another. In the same vein, collaborations between academic laboratories and firms are also opportunities for knowledge transfer, through the exchange of staff (recruitment of PhDs, collaboration with PhDs and post-docs). In the life sciences, whereas staff exchanges between academic laboratories – especially of post-docs – are relatively dense, relations between the academic and private sector are more tenuous. Yet even if fewer than 20% of PhD students occupied a post in industrial research between 1990 and 2000, they constitute a large numeric population that represents a strong link between academia and the private sector. Although France has a policy of encouraging the mobility of academics with tenure towards the private sector, the movement remains very limited compared to the mobility of people with a temporary position. These people thus constitute one of the determining links in the circulation of tacit knowledge and the dissemination of know-how.

Whether within research groups or between organisations, researchers who have a temporary position are the main vehicle in the circulation of tacit knowledge gained "on the job". The accumulation of this experience within organisations involves the recruitment of these embodied competencies.

2.2. Inter-generational circulation of knowledge

PhD students are the living strength of tomorrow's scientific production. The increasing complexity and specialisation of science accentuate the cumulativeness of scientific work and

the local character of learning (the more specialised knowledge is, the lower the number of teams or persons capable of applying it). In the seventeenth century already, Newton stated that if he was able to see so far, it was because he was standing "on the shoulders of giants". This is all the truer when the work is specialised (S. Scotchmer, 1991). In each sub-discipline, young researchers contribute to scientific production by specialising in a specific domain in which the ground was cleared by their seniors. They contribute towards scientific progress in that domain and in so doing may increase its scope and importance. Thus, junior scientists trained in time t constitute the qualified manpower of academic and private laboratories in time $t + 5$, and the research managers and professors who will set out the main scientific guidelines in $t + 15$. The training of PhDs thus ensures that there will be researchers in the future and leaders of scientific research in the next generation. The quality of initial training, the open mind that are given, as well as sensitivity as regards the corporate world are therefore very important elements for the perpetuation – and evolution – of the scientific community.

In this way the PhD students trained today will be instrumental in shaping the country's future scientific developments. As a result, management practices regarding PhDs are of particular importance at a time when the risk of a loss of interest in post-graduate training is high. If the current decline in the number of PhDs continues, it is likely, given the current practices and culture of researchers with tenure, that the private sector will suffer most from the lack of skilled manpower. As Table 2 (section 1.2.2.) shows, academic research remains one of PhD students' main objectives.

2.3. The necessary management of temporary researchers

While the majority of PhD students clearly have a profound lack of knowledge about the functioning of the academic community at the beginning of their training, the PhD seems to be a time of discovery of the scientific world. It is mainly the time to discover academia rather than the corporate world. Less than 23% (see table 1 in box) have significant relations with industry during their PhD. Thus, They are not able to discover this world. Indeed, as shown by Mangematin *et al.* (V. Mangematin, 2000a), the PhD contributes not only to scientific and technical training (to learn how to perform an experiment, how to design and write a paper) but also to the discovery of the modalities of functioning of the different working communities: primarily the academic community, since it constitutes the PhD student's immediate environment, but also the corporate world when PhD training is based on university/industry collaboration. The percentage of PhD students who make a career in the private sector varies, depending on the discipline. The life sciences generally have few formal ties (contracts) with industry, as is evidenced by the low level of involvement of research teams with industry. As a result, the private sector does not constitute a significant source of employment for PhDs who have little knowledge of the corporate world. By contrast, in a discipline oriented more towards enterprise, like the engineering sciences, this figure is 40% (V. Mangematin, 2000b) The proportion of life science PhDs who turn towards the private sector after graduating might nevertheless increase in coming years, for both conjunctural reasons (rapid development of biotechnology in Europe and especially France³⁴) and institutional ones (public policy in favour of technology transfer, incubators, spin-off, etc.).

The poor attractiveness of private sector towards PhDs is not only the result of the lack of information of PhDs about industry. It is also the result of the attitude of permanent

³⁴ Of the 11,000 posts created in biotechnology SMEs in France, close to 30% are filled by PhDs: Lemarie, S., and V. Mangematin. (2000) "Biotech firms in France.", *Biofutur*, Special Issue, pp. 32-42.

researchers in labs who mainly monitor the beginning of career of those who want to enter in academia, as table 4 points it out.

Table 4: Assistance for a member of the laboratory in planning their future career

Career expectations	Industry	Academic Research	No career plans	Total
Help from the lab regarding their future career	2%	34%	6%	43%
No help	6%	37%	14%	58%

Chi-square DF:3, value : 22.3; prob: 0.001

The lack of helping received by PhDs who plan to have a career in industry does not necessarily reflects the bad will of permanent research of the team. It mainly reflects their lack of knowledge and information about corporate world.

While careers are totally open and PhD students could be aware of different types of career opportunities, neither research teams nor other university structures fulfil this advisory role. Yet the choice of a career at the beginning of a PhD is partially irreversible in so far as it is difficult to maintain "options" (potential job opportunities) in both the academic and private sectors. PhD students have a limited amount of time to finish their thesis (around three and a half years, in general). Junior researchers' first steps in the world of research are a form of professional experience in which they make contacts and develop scientific habits and reflexes. An analysis of the professional trajectories of two populations of life science PhDs (F. Dany and V. Mangematin, 2000) reveals that the conditions in which the PhD is done are decisive. In particular, the PhD corresponds to a period during which junior researchers build up their networks. As shown by Eymard-Duvernay and Marchal (F. Eymard-Duvernay and E. Marchal, 1997), the interpersonal networks woven during prior functions are the main channel for the recruitment of people with specific skills. Close to 50% of PhD graduates say that they found their first job through contacts made during their doctoral training. Thus, a PhD student's professional environment strongly influences her/his future career. A survey on PhDs at INRA highlights two key elements:

- (1) the skills acquired during the PhD, especially through contact with firms. PhDs who collaborate in any way whatsoever with a firm during their training develop competencies in addition to purely scientific training, which helps them to find jobs in the private sector.
- (2) relations between the laboratory in which they did their PhD and the private sector. A laboratory with numerous partnerships with industry (research contracts, etc.) produces PhDs who are more easily recruited in the private sector than those from laboratories with fewer such relations.

It thus appears necessary to construct a veritable human resources management for temporary staff. The PhD is a period not only of scientific training but also of discovery of the professional world. PhD students have no active support in their research groups in planning their future careers, although the decisions they have to take determine their futures in the medium term.

Conclusion

The recent decline in the unemployment of managerial staff and the specific problems of employment encountered by PhD graduates has already started to impact strongly on the number of graduates who opt for training through research. If this situation lasts it could prove to be very damaging to the dynamics of scientific production and, in the long run, to the dissemination of knowledge between the academic and private sectors. This decline could result in a drop in the total number of researchers (while many posts will go vacant when larger numbers of researchers of the baby-boom generation retire) and in difficulties in the establishment of *Big Science* (and especially the life sciences).

In this context, a possible "shortage" of researchers could limit still fragile links existing between university and industry (the triple helix model). More generally, in view of the importance of people in the diffusion of scientific knowledge, fewer researchers could inevitably lead to less diffusion of knowledge.

The risks are already visible in current trends. The number of life science masters' degrees has dropped by 10% since 1993 and the number of PhD students decreased by 1,100 persons between 1995 and 1999. This situation argues for in-depth reflection on the careers of persons trained through research. An analysis focused on intra- and inter-organisational mobility of individuals naturally leads to the suggestion of organisational solutions:

1. Since public resources available for research are limited, it seems necessary to set up a reliable system for informing master's students on career opportunities in research and the recruitment criteria in this type of job. Better information *ex ante* would help to guide students better. Within research groups, a researcher could have the responsibility of advising a junior researcher in planning her/his career, not unlike systems of sponsorship in certain consultancy groups.
2. The PhD corresponds to a period of training through research during which junior scientists weave their networks and establish collaborative relations. Depending on their career plan, they build up their C.V. in line with what they believe the selection criteria of their future employers to be. It therefore appears essential to help students who want to embark on training through research to better choose their PhD laboratories. They currently have only very limited and approximate knowledge of the modes of functioning of the academic community. The functioning of laboratories remains opaque, sometimes even after several years of presence. If academic laboratories want to be able to continue recruiting PhDs and post-docs to participate in scientific production and the creation of surplus, they have to feel accountable for the future of PhDs in order to limit situations of failure and continue to attract the most brilliant students towards research.

These top students could thus renew the pool of junior researchers that keep relations between academic research and the private sector alive.

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Research Training – Education and Science Policy between Profession, Discipline and Academic Institution

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Introduction

In this paper I shall discuss the consequences of policy changes for research training in three countries - England, Norway and Sweden - focusing on how research training were shaped by reforms during the 1980s and 1990s. The argument that is put forward here, is that the way in which research training is affected by political reform, is shaped by the way in which characteristics of state policies, academic institutions and disciplines interact. Underlying this discussion is also the question of the extent to which academics constitute a profession that gives cohesion and direction to the training effort.³⁵ The paper presents the main lines of reform policies with reference to the conditions of the academic profession in each country. A closer look at certain effects of the reform policies is taken in the third part of the paper in which we discuss changes in research training, or with regard to the way in which students become academics.

Status Before The Reform Periods

The professional ethos of the modern *English* academics was formed in the 19th century and centered on the gentlemanly-amateur. General education was preferred to specialist training for a specific occupation. This ideal was coupled to pedagogic practices of small-group tutoring and a continuation of the guild-tradition of students living at colleges or residential halls under the supervision of their teachers. Universities attempted to continue these professional ideals and practices through the expansion of the universities in the

³⁵ In many ways the academic professions in England, Sweden and Norway may be said not to be fully professionalized. In the literature on professions it is usually emphasized that in order to be useful as a concept, there should be some characteristic that distinguishes a 'profession' as an occupational group from other closely related groups. There must be some sort of cohesion between the members of the group. Usually groups such as the Anglo-American professions of doctors and lawyers serve as master templates for what to look for: common educational background, autonomy in professional questions, protection through certification, a strong professional association and a common occupational ethos (Abbot 1988; Erichsen 1997; Johnson 1982; Parsons 1939; Torgersen 1994; Wilensky 1964). Compared to such classical professions as doctors and lawyers, the notion of an academic profession may be problematic (Clark 1987). It is important to see this notion in our context more like an open question or a regulative idea for our investigation. Professional and disciplinary allegiances may represent alternative points of identification for university teachers that impede the emergence of a specific academic profession. An academic profession must somehow be united across disciplinary boundaries and extra-mural professional obligations. Integrating forces may emerge from the fact that academics are situated within the same type of institutions and therefore have many relations in common. The nature of these relations and the extent to which they promote cohesion and common points of identification are the topic of this chapter.

late 19th century ('redbrick' universities) and after the Second World War (the 'greenfield' universities). This continuation of ideals was maintained through the employment of mainly Oxbridge graduates as teachers and academic leaders. Although universities established after the Second World War were less well-endowed than the older ones, they attempted, at least to some degree, to attain some of the same ideals of small scale teaching and communal living (Halsey and Trow 1971). The Robbins Report of 1963 initiated an increased expansion for universities, but also a redefinition of their clientele. The report's pledge for open access was seen to be the universities' contribution to a democratization of education.³⁶ The main effect on the profession was to change its outlook from being private, elite and eclectic to become more open and socially responsive by 1970 (Becher and Kogan 1992 pp.32–33). Another interpretation of this development is that of proletarianization of a professional group (Halsey 1992). A historical decline of status and wages through most of the 20th century gradually forced the profession to find new social alliances. This alliance was in Halsey's view formed when the major teacher union, the AUT, joined the TUC (ibid.).

The basis of the academic professions in *Sweden and Norway* was quite different from the English one. In both cases universities followed the continental pattern of being state institutions. Their *raison d'être* was to educate civil servants for the state, and the professoriate, who until the 1950s remained the majority of the university employed, were higher civil servants. Their professional activities were regulated by ordinances concerning the institutions, degree structure and exams and the general legislation concerning civil servants. Within this framework, however, there was considerable leeway for autonomous decision-making and self-regulation.

The pedagogical ideals of Norwegian and Swedish academics were quite different from those of the English. The ideal of the self-sustained gentleman had no influence, and the main purpose of attending a university was to learn a trade and become a professional. In accordance with the continental university model, teaching was mainly given as lectures in auditoriums and assessment of students concentrated on examinations. While small-group teaching and writing of essays were central to the English system, the continental model in its Swedish and Norwegian form was concentrated around the syllabus, and little attention given to students' written work, except at the advanced stages. The syllabus may be seen as a contract between teacher and student, and the function of the examination was to test whether the student had read and understood the syllabus. Between the time the student started to study a certain topic and the examination day, he or she remained in a sort of limbo with few if any signs of to what degree they were living up to the expectations of their teachers. A certain level of failure was expected in such a system, and it was common for some students to take exams more than once to improve their results.

The overall characteristics of the academic professions in Sweden and Norway started to diverge from the 1950s as universities and the state chose to meet the expansion of student numbers in different ways. From the late 1950s and through the whole of the 1960s the number of students increased enormously. The initial response of the growing demand for teaching was the same in both countries; to increase the number of teachers. Here the similarity stops. In the same way as Finland, Sweden introduced a large number of adjunct teachers and lecturers in this period. This situation led to a division of labor within the academic profession between those academics who do undergraduate teaching (lecturers and adjunct teachers) and those academics whose main task is to do research and teach at graduate level (professors, research assistants). Lecturers and adjunct teachers had few possibilities to undertake research, as their teaching loads were heavy. At the same time there was a substantial increase in external funding for research, and for

³⁶ Although before the expansion of the 1980s and 1990s, universities still enrolled only 6% of each age-group and the whole of higher education 15% of each age-group.

those academics that primarily wanted to do research external funding was a way to avoid too much teaching. In this way two different career patterns developed among Swedish academics; one oriented towards teaching and one for research. The latter often included periods of external funding in order to qualify for a professorship.

The Norwegian academic profession developed in a pattern closer to its Danish counterpart and went through a process of homogenization and equalization of status and working-conditions. By the 1950s there were demands that the different categories of the 'middle group' of the positional hierarchy, lecturers, should have the same opportunity to do research. During the 1960s a homogenization of work-conditions according to the principles of a 50/50 partition of work between teaching and research *de facto* took place in many departments, and in 1969 some of these changes were taken into the regulations concerning these positions.

The homogenization and equalization of status and work-conditions did not stop at the level of the middle-tier, but also engulfed the professoriate. Norwegian universities were at the time based upon the chair-faculty principle. The introduction from 1975 of a new governing structure meant that the chair became an elected office and the boards at departmental, faculty and university levels became representative bodies in which all tenured staff (professors and middle tier positions) became one of several groups represented.³⁷ This election system added to the homogenization of the profession both in terms of work-load and representative privileges, and the main status divide in the profession became between those with tenure and those without it.

The development of the academic profession in Norway from the 1960s to the 1980s may be characterized as an ascent of the middle-tier, and the profession itself was the main policy-maker in this process. Many professors supported the middle-tier and even took part in their own 'downfall'.

In Sweden educational planning and politics were much more centralized and professional wishes in favor of research opportunities for lecturers were not heard. In Sweden the divide between teaching and research was strengthened by the 1977 reform in which undergraduate education was taken out of the control of the disciplines and the departments. Undergraduate education was subordinated to professionally oriented and centrally defined study-tracks. These tracks had their own boards (*linjenämnder*) and administrative personnel. The boards had representatives from the relevant departments, but also from students, non-academic staff and from the professional field relevant for the track. Although the authority of the professoriate was thwarted at undergraduate level by this dispersion of powers, the governance of departments and at the graduate education level still retained many of its traits from the chair-faculty system.

In England and Norway the department and the disciplines retained control over undergraduate education. When it came to governance English university departments were traditionally less centralized around a chair-holder than on the continent, and individual members enjoyed a greater degree of autonomy (Neave and Rhoades 1987). The traditions of the universities varied and there may also have been differences between the disciplines in this respect. Nevertheless, the higher degree of equality among members was probably one of the reasons why the English academic profession, was less changed as a result of the expansion period of the 1960s than was the case in Sweden and Norway. While the Swedish university department modified its chair-faculty structure, the Norwegian department saw a

³⁷ The others were non-tenured staff, technical staff and students.

lapse into a situation with little formal academic authority whatsoever. All tenured staff could be elected head of department and the task mainly entailed administrative work.³⁸

The academic professions on the brink of the political reforms of the 1980s and 1990s were thus very different. The divide between teaching and research was well established in Sweden, while the same divide largely followed institutional statuses in Britain and Norway.

From 1966 a new sector of higher education was constructed in the UK led by the polytechnics governed by local councils and regulated by the CNAA. These were institutions in which the staff was not expected to do research (Becher and Kogan 1992:29-32), although it was not formally restricted. Similar developments came in Norway as professional colleges (teacher-training, nursing, social-work, etc.) were upgraded to higher education standards in the 1970s and early 1980s. A specific case is the new institutions of the district-colleges. These institutions were supposed to offer teaching at undergraduate level and not engage in research. Many of the academics in these institutions managed a considerable amount of research and gradually their terms of employment, i.e., their opportunity to do research became equal to those of the university academics (Jerdal 1996). The line struck between teaching and research institutions thus to some degree eroded, a development that has developed further during the rest of the 1990s and early 2000s (Bleiklie 2000).

The Reforms

The reform processes in the UK from the early 1980s and in Sweden and Norway, both from the late 1980s, diverged in many aspects. Compared to the changes in the condition of the academic profession in England, the reforms in Sweden and Norway only scratched the surface. The reform period in the UK may be said to start in 1981 when the UGC was left to handle a severe cut in funding and chose to reduce the number of places at universities by 20,000 students instead of reducing the unit of resource for each student (Becher and Kogan 1992, p.42; Kogan and Kogan 1983). This decision forced many universities to lay off teachers. Further cuts were imposed on the universities in the years to come, and left many of them with few alternatives to increasing their student numbers, whilst staffing ratios went down, and to seek alternative incomes from contract research, consultancies and by enrolling students from non-EU countries (Fulton 1999).

While the government tried from the mid-1980s to increase its direct hold on universities by better control of the financing bodies and through common legislation, the policy changed in the late 1980s to a stronger strand of marketization. All institutions should compete for the same resources on the same market and would thereby be able to strengthen their specific qualities (Fulton 1999). A logical conclusion of that policy was to elevate the polytechnics to university status in 1992 (the 1992-universities). This resulted in huge differences between universities in their rate of funding and their opportunities to combine research and teaching.

The reform processes in *Sweden* had much less dramatic consequences for the academic profession than in the case of England. The major aim of the Swedish

³⁸ An evaluation of the position of Norwegian department chairs from a British perspective was given in NAVF's evaluation of English studies. The evaluators concluded that '... there is a lack of good basis for leadership within the department given the short span of office', and the function of the chair is often '...as a committee leader without much accepted authority' whatsoever. NAVF; Evaluation of English Studies, 1991, p.42

reforms has been two-fold: 1) to reduce centralized governance of university relations and 2) to increase the quality of teaching and research in higher education institutions. Both of these issues for the most part concerned academic leaders and administrators who were now more left to their own initiatives and had a greater responsibility than before. The quality systems were also to a high degree managed by them and only indirectly impinged on the work-relations of 'lay' academics (cf. below). Aside from the fact that both the number of students and the responsibility for them increased and the teaching/research divide was softened, the reforms in Sweden may be characterized as a reform of leadership and administration (Askling 1999).

Similarly the reforms in *Norway* to a high degree concerned delegation of responsibility and increased weight given to quality management. The results of delegation of powers were much less dramatic than in Sweden as institutions already enjoyed a high degree of autonomy. For several years the quality issues were subject to public deliberation, but they drowned in the tremendous increase of students from 1988–1995. Universities concentrated their efforts to meet this challenge, and all discussions of quality of teaching became transformed to efficiency-oriented discussions about how to attain higher throughput (Høstaker 1997). The sudden increase of students also put the finger on the inability of universities to control their environment. Free admissions traditions within the humanities, social sciences, law and sciences made them victims of great fluctuations. Yet when the institutions took measures to regulate their intake of new students, Parliament and the Government acted against it in order to decrease youth unemployment and to maintain education for everyone as a welfare right. This policy was not met by hostility by academics because, until the mid-1990s, universities were compensated in the form of higher grants and more academic posts. The early 1990s were marked as a period with a high strain on academic staff, while one of the more permanent features was a higher teaching load at the graduate level as a higher share of students continued beyond their basic training (ibid.).

Consequences for research training and the academic profession

As the university systems, the policies and the historical traditions of the academic professions in the UK, Sweden and Norway are very different; it is neither possible nor desirable to make sweeping conclusions of any kind about the effects on the professions. It is more relevant to discuss different aspects of the professions' condition in relation to changes within academia, and a starting point may be to discuss integrating and disintegrating relations. While there are forces that may threaten to tear all kinds of unity apart, there is clearly also a basis for unity based on common points of reference among academics. Some processes engender a higher degree of unity and strength on the part of the academic profession while others may split it into fractions or change its face fundamentally. In this section we will illustrate this point by focusing on how integrating and disintegrating forces affected research training in the three countries.

One of the major potentials for the creation of an academic identity across disciplines is the standardizing effect of common professional trajectories. The academic career may be seen as a series of more or less narrow gates through which the university-educated person has to pass in order to become and stay an academic. The common experience of these stages in intellectual and professional education is not only part of academic folklore or simply rites of passage, but also signifies transformations in ascribed 'inherent' qualities. The constructions of academic trajectories differed among the three countries as they also differed between academic generations and

between disciplines. In this section we will concentrate on the degree of a standardization of academic trajectories provided by graduate education and by important hurdles like obtaining the first job and a permanent contract.

The UK probably saw the greatest changes in the work conditions of academics and also in the career expectations and in career tracks. These changes were due to general cuts in funding, but also changes in public and institutional policies. Henkel's research shows that the experience of young academics must have changed significantly since the 1970s. While young aspiring academics in the expansion periods in the 1960s and early 1970s obtained teaching posts relatively easily, this came to an abrupt end with the general contraction of this labour market from the early 1980s. The competition for most positions was fierce and the introduction of selectivity in research financing underscored that appointment policies at departments also could affect future research gradings. Financial insecurities also led many universities, especially the pre-1992 universities, to use fixed-term contracts for junior teaching staff (Fulton 1999, p.23). The mounting pressures on junior academics led to a much more conscious career planning on their part, and they became much less inclined to engage in activities for which they could not gain experience that would enhance their career. Career planning already started at the PhD-student level, as some supervisors would try to let their students get a headlong start in the job-market with an early co-publication (ibid, Henkel 2000.).

In the 1980s the PhD became the standard entry requirement for lecturing staff in most disciplines within the pre-1992 universities (Fulton 1999, p.22). Historically the PhD was connected to research training in the natural sciences, while in the humanities and the social sciences lecturing staff came into teaching at an early stage after their master degree. Some completed their PhDs after obtaining their first position, while others had very weak if any intentions to complete a doctorate. In some disciplines there was even certain notions that the best people never finished a doctorate. In additions, graduate education occupied for a long period a residual place both in public policy making and at departments. Teaching at departments had always been concentrated at the undergraduate level, and research training was usually a sort of apprenticeship in the sciences and an individual quest in the humanities and social sciences (Becher *et al.* 1994).

In the early 1980s there was a change in public policies in this field; the teaching of PhDs was redefined from being a function necessary for the reproduction of the academic corps to a necessity for the economy and society in general. The research councils who paid for studentships and supported PhD-programmes redefined the objectives of the PhD in less ambitious terms and also wanted to broaden the inculcation of skills in order to make doctors more relevant for a broader labour market (ibid.). Later the conditions for studentships were sharpened as research councils tightened the demands for a certain time-to-degree. The English PhD was defined to consist of a year for a master's degree and two additional years for the PhD (Fulton 1999), although in practice this policy proposal did not take hold. The reallocation and concentration of funds made studentships much more difficult to obtain from research councils and many universities appointed PhD-students as teaching assistants in order to finance their studies. However, the hierarchical differences between universities also intervened in the financing of graduate education. It was common for graduate students at Cambridge and Oxford to receive additional funding in addition to a studentship from a research council, amounting to a total period of seven years preparations for the PhD.

The increased weight given to graduate teaching at universities, a common public policy in this field, together with the propensity of universities themselves to make the PhD a point of entry to the first normal lecturing position, undoubtedly had a standardizing effect on academic trajectories in the UK. It was, however, a standard of the natural sciences that was imposed across the board. This standardization was possible partly due to indirect financial sanctions and by making the PhD-thesis less demanding for the student in the humanities and the social sciences (ibid.).

Similar standardization took place in many European countries and for most of these reforms the American PhD with a course component and a researched thesis was the model. In Sweden graduate education was restructured in 1969 and both the doctorate and the licence degree (*licensiatgrad*) were replaced by a new doctoral degree supposedly similar to the PhD. The licence degree had had the function of an obligatory exam before the student could start with the solitary ordeal of writing the thesis for a doctorate³⁹ (Ståhle 1996, pp.257–259). In Norway during the 1960s many natural scientists worked for a similar solution in Norway, and from the mid-1970s until the early 1980s new doctoral degrees were introduced in all disciplinary fields. This happened not without resistance and the older doctorates were kept for those who wanted to take a less structured trajectory for their degree. This doctorate did not include any course-component and, historically, graduate education in Norway has in the fields of natural sciences, humanities and the social sciences been connected to the *hovudfag* level of the candidate degree – a sort of two-year master degree – or the *magister* degree. Most Norwegian academics have received their basic research training working for these degrees, and still in many disciplines the *hovudfag*-students have an important function as unpaid research 'workers' (ibid.).

Both in Sweden and Norway the intention of standardization was only in part followed through by organized courses and grants to doctoral programs. In Sweden the rate of awarded doctorates fell during the 1970s as a result of this situation and only at the end of the 1980s the rate of completion reached the level of the 1960s (Ståhle 1996, ch.6). In Norway the first serious attempts to organize doctorate studies came within the fields of the natural sciences and technology while in the other fields the traditional doctorates even strengthened their positions as the total number of completed doctorates increased during the 1980s. In most fields the new doctorate did not have any prestige compared to the older one. One of the main political objectives of the Hernes Commission of 1988 was to get all the new PhD-like doctorates to function properly, and, aside from the incorporation of the doctorates into organized studies, the Commission wanted to make the doctorate a requirement for a permanent position at universities (NOU 1988, p.28).

In Sweden the position of the doctorate has historically been, and still is, very central for appointments. It is a requirement for professors, research assistants and lecturers, but not for adjunct teachers (Askling 1999). In Norway a doctorate was in the 1960s a *de facto*, and not *de jure*, requirement for leading positions like professors and readers, and before that often seen as a requirement for any permanent contract. The devolution of academic authority from the late 1960s also hit the doctorate as one of the epitomes of the bourgeois university. The expansion of the number of university teachers and the homogenization of the academic corps in many ways made the doctorate irrelevant for an academic career. It was not usually needed for the achievement of a professorship in the 1970s and the 1980s (Høstaker 1997, Ch. 7). A statistical survey from 1985 found that only 38 per cent of all academic staff held doctorates (Olsen 1988, P.48). The lowest percentage was found among the humanities and social sciences teachers. Medicine was the only field in which the

³⁹ The possibility to take the licence degree was reopened in the early 1980s, but it was not made compulsory.

doctorate had maintained its status as an obligatory requirement (ibid.). The policies from the mid-1980s made the doctorate more important as an academic distinction and from 1990 the doctorate or similar qualification was made into a *sine qua non* for all permanent positions at universities. In practice this change in regulations has made the doctorate the only gate of entry for junior academics (Høstaker 1997, ch. 7).

In a historical perspective the standardization of graduate education according to the ideal of the natural sciences is a common trait in the three countries. Predictably the policy influences in the UK were indirect through financing bodies while in Norway and Sweden changes in this field were much more based upon direct interventions. The actual layout of doctoral education is quite different in the three countries mainly due to the differences in the place of the doctoral student in the university system. The greatest difference was between Norway and the two other countries as a doctoral student was a member of the academic staff and is paid a salary that is comparable to what he or she would expect outside academia. Historically, students at the doctoral level in Norway were not students at all, but seen as 'research recruits'. They were needed to reproduce the academic corps and this view still informs much of the policy-making in this field. Despite the 'studentification' of doctoral students from the early 1990s there were rigorous demands for a financial plan in order to be admitted to a doctoral program, and it is not possible to study for a doctorate as a part-time student (Høstaker 1997).

In Sweden the graduate student started by taking courses and gradually became a part of the academic staff when appointed to a 'doctoral position' (*doktorandtjänst*), which might be financed externally or by the institution. The level of external finance often decided the possibilities of students to complete their degrees, and many students remained in a state of limbo after the course period. One of the results of this situation was a low rate of completion⁴⁰ (Stähle 1996, ch.6). Lately universities have been met with demands that no student should be admitted without a complete financial plan (Askling 1999). In the UK the policies introduced in the 1990s required post graduate students to start with a master's degree. This was to provide a filter for entry to doctoral studies. Typical of the English system was closer monitoring of the progress of the student, and the department decided at the end of the first year whether the student should continue with the doctorate or settle for the less ambitious MPhil. Due to the policies of the research councils on the question of time to degree, the ability of students to complete their doctorates on time was a matter of importance for departments and not solely a personal question for the student. A way to side-step the rigour of this system was to take the PhD on a part-time basis (Becher *et al.* 1994).

An important difference between the UK and Sweden and Norway was that newly awarded doctors were regularly older in the latter two countries (cf. Stähle 1996, ch.6) and their career expectations were higher. The reasons for this are many, and we will here mention two of them: only reluctantly have expectations of the quality of the thesis been decreased, if decreased at all, and doctors were also supposed to be qualified for employment in teaching and research. In England, however, a PhD was the point of entry for the lowest level on the pay scale of lecturers. While academics in the social sciences and the humanities might achieve a first teaching job with a PhD, this was usually not sufficient in the sciences. Henkel found that it was not uncommon for science doctors to work for ten years as researchers in order to achieve an appointment for a teaching post, and the risks of failure were considerable. An important difference between Norway and the two other countries was that a

⁴⁰ Stähle claims that less than 50% of all graduate students complete their doctorate in Sweden, but he admits that these figures should be taken with a serious health warning (1996:311).

Norwegian doctoral student would be a member of the academic staff and paid a salary comparable to what he or she would expect outside academia.

The way academic careers were constructed was also different between the UK and the two Scandinavian countries. A distinct feature of both Sweden and Norway was that most careers were made at the same university and even at the same department as an academic took his/her higher exam or doctorate. Usually this question is addressed in the literature as a matter of low mobility (Askling 1999; Johansson 1989; Tvede 1992), and may be a result of the small sizes of the university systems. This absence of exchanges of personnel between universities has in many ways impeded a proper labor market within academia. All hopes of being recruited to an academic trajectory and later to the advancement of a career were connected to a rather small number of senior academics. This situation opened, of course, for relations of patronage and favoritism (Høstaker 1997, ch.4). Such relations, however, are difficult to document beyond statements of interviewees. One of the few well-documented cases of outright favoritism was made within the medical field in Sweden by the immunologists Wennerås and Wold (1997). They found that the assessment and ranking of applicants to post-doctoral fellowships at the medical research council to a high degree depended upon the applicant's sex and/or if the supervisor of the applicant sat at the assessment committee⁴¹.

These patterns of internal recruitment of staff or auto-reproduction of academic groups are a distinctive mark of Swedish and Norwegian academia. The effects of this pattern are not fully researched, but evidence from the humanities and the social sciences in Norway suggests that within these fields, one effect might be a strong localism in the development of the disciplinary traditions (Høstaker 1997, ch.4). In the UK junior academics usually had to seek academic employment at other institutions and they depended to a high degree upon 'invisible colleges' of peer groups and of conference attendances to get the first appointment and later to publish their work. Many academics seem to have settled early at a university for the most part of their careers. This latter pattern, however, seems to be changing as one of the long-term effects of the RAE has been a higher mobility of senior academic personnel in order to build up research profiles at certain departments (ibid. ch.5). To a higher degree than in the Swedish and the Norwegian cases it is possible to talk about academic labor markets in the UK. One of the effects of the RAE was to produce a general standard for what to expect from an academic in the different disciplines and those who tried to live up to this standard also made themselves attractive in specific academic labor markets.

One of the general traits of the developments in the three countries has been that of increased standardization of academic trajectories. This standardization has taken place with reference to the existing system of relations within each country. The university systems have not converged, but within each system the career expectations, the gates to pass in order to succeed and the matter of what success is all about have become more standardized. The research practices of the natural sciences and the research policies emanating from the scientific field have served as the master patterns for much of this standardization process, including the RAE in the UK. These processes are important as academics were forced to relate to them and form common points of identifications around them. The doctorate, for instance,

⁴¹ Female applicants were disadvantaged in the assessment as well as those applicants, both male and female, who did not know anyone at the committee. The gender 'handicap' could be evened out by having the supervisor at the committee. Only extremely few women could rely solely upon their publication record to make the trick (Wennerås & Wold, 1997).

may be seen as a social marker of what distinguishes academics from other professionals.

Conclusion

From the image we have tried to provide in the text above, it is quite clear that the three academic professions in England, Sweden and Norway, respectively, led quite different 'lives' during the reform-periods of the 1980s and 1990s. This was due not only to differences in policies between the three countries, but also to quite different traditions in higher education. While universities in the UK are chartered semi-independent institutions, universities in Sweden and Norway are state-owned and the teachers civil servants. The mode of regulation and state influence was thus different, as direct intervention is much easier in a state-owned system, although the reform policies both in Sweden and Norway involved devolution of powers to the institutions.

Although the developments of the three university systems were quite different in the period, it is possible to identify some common dimensions that either standardize the experience of being an academic within each country or, to the contrary, divide this experience into particular points of view. The most important of the latter kind was clearly the 'seed of discontent' connected to the intellectual activity itself. All reform policies seemed to give benefits or disadvantages to different groups along the disciplinary divides. Similarly the hierarchization of academic institutions in the UK and the divide between teaching and research, in its different manifestations in the three countries, all gave different experiences of being an academic. Nonetheless, there were strong tendencies toward certain standardizations of academic experience connected to graduate education, academic trajectories and accountability in universities. One of the strongest forces of standardization in the UK seemed to be the RAE, which has come to define the rhythm of much academic life. The importance of such standardizing relations is that they may provide common points of identification for academics. If it should be possible to state what an academic profession *is*, it must start with these common markers connected to common experience. Maybe the definition of an academic is just this heterogeneous collection of points of identification? This may be a strange profession in the views of professional theory, but it leaves us with more than a non-entity.

We may conclude that the academic profession went through considerable structural changes in terms of growth, differentiation and standardization between 1970 and 2000. The profession as such did not play the role of an actor in the three countries. To the extent we find actors at this level they were representatives of academic disciplines rather than the profession as such.

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