

Design-focused Professional Doctorates: Implications for Other Professional Doctoral Programs

Dr. Terence Love

Abstract

The paper draws on recent research by Love, Tellefsen and Cooper into the nature of doctorates in design disciplines. It identifies a radical and central role for design-focused professional doctorates in shaping the balance and direction of professional doctorates in other disciplines. The paper reviews international forces acting to change professional doctoral education and outlines forms of doctorate likely to be successful in the new political and organisational contexts in which universities find themselves

Introduction

Design-focused doctoral education has been the subject of strong and vigorous debate in recent conferences in Ohio (Buchanan et al., 1999), La Clusaz (David Durling & Friedman, 2000), Milan (Pizzocaro, Arruda, & De Moraes, 2000), Perth (Swann & Young, 2000), Runnymede (D Durling & Shackleton, 2002) and on the PhD-Design listserver at www.jiscmail.ac.uk/lists/PHD-DESIGN.html. This paper will argue that these discussions about design-focused professional doctorates are important to professional doctorates in general because designing is an activity undertaken in all disciplines, and a key part of the way that professionals contribute to human futures (T Love, 2000; Terence Love, 2000; Tellefsen & Love, 2002 (working paper)). Design is defined by Simon (1984) as devising a plan to change one situation into another. This activity of devising a plan for change is an essential part of what all professional's do.

The analyses presented in this paper bring together themes from research by Cooper, Cooper and Love, Love, Tellefsen and Love. They are grounded in a theoretical view of design that emphasises its integration with other disciplines (see, for example, Agre, 2000; Alexander, 1980; Bryce, 1997; Coyne & Snodgrass, 1993; Gero, 2000; Vladimir Hubka & Eder, 1996; Jones, 1970; T Love, 2000; Terence Love, 2000; Lyle, 1985; Simon, 1984; Tellefsen & Love, In Press) and which defines key terms otherwise widely regarded as being problematic (see, for example, French, 1985; Hollins, 1994; Vladimir Hubka & Eder, 1996; V Hubka & Eder, 1988; Jones, 1970; Lewis, 1964; O'Doherty, 1964; Reich, 1994, 1994; Ullman, 1992).

'Design' - a noun referring to a *specification* for making a particular artefact or for undertaking a particular activity. A distinction is drawn here between a *design* and an artefact - the design is the basis for and precursor to the making of the artefact. In this sense, this distinguishes the outcomes of designing from the outputs of craft or art alone.

'Designing' - non-routine human internal activity leading to the production of a *design*.

'Designer' - someone who is, has been, or will be *designing*. Someone who creates *designs*

'Design process' - any process or activity that includes at least one act of 'designing' alongside other activities such as, calculating, drawing, information collection many of which are, or can be, routine or automated.

These definitions of designing and design process align well with Simon's less technical definition: *designing is devising a plan for changing one situation into another*. This latter is used as a working definition for this paper

The paper addresses three issues:

- The role of designing in professional activities
- National and international factors acting on professional doctoral education
- Competencies in professional doctoral education and the role of portfolios

The final section of the paper reviews the implications of increased awareness of the central role of design in professional activity. It points to the utility of combining this awareness of designing with the use of portfolios in addressing many of stakeholders criticisms of professional doctorates.

The role of designing in professional activities

Most of the world that humans live in is artificial and has been designed – this includes apparently ‘natural’ contexts also. Designing is the human activity of devising a plan to change one situation into another (Simon, 1984). Viewing designing as the devising of plans for change, points to the activity of designing being a core competence of professional activity across all situations and disciplinary contexts, and is therefore an essential element of all professional disciplines. Research by Love into the underlying epistemological, processual and physiological issues confirms the benefits of this approach and suggests that designing is intrinsic to most professional activity. (T Love, In Press, 2001, 2001, 2000, 1998). The evidence of the key role that designing plays in professional and semi-professional activity is extensive. It is evident, for example, in the designing of social programs (using data from the social sciences); designing educational programs (using data from fields and sub-fields of Education); and designing government policies and procedures (drawing on a wide variety of civil disciplines). A special all-encompassing case is the designing of products, services and systems. Increasingly, the definitions of ‘products’, ‘services’ and ‘systems’ are being extended so that together they include almost all of the context of the human world – even wilderness and ‘nature’ are in many cases, can be viewed as products, services or systems designed by humans. This modern conceptualisation of ‘products’, ‘services’ and ‘systems’ extends significantly beyond traditional definitions to include, for example:

- Banking products
- Organisations – which may be viewed either as products or services (or perhaps both). This is especially visible in the designing of virtual organisational structures and processes, supply chains, business partnerships and contracts
- Social processes – for example, the design of appropriate social behaviors for retail sales assistants
- Knowledge-based products and services involving information provision
- Systems that bring together products and services that are otherwise more limited in scope, for example, integrated social support services, enterprise resource planning systems software, integrated public local, national and international transport systems, nuclear and toxic waste disposal and storage, product life-cycle management systems; integrated news and infotainment systems.

Pragmatically, a key issue in professional doctorates is their usefulness in designing new futures, rather than the collection of new knowledge that contributes to building disciplinary empires. This design activity in professional and semi-professional realms provides in most cases, the reasons for existence of these professional fields. In terms of educational economy, it also tacitly underpins most educational and research programs, especially those high level doctoral programs aimed at professional activity.

The broad neglect of the activity of designing in professional doctoral education may be a result of disciplines focusing on information used by professionals in designing rather than knowledge intended to improve the ways that they design future situations. In fact, disciplinary structures can be seen from a design perspective as no more than convenient means of cataloguing data and a convenient means for simplifying the marketing of education programs, identifying suitable recipients of education and research funding programs and identifying potential conference participants.

Few ‘real life’ projects utilise only single discipline information. This is a convenient fiction of those creating theory in specialist research areas. The strength of this fiction, however, has led to the neglect of the main issue that the purpose of education, and especially professional doctorates is in equipping people with the skills and knowledge to *design* - drawing on understandings, research findings, theories, concepts and ideas as necessary across any or all disciplines. It is this view of *designing as the core knowledge and practice across all disciplines* that this paper proposes as an issue that must be addressed in professional doctoral education.

National and international factors acting on professional doctoral education

Globally, there is substantial criticism of doctoral education from stakeholders: government, funding bodies, academic institutions, students, the community, and commercial and industrial organisations. These criticisms, in the main, focus on practical concerns about the quality, appropriateness, efficiency and effectiveness of doctoral-level education in relation to the fulfilment of governmental socio-economic and technological objectives and levels of government funding (see, for example, Academy of Finland, 1997; Commission of The European Communities, 2000; Council for Science and Technology, 2001; ESRC, 2001; Kemp, 1999, 1999; Ministry of Research and Information Technology, 1998; National Science Foundation, 1998; Norwegian Research Council, 1998). Doctoral courses are also criticised on the grounds they do not adequately assess skills such that employers can depend on postdoctoral graduates having specific skill sets (ESRC, 2001). Similar issues are found in the USA (Nyquist & Woodford, 2000, pp. 5, 6, 8, 15, and 17) but with additional problems in relation to the spread of funding across areas of scholarship and the match between doctoral outcomes and employment opportunities (Nyquist & Woodford, 2000; Woodrow Wilson National Fellowship Foundation, 2001, 2000, 1998). In detail, the main criticisms focus on:

- Poor completion rates, significant incidence of time overrun (in magnitude and incidence), and variability in output quality
- Lack of usefulness of research outcomes for commerce, industry, society and other national priorities and objectives, and poor collaboration with industry
- Poor return on government funding for post-graduate education

These criticisms are resulting in university-based post-graduate training being increasingly directed by governments. This is apparent, for example, in the recent research guidelines from Commission of the European Union (EU) that direct member states to coordinate their research to produce knowledge to both guide and strengthen political policies and outcomes (Commission of The European Communities, 2000).

There are many forms of doctoral education (Woodrow Wilson National Fellowship Foundation, 2000) which mainly have originated in one or both of:

- The German model of 'Doctor of Philosophy' combining an initial period of formal study that prepares the candidate for undertaking research, and the preparation of a thesis based on research. Many universities in the USA and Norway use this model (Reinstein, 1997).
- The 'long thesis' describing an individual's original research and assessed by other doctors. This originated in medieval universities (Catholic Encyclopedia, 2001, 2001)

Currently, the most common formats for professional doctorates and PhD programs are:

- Study mainly through taught courses plus a research project requiring completion of a thesis document describing a candidate's contribution to new knowledge.
- Individual research project leading to the submission of a thesis document requiring completion of taught courses taking up less than 25% of the candidature, for example, a 1st year research training plus 3 years research.
- Taught courses that lead to the production of an artefact and exegesis about the designing of the artefact or the process of producing it.
- Study mainly through taught courses leading to a given number of peer reviewed journal articles and an account of how the articles fit together into the development of a coherent addition to a body of knowledge.
- Individual research project leading to assessment via a thesis document

Doctoral education is, however, undergoing significant change (Deem, 1998). In the main, this is due to pressure from government funding agencies' to align doctoral education outcomes with national aims and objectives (see, for example, Academy of Finland, 1997; Association of American Universities Committee on Graduate Education, 1998; Canadian Agri-Food Research Council, 1997; Commission of The European Communities, 2000; Council for Science and Technology, 2001; EPSRC, 2001; ESRC, 2001; Gaff, 2001; Kemp, 1999; Leith, 1995; Ministry of Research and Information Technology, 1998; National Endowment for the Arts, 2001; National Endowment for the Humanities, n.d.; National Science Foundation, 2001, 2001, 1998; Norwegian Research Council, 1998; The Quality Assurance Agency for Higher Education, 2001). In addition, the economic rationalisation of the higher education sectors has led to competition in and between institutions and disciplines, particularly where funding is tied to successful outcomes (see, for example, Kemp, 1999). Together, these factors imply the format of professional doctoral programs are likely to change as universities develop new strategies to maximise opportunities in these new national contexts. The influence of these factors is different in different countries but follows similar patterns.

In the UK guidelines were implemented in 2001 to rationalise higher education awards (see, for example, The Quality Assurance Agency for Higher Education, 2001, 2001). These specify two pathways:

- Credit accumulation from credit carrying taught courses at a doctoral level
- Research training leading to the PhD/DPhil and not awarded for credit accumulation

The outcome-based 'New Labour' government has focused on competencies as a measurable outcome of doctoral education programs. This has resulted in the Economic and Social Research Council listing specific competencies to be expected from PhD graduates for each sub-domain under its remit and tying funding to these competencies (ESRC, 2001). This trend would be expected to propagate also in professional doctorates. In parallel, are changes to assessment modalities to make candidates' competencies more visible. These new modes of assessment include books, and published monographs and similar documents; collections of publications; artefacts combined with an appropriate academic exegesis; and portfolios of work (Deem, 1998; The Quality Assurance Agency for Higher Education, 2001).

US doctoral education is impacted by similar forces but acting in different contexts. The German model of doctoral education is most prevalent: taught courses precede candidates' undertaking a short research project and thesis. Assessment is typically divided between competencies assessed during the taught courses, and research skills assessed via a thesis. A significant characteristic of US Doctoral education is the confused way that programs are shaped by visions of government and private funding bodies (Woodrow Wilson National Fellowship Foundation, 1998). Tension exists because of differences in aims and objectives between actors. Doctoral education is intended to be congruent with the aims of the Executive Office of the President and Congress (Leith, 1995). Funding, however, is mainly provided by through federal agencies each with their own socio-economic roles, responsibilities, and individual funding strategies and criteria (see, for example, National Endowment for the Arts, 2001; National Endowment for the Humanities, n.d.; National Science Foundation, 2000, Note 5). Their power shapes doctoral education independently of government aims. For example, research funding for the National Endowment for the Humanities (n.d.) has been mainly directed to projects disseminating knowledge about history, thought and culture rather than research. This may explain significant reductions in research funding (>80% in 40 years) in this area (Woodrow Wilson National Fellowship Foundation, 1998). Similar contradictions are evident in the omission of national socio-economic considerations from the strategies, mission, aims and outcomes of the National Science Foundation (see, for example, National

Science Foundation, 2001, 2001; National Science Foundation, 2000). There are tensions between institutional actors, departments and disciplines within universities (Woodrow Wilson National Fellowship Foundation, 2000). This is compounded by initiatives to support doctoral students having the freedom to choose their own agendas and topics (Association of American Universities Committee on Graduate Education, 1998) and by industry organisations lobbying alongside any of the above actors. Current trends are towards programs that are:

- Practitioner valued
- More interdisciplinary
- Drawing more on the knowledge base of social groups who have not traditionally had access to doctoral study.

In Australia, there is currently government pressure on universities to increase the effectiveness and efficiency of doctoral education and its contribution to national, social and industry development (see, for example, Kemp, 1999, 1999). This has resulted in universities making changes that maximise their incomes and minimise penalties under new funding arrangements:

- Alternatives forms of assessment submission such as refereed publications
- Increased use of taught courses
- Different forms of supervision
- Changes to entry criteria.
- Reductions in the scale of doctoral programs to enable their completion in significantly reduced times
- Increasing support for candidates through compulsory taught courses prior to undertaking research.

These changes increase diversity in doctoral programs whilst increasing the convergence of professional doctorates and PhD programs.

Norwegian professional doctorates mainly follow the German/US model. The main funding body, the Norwegian Research Council, regularly establishes priority research areas directly related to producing a better society (Norwegian Research Council, 1998) with governmental research being directed towards better value creation in their services and serving broad societal needs in for example the environment and health. In contrast, research funded by non-government sectors emphasises value creation, competitiveness and profits in strategic industries. The adoption of German/US style professional doctorates aligns with these specific characteristics of the Norwegian doctoral education context.

Competencies and Portfolios

Designing professional doctoral programs is essentially similar to designing other education programs, except for the autonomy expected of the candidate. From reviewing national and international developments, it is apparent that two significant themes have emerged that impact strongly on the design of professional doctoral programs:

- Making explicit the competencies and performance indicators for professional doctoral education in different areas of scholarship.
- Alternative means of assessment including publications, portfolios and artefacts with appropriate exegesis.

In developing such competency-based professional doctoral programs, three issues must be addressed (Cooper, 1999; Cooper, Hutchins, & Sims, 1999; Cooper & Love, 2002):

Quality assurance – identifying learning aims, competencies, performance indicators and moderation processes

Pedagogy – designing learning processes for candidates to develop the necessary competencies

Assessment – designing assessment appropriate to the performance indicators

In competency-based educational contexts, course designs should focus on supporting candidates' education through building competence. Evidence of candidates' skills is compared with performance indicators of competence in the core skills and knowledge of a domain of professional practice. In turn, this implies that there may be a variety of types of evidence that would show that a candidate satisfies performance indicators in their area of study.

Portfolios are well suited to competency-based learning and assessment in the professions and semi-professions (Cooper, 1999). They have been widely used in the 'Art and Craft' design disciplines (e.g. graphic design, fashion design, industrial design, and architecture) (McCracken, 1997). These uses of portfolios, however, are open to significant criticism, especially in relation to equity. Traditional portfolios contain visual representations of a designer's work without reference to detailed explicit performance indicators of competence. It is not possible to infer from these visual representations the full range of professional competencies being assessed. This is in the nature of the differences between representations, objects and skills. By keeping issues of teaching, learning and assessment tacit, traditional portfolios preclude educational improvements through research and leave them open to charges of bias, subjective assessment, favoritism and other equity problems.

Recent developments in portfolio-based learning and assessment, such as Cooper's (1999) six step portfolio-building process, offer new forms of educationally sound portfolios. These align well with competency-based learning and assessment and resolve many of the androgical difficulties presented by more conventional modes of assessment such as theses or examinations (Cooper, 1999; Cooper et al., 1999; Cooper & Love, 2002, 2000).

Implications and summary

The findings from the debate and analyses of design-focused professional doctorates raise issues for professional doctorates more generally. First, they point to the relative neglect of *designing* as a core competence and *raison d'être* of all professional disciplines. This has three implications: it shows that there is a substantial area of research awaiting attention in most professional disciplines; it points to the opportunity to draw on extensive research and theory found in the field of Design Research and published in international peer-reviewed journals such as *Design Studies*, *International Journal of Design Research*, *The Design Journal*, *Journal of Design Management* and *Design Issues*; and, lastly, the essentially multidisciplinary nature of design activity provides a clear conceptual pathway for focused cross-disciplinary research into professional practices.

The paper has outlined forces and factors impacting on the development of successful forms for design-focused professional doctorates. There are increasing government pressures for doctoral education funding to result in outcomes that align with national social, economic and political agendas. In consequence, professional doctoral education programs are increasingly judged in terms of their role in:

- Training highly skilled knowledge professionals useful to industry and society
- Creating a pool of individuals with broad expertise and competence in research skills applicable to a variety of circumstances
- The timely creation of new knowledge that supports the fulfilment of national socio-economic objectives
- Significant improvements to the efficiency and effectiveness of doctoral education processes
- Beneficial employment outcomes

The inclusion of design as a core competence and key aspect of all professional doctorates contributes strongly to addressing all of the above issues because it provides a focus for skill and knowledge formation around the useful outcomes that can be designed by professionals.

Along with this shift in emphasis onto the role of designing in professional activity, new forms of portfolio-based assessment and learning, and their online equivalents, offer improved modes of submission and assessment for professional doctorates in both design and other professional domains.

References

Academy of Finland (1997) *National Strategy for Centres of Excellence in Research*. EDITA, Helsinki.

Agre, P. (2000) *Notes on the new design space*. Available: <http://dlis.gseis.ucla.edu/pagre/>.

Alexander, C. (1980) Value, *Design Studies*, 1(5), pp. 295-298.

Association of American Universities Committee on Graduate Education. (1998). *Association of American Universities Committee on Graduate Education Report and Recommendations*. Association of American Universities, Washington, DC.

Bryce, M. (1997) *Reinventing Design in Australia*. Curtin School of Design Occasional Paper. Curtin University School of Design, Perth.

Buchanan, R., Doordan, D., Justice, L., & Margolin, V. (Eds.) (1999) *Doctoral Education in Design: Proceedings of the Ohio Conference*. The School of Design, Carnegie Mellon University, Pittsburgh.

Canadian Agri-Food Research Council (1997) *Canada's National Strategy for Agri-Food Research and Technology Transfer 1997-2002*, [html document]. Canadian Agri-Food Research Council. Available: www.carc-crac.ca/english/national_strategy/strge.htm [2001, Sept].

Catholic Encyclopedia (2001) *Doctor*, [html document]. Catholic Encyclopedia. Available: <http://www.newadvent.org/cathen/05072b.htm> [2001, Sept].

Catholic Encyclopedia (2001) *Universities*, [html document]. Catholic Encyclopedia. Available: <http://www.newadvent.org/cathen/15188a.htm> [2001, Sept].

- Commission of The European Communities (2000) *Making a reality of The European Research Area: Guidelines for EU research activities (2002-2006)*. Commission of The European Communities, Brussels.
- Cooper, T. (1999) *Portfolio assessment: A guide for lecturers teachers and course designers*. Praxis Education, Perth.
- Cooper, T., Hutchins, T., & Sims, M. (1999) Developing a Portfolio which demonstrates Competencies. In *Learning materials: Certificate in Children's Services; 0-6 years (bilingual support)*. Edited by M. Sims & T. Hutchins, (pp. 3-29). Ethnic Childcare Resource Inc. Western Australia, Perth.
- Cooper, T., & Love, T. (2000) Portfolios in university-based design education. In *Re-inventing Design Education in the University*. Edited by C. Swann & E. Young, (pp. 159-166). School of Design, Curtin University, Perth.
- Cooper, T., & Love, T. (2002) Online portfolios: issues of assessment and pedagogy. In *AARE 2001: Crossing Borders: New Frontiers of Educational Research*. Edited by P. Jeffrey. AARE Inc, Coldstream, Victoria.
- Council for Science and Technology (2001) *Imagination and Understanding: A Report on the Arts and Humanities in relation to Science and Technology*, [html document]. Council for Science and Technology. Available: www.cst.gov.uk/cst/imagination.htm [2001, July].
- Coyne, R. D., & Snodgrass, A. (1993) Rescuing CAD from Rationalism, *Design Studies*, 14(2), pp. 100-123.
- Deem, R. (1998, 15th-16th July). *Doctoral routes - different paths to the same destination?* Paper for UK Council for Graduate Education Summer Conference, University of Greenwich.
- Durling, D., & Friedman, K. (Eds.) (2000) *Foundations for the Future*. Staffordshire University Press, Stoke on Trent, UK.
- Durling, D., & Shackleton, J. (Eds.) (2002) *Common Ground. Proceedings of the Design Research Society International Conference at Brunel University, September 5-7, 2002*. Staffordshire University Press, Stoke on Trent, UK.
- EPSRC (2001) *Scheme Conditions*, [html document]. EPSRC. Available: www.esprc.ac.uk/ESPRCWEB/MAIN/TRAINING/INUNI/Scheme_Conditions.html [2001, Sept].
- ESRC (2001) *Postgraduate Training Guidelines 2001 Chief Executive's Foreword* (3rd ed.). Economic and Social Research Council, Swindon, UK.
- ESRC (2001) *Section F Subject, discipline and multidisciplinary guidelines* (3rd ed.). Economic and Social Research Council, Swindon, UK.
- French, M. J. (1985) *Conceptual Design for Engineers* (2nd ed.). Design Council, London.
- Gaff, J. G. (2001) *Reforming Graduate Education*, [html file]. University of Washington. Available: <http://depts/washington.edu/envision/gaff.htm> [2001, May 2001].
- Gero, J. S. (2000) *Research Methods for Design Science Research: Computational and Cognitive Approaches*, [html file]. University of Sydney. Available: <http://www.arch.usyd.edu.au/~john/publications/2000b.pdf/GeroDocResearch.pdf>.
- Hollins, B. (1994) Conference report: International conference on engineering design (ICED 1993), *Design Studies*, 15(2), pp. 227-229.
- Hubka, V., & Eder, W. E. (1988) *Theory of Technical Systems*. Springer-Verlag, Berlin.
- Hubka, V., & Eder, W. E. (1996) *Design Science: Introduction to the Needs, Scope and Organization of Engineering Design Knowledge*. Springer-Verlag, London.
- Jones, J. C. (1970) *Design Methods: seeds of human futures*. Wiley-Interscience, London.
- Kemp, D. (1999) *Knowledge and Innovation: A policy statement on research and research training*. Legislative Services, AusInfo, Canberra.
- Kemp, D. (1999). *New Knowledge, New Opportunities: A Discussion Paper on Higher Education Research and Research Training*. Dept of Education, Training and Youth Affairs, Canberra.
- Leith, A. T. (1995) *NAS/NAE Report: Recommendations for Federal S&T Funding*, [html document]. American Institute of Physics [2001, Sept].
- Lewis, B. N. (1964) Communication in Problem Solving Groups. In *Conference on design methods*. Edited by J. C. Jones & D. G. Thornley, (pp.

169-184). Macmillan, New York.

Love, T. (1998). *Social, environmental and ethical factors in engineering design theory: a post positivist approach*. Unpublished PhD thesis, University of Western Australia, Perth.

Love, T. (2000) Educating those involved in changing human futures: a more coherent programme for design education. In *Re-inventing Design Education in the University*. Edited by C. Swann & E. Young, (pp. 242-248). School of Design, Curtin University of Technology, Perth.

Love, T. (2000) New roles for design education in university settings. In *Re-inventing Design Education in the University*. Edited by C. Swann & E. Young, (pp. 249-255). School of Design, Curtin University of Technology, Perth.

Love, T. (2000) Philosophy of Design: a Meta-theoretical Structure for Design Theory, *Design Studies*, 21(3), pp. 293-313.

Love, T. (2001) Changes to Theory Making about Systems Involving People: Meta-theoretical Analysis and Brain Research. In *The Relevance of Systems Thinking in the Contemporary World: Systems in Management 7th Annual ANZSYS Conference Proceedings*. Edited by W. Hutchinson & M. Warren, (pp. 69-79). We-B Research Centre, Edith Cowan University, Perth.

Love, T. (2001) Concepts and Affects in Computational and Cognitive Models of Designing. In *Computational and Cognitive Models of Creative Design*. Edited by J. S. Gero & M. L. Maher, (pp. 3-23). University of Sydney, Sydney.

Love, T. (In Press) Design as a Social Process: Bodies, Brains and Social Aspects of Designing, *Journal of Design Research*.

Lyle, J. T. (1985) *Design for Human Ecosystems*. Van Nostrand Reinhold, New York.

McCracken, W. M. (1997). *Portfolio Assessment in Design Education*. EduTech Institute and College of Computing, Georgia Institute of Technology, Atlanta, Ga.

Ministry of Research and Information Technology (1998) *The National Research Strategy*, [html document]. Ministry of Research and Information Technology, Denmark. Available: www.fsk.dk/fsk/publ/1997/research/inde0002.htm [2001, July].

National Endowment for the Arts (2001) *NEA Strategic Plan 1999-2004*, [html document]. National Endowment for the Arts. Available: <http://arts.endow.gov/learn/Strategic/Contents.html> [2001, Sept].

National Endowment for the Humanities (n.d.) *NEH Overview*, [html document]. National Endowment for the Humanities. Available: www.neh.gov/whoware/overview.html [2001, Sept].

National Science Foundation (1998) *Norway's Science Policy*, [html document]. National Science Foundation. Available: www.nsf.gov/home/int/europe/reports/98.htm [2001, July].

National Science Foundation (2000) *Indicators 2000, Chapter 2: US and International Research and Development: Funds and Alliances*, [html document]. National Science Foundation. Available: www.nsf.gov/sbe/srs/seind00/access/c2/c2s9.htm.

National Science Foundation (2001) *NSF GPRA Strategic Plan FY 2001-2006: III. Outcome Goals: Investing in today's promise for tomorrow's achievement*, [html document]. National Science Foundation. Available: www.nsf.gov/pubs/2001/nsf0104/outcome.htm [2001, Sept].

National Science Foundation (2001) *NSF GPRA Strategic Plan FY 2001-2006: IV. Strategy*, [html document]. National Science Foundation. Available: www.nsf.gov/pubs/2001/nsf0104/strategy.htm [2001, Sept].

National Science Foundation (2001) *Social, Behavioural and Economic Sciences Overview*, [html document]. National Science Foundation. Available: www.nsf.gov/home/sbe/ [2001, Sept].

Norwegian Research Council (1998) *Forskning for fremtiden*. The Norwegian Research Council, Oslo.

Nyquist, J. D., & Woodford, B. J. (2000) *Renvisioning the PhD- what concerns do we have?* University of Washington, Washington.

O'Doherty, E. F. (1964) Psychological Aspects of the Creative Act. In *Conference on design methods*. Edited by J. C. Jones & D. G. Thornley, (pp. 197-204). Macmillan, New York.

Pizzocaro, S., Arruda, A., & De Moraes, D. (Eds.) (2000) *Design plus Research. Proceedings of the Politecnico di Milano conference, May 18-20, 2000*. Politecnico di Milano, Milan.

- Reich, Y. (1994) Annotated bibliography on Research Methodology, *Artificial Intelligence in Engineering Design and Manufacturing*, 8, pp. 355-366.
- Reich, Y. (1994) Layered models of research methodologies, *Artificial Intelligence in Engineering Design and Manufacturing*, 8, pp. 263-274.
- Reinstein, G. (1997) *Happy Birthday to the Oldest American Graduate School*, [html document]. Yale University. Available: www.yale.edu/opa/newsr/97-04-21-01.all.html [2001, Sept].
- Simon, H. A. (1984) *The Sciences of the Artificial* (2nd ed.). MIT Press, Cambridge, Ma.
- Swann, C., & Young, E. (Eds.) (2000) *Re-inventing Design Education in the University, Conference Proceedings*. Curtin University of Technology, Perth.
- Tellefsen, B., & Love, T. (In Press) Understanding Design as a Social Process through Constituent Market Orientation, *Journal of Design Research*.
- Tellefsen, B., & Love, T. (2002 (working paper)) *Doctoral Research in Design: The Future of the Practice-based Doctorate*. We-B Research Centre, Edith Cowan University, Perth.
- The Quality Assurance Agency for Higher Education (2001) *A consultative paper on Higher Education qualifications frameworks in England, Wales and Northern Island (EWNl) and for Scotland - October 1999*, [html document]. The Quality Assurance Agency for Higher Education. Available: www.qaa.ac.uk/crntwork/nqf/consultation/develop.htm [1999, Sept].
- The Quality Assurance Agency for Higher Education (2001) *The framework for higher education in England, Wales and Northern Island*, [html document]. The Quality Assurance Agency for Higher Education. Available: www.qaa.ac.uk/crntwork/nqf/ewni2001/annex1.htm [2001, Sept].
- Ullman, D. G. (1992) A Taxonomy for Mechanical Design, *Research in Engineering Design*, 3, pp. 179-189.
- Woodrow Wilson National Fellowship Foundation (1998) *Unleashing the Humanities*, [html document]. Woodrow Wilson National Fellowship Foundation. Available: www.woodrow.org/conferences/phd/agenda.htm [2001, Sept].
- Woodrow Wilson National Fellowship Foundation (2000) *An Initiative to Improve the Doctoral Experience in the Arts and Sciences: Towards a More Responsive PhD*, [html document]. Woodrow Wilson National Fellowship Foundation. Available: www.woodrow.org/responsivephd/ [2001, July].
- Woodrow Wilson National Fellowship Foundation (2001) *New Paradigms, New Practices, New People: The Responsive PhD*, [html document]. Woodrow Wilson National Fellowship Foundation. Available: www.woodrow.org/newsroom/newsletters/sp01-responsive_phd.html [2001, Sept].