Graphisme, animation et nouveaux médias

Graphics, Animation and New Media

Book One: Proposal

2009 Competition for New Networks

Networks of Centres of Excellence
Full Application Form

Please refer to the *NCE Full Application Guide (2009 Competition)* for more information.

Note: only write in green cells.

Date: August 4, 2009

SECTION A: SUMMARY INFORMATION

SCIENTIFIC DIRECTOR

Family name	Given name	Initial(s) of all given names	Personal identification no. (PIN)
Booth	Kellogg	KS	10455

Preferred language of correspondence	Percentage of salaried time committed to Network by the Scientific Director.
☒ English ☐ French	0.75

NETWORK TITLE (provide name in both official languages)

English	Graphics, Animation and New Media Canada
French	Graphisme, Animation et Nouveau Média Canada

NETWORK ACRONYM (provide acronym in both official languages)

English	GRAND
French	GRAND

TARGET RESEARCH AREA(S) (select up to 2 from dropdown menus)

Information and communication technologies: new media, animation and games

KEYWORDS (provide up to 10 keywords)

animation, collaboration technology, cyberspace, digitial archive, games, intellectual property, journalism, museums, new media, social networking

TOTAL NCE FUNDING REQUESTED (Years 1-5)	(From Section B1 - Budget)	**$23,250.000**

ANTICIPATED NUMBER OF PARTICIPANTS

Researchers:	50	Private Sector Partners:	18+
Post Secondary Institutions:	19	Community Partners (Hospitals, Government, Public Sector):	13+

SIGNATURES

It is agreed that the general conditions governing grants as outlined in the Granting Agencies literature apply to any grant made pursuant to this application and are hereby accepted by the Scientific Director and the proposed Network Host Institution.

Scientific Director

President or Chief Executive Officer,
Proposed Network Host Institution

SCIENTIFIC DIRECTOR'S CONTACT INFORMATION

Department	Title
Computer Science	Professor

Organization	Address
University of British Columbia	Department of Computer Science 201-2366 Main Mall University of British Columbia Vancouver BC V6T 1Z4

Phone	Area code	Number	Extension
	604	822.8193	

Fax	Area code	Number	City/Municipality	Prov.	Postal code
	604	822.5485	Vancouver	BC	V6T 1Z4

E-mail address

ksbooth@cs.ubc.ca

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THE UNIVERSITY OF BRITISH COLUMBIA

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Vancouver, B.C. Canada V6T 1Z2

Telephone (604) 822-8300
Fax (604) 822-5055

Professor Stephen J. Toope
President and Vice-Chancellor

July 29, 2009

Dr. Suzanne Fortier, Chair
NCE Steering Committee
350 Albert Street
Ottawa, ON K1A 1H5

Dear Dr. Fortier,

On behalf of the University of British Columbia, I lend my strongest support to the establishment of the GRAND Canada (GRaphics, Animation and New meDia) Network of Centres of Excellence. New media touch on every aspect of daily life, from e-commerce to social networking, to complex modeling, simulations and imaging processes in medicine, science and the entertainment industry. GRAND will provide meaningful solutions to major challenges with new media technologies, ranging from the industrial applications of new technology through to better management and understanding of the evolution of copyright legislation for virtual worlds.

Aligned with the NCE's objectives, GRAND will add value by addressing technological, creative, commercial, socio-economic, legal and cultural new media challenges with an interconnected approach. It will engage industry, science and social science at the point of technology development with a vision to reduce the disruptive nature of new media technologies on our social and legal structures. The truly national scope of GRAND will provide greater capacity to integrate academic expertise with the needs of industry partners. UBC is proud to work with leading companies such as Autodesk, BioWare/Electronic Arts, Deluxe Postproduction, Rapid Mind, and Side Effects. Their substantial contributions are testament to the strength of their relationships with the network leaders, and bode well for the long term success of GRAND.

Having one of the top five animation and computer graphics groups in North America, UBC is a long-term centre of excellence in Canada. We continue to invest in these research areas and to train outstanding HQP in these fields. Many graduates from UBC have gone on to take leadership roles in organizations such as Autodesk, Electronic Arts, and other partners. The proposed NCE is designed to provide ample opportunities for trainees to engage in "real-world" problem-solving opportunities. GRAND will collaborate with UBC's $12 Million investment in the Carl Wieman Science Education Initiative (CWSEI), a unique training enhancement for HQP involved in the network.

Professor Kellogg Booth has successful leadership experience at UBC, and as former Chair of ACM SIGGRAPH (Association for Computing Machinery Special Interest Group for Graphics and Interactive Techniques), Fellow of the British Columbia Advanced Systems Institute, and Associate Director of

NECTAR (Network for Effective Collaboration Technologies through Advanced Research). He has proven his capacity to build enduring networks, and is the founder, in 1990, of the Media and Graphics Interdisciplinary Centre (MAGIC), which will be the UBC node in the GRAND Network.

MAGIC is a catalyst to assimilate and exploit new technology in research and education at UBC and has strengthened UBC's interaction with industry through collaborative research. Affiliates of MAGIC range across the departments of Computer Science, Electrical & Computer Engineering, Music, Forestry, Psychology, Medicine, Education, Commerce and Fine Arts; we believe that this experience of multidisciplinarity will be a critical success factor for GRAND.

UBC has also invested in two directly relevant Canada Research Chair appointments, and an endowed Dolby Computer Science Research Chair. Additionally, the Museum of Anthropology has received a major CFI investment and continues on the cutting edge of research, design and dissemination for new modes of accessing and "handling" cultural resources in digital and virtual realms. The MOA will be a leader amongst the cultural institutions engaged in this network toward the provision of greater public access to cultural resources. Directly aligned with the sustainability priority at UBC, GRAND also connects with the Centre for Interactive Research on Sustainability through a research project on Human-Centred Technologies for Sustainable Living.

To be physically headquartered at the Great Northern Way campus, GRAND will be co-located in space that houses the new Masters in Digital Media program initiated with our sister organizations. This site offers GRAND a unique opportunity to bring the talents and strengths of the partnering institutions together into the NCE, and allows UBC to provide appropriate administrative and fiscal oversight. With experience as host and co-host to six NCE's including MITACS, UBC will provide effective support for the network, with experienced personnel and systems already in place.

UBC is pleased to accept the role of host institution for the GRAND NCE, and should it be funded, will commit to a combined cash and in-kind contribution of $1.068 Million. This includes a total cash contribution of $125,000 over five years, plus a total in-kind commitment of $943,000 over five years that encompasses $750,000 in salary support for the Scientific Director to devote 75% of his time to the NCE, $100,000 in-kind for two 0.25 FTE positions for administrative and technical support, plus $93,000 in-kind in student stipend and travel support. We will also ensure support for the use of space at our Great Northern Way campus, continued support from the Office of the Vice President Research, the Office of Research Services and our financial and administrative systems for NCE's at UBC. The University Industry Liaison Office will play a strong role in ensuring the network agreements are sound, and will share its expertise with the Technology Transfer and Commercialization Committee.

Once again, we strongly support the establishment of the GRAND NCE, and look forward to working closely with our partners and collaborating institutions to move this Network forward.

Sincerely,

SIGNATURE OMITTED

Kellogg S. Booth
Professor of Computer Science

SIGNATURE OMITTED

for Stephen J. Toope
President and Vice-Chancellor

3. Executive Summary

New Media, Animation, and Games – these technologies are the building blocks of the Digital Age. The Science, Technology and Innovation Council report in 2008 recognized this as a priority research sub-area within Canada's Science and Technology Strategy. This application responds to the needs identified in that report. The GRAND NCEwill undertake a comprehensive research program whose goal is to understand the underlying technologies and to make selective advances in a coordinated, multidisciplinary setting that lead to social, legal, economic, and cultural benefits for Canadians.

This brings significant challenges because the ability to access, manipulate, and disseminate information in its various media forms radically changes on almost a daily basis. The research program will meet these challenges through a dynamic set of interconnected projects built on a conceptual framework of five themes. Three themes focus on the technology clusters identified by the Science, Technology and Innovation Council: (1) New Media Challenges and Opportunities, (2) Games and Interactive Simulation, and (3) Animation, Graphics and Imaging. The other two cross-cut the first: (4) Social, Legal, Economic and Cultural Perspectives, and (5) Enabling Technologies and Methodologies. Thirty projects each explore a different aspect of selected problems. Fifty Network Investigators lead projects, with Collaborating Researchers and Partners from the public and private sectors participating as domain experts and receptors to exploit the resulting new knowledge and technologies.

GRAND is guided by a vision of world-class, multidisciplinary research that is solution-driven and focused on complex questions in New Media, Animation, and Games where significant impact can be achieved. Some questions ask how enabling technologies can be efficiently developed and effectively deployed. Others examine the consequences of new technologies for Canadian social, legal, economic, and cultural institutions. Strategies for public policy decisions – on matters such as regulatory structures, intellectual property rights, privacy and security of personal identity and data, and Canadians' ability to express themselves artistically and culturally on the world stage – will be explored.

Serious games, social networking, live performance augmented by digital technologies, Internet-enabled e-journalism, and mobile applications for work and play are obvious examples of problem domains to be explored. Less obvious but equally important are e-government and e-health services.

Benefits will be realized through creating new knowledge and technologies, training highly qualified personnel, creating wealth by exploiting the possibilities of New Media, Animation, and Games for economic growth, and improving the quality of life for Canadians. Technologies that improve healthcare, encourage sustainable lifestyles that honor and preserve the natural environment, and promote greater participation in public dialogue will be powerful benefits in the Digital Age.

Accelerating the exploitation of new knowledge and technology, GRAND will encourage, enable and support the rapid exchange of ideas between academic researchers and receptor communities. Special attention will be paid to the role of Entrepreneurs, and the need for Design, not just Engineering and Marketing, in every stage of the innovation pipeline to ensure that products meet the needs of their customers and services meet the needs of their clients.

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4. Table of Proposed Network Investigators

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
BAECKER, RON University of Toronto Department of Computer Science Professor	ON	35%	PCL, NI	All	CPRM, INCLUDE, GAMFIT
BALAKRISHNAN, RAVIN University of Toronto Department of Computer Science Associate Professor	ON	40%	PCL, NI	All	AMBAID, SHRDSP, SKETCH, VIRTPRES
BIDDLE, ROBERT Carleton University School of Computer Science Professor	ON	35%	PL, NI	All	DIGLT, PLAYPR, PRIVNM
BOOTH, KELLOGG University of British Columbia Department of Computer Science Professor	BC	75%	SD, PCL, NI	All	MEOW, NAVEL, SHRDSP
BROOKS, STEPHEN Dalhousie University Faculty of Computer Science Associate Professor	NS	35%	PCL, NI	All	NGAIA, PROMO, VIRTPRES
CARPENDALE, SHEELAGH University of Calgary Department of Computer Science Associate Professor	AL	20%	PL, NI	All	AESTHVIS, CPRM, INCLUDE, SHRDSP, SKETCH
CLARKE, CHARLES University of Waterloo School of Computer Science Professor	ON	20%	PCL, NI	All	NEWS, NGAIA, PERUI
CONATI, CHRISTINA University of British Columbia Department of Computer Science Associate Professor	BC	25%	PL, NI	All	DIGLT, AFEVAL, EOVW

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
COOPERSTOCK, JEREMY McGill University Department of Electrical & Computer Engineering Professor	QC	50%	TL, PL, PCL, NI	All	VIRTPRES, AFEVAL, HSCEG, SHRDSP
EAGLESON, ROY University of Western Ontario Faculty of Engineering Associate Professor	ON	30%	PL, NI	All	HLTHSIM, AMBAID, PROMO, VIRTPRES
FEDOROVA, ALEXANDRA Simon Fraser University School of Computing Science Assistant Professor	BC	35%	PL, NI	All	ENCAD, HSCEG, PLATFORM
FELS, DEB Ryerson University School of Information Technology Management Professor	ON	20%	PL, NI	All	AESTHVIS, DINS, INCLUDE
FELS, SID University of British Columbia Department of Electrical and Computer Engineering Professor	BC	50%	PL, NI	All	NGAIA, SHRDSP, VIRTPRES
FIUME, EUGENE University of Toronto Department of Computer Science Professor	ON	50%	PCL, NI	All	CAPSIM, MOTION, PROMO
GARDNER, PAULA Ontario College of Art & Design Faculty of Liberal Studies Associate Professor	ON	30%	NI	All	CPRM, DINS, PLAYPR
GOOCH, BRUCE University of Victoria Department of Computer Science Associate Professor	BC	40%	PCL, NI	All	GAMFIT, PLATFORM

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
GOODRUM, ABBY Ryerson University School of Journalism, School of Management Associate Professor	ON	30%	DR, PL, PCL, NI	All	HDVID, MEOW, NAVEL, NEWS
GRAHAM, NICK Queen's University School of Computing Associate Professor	ON	20%	PL, PCL, NI	All	GAMFIT, HSCEG, SIMUL
GROMALA, DIANE Simon Fraser University School of Interactive Arts & Technology Associate Professor	BC	40%	TCL, PL, NI	All	AESTHVIS, CPRM, ENCAD
GUTWIN, CARL University of Saskatchewan Department of Computer Science Professor	SK	25%	TCL, PL, PCL, NI	All	HSCEG, SHRDSP, SIMUL, VIRTPRES
HEIDRICH, WOLFGANG University of British Columbia Department of Computer Science Associate Professor	BC	20%	TL, PL, NI	All	CAPSIM
HUGHES, LYNN Concordia University Faculty of Fine Arts Associate Dean	QC	30%	PL, PCL, NI	All	DIGLT, HDVID, PLAYPR
JENSON, JENNIFER York University Faculty of Education Associate Professor	ON	30%	PCL, NI	All	DIGLT, PLAYPR
KRY, PAUL McGill University School of Computer Science Assistant Professor	QC	40%	PCL, NI	All	CAPSIM, MOTION, VIRTPRES
LANK, EDWARD University of Waterloo School of Computer Science Assistant Professor	ON	35%	PL, NI	All	DIGLT, HDVID, SKETCH

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
MACLEAN, KARON University of British Columbia Department of Computer Science Associate Professor	BC	30%	PL, NI	All	AFEVAL, AMBAID, CPRM, GAMFIT, HLTHSIM
MANDRYK, REGAN University of Saskatchewan Department of Computer Science Assistant Professor	SK	60%	TCL, PL, PCL, NI	All	AFEVAL, AMBAID, EOVW, GAMFIT
MIDDLETON, CATHERINE Ryerson University School of Information Technology Management Associate Professor	ON	25%	TL, PL, NI	All	DIGILAB, DINS, HDVID, MEOW
MOULD, DAVID Carleton University School of Computer Science Associate Professor	ON	35%	NI	All	BELIEVE, PROMO, SKETCH
PENN, GERALD University of Toronto Department of Computer Science Associate Professor	ON	40%	PL, NI	All	INCLUDE, NEWS, SIMUL
POULIN, PIERRE University of Montreal Département d'informatique et de recherche opérationnelle Professor	QC	30%	TCL, PL, NI	All	AESTHVIS, MOTION, PROMO, SKETCH
PRUSINKIEWICZ, PRZEMYSLAW University of Calgary Department of Computer Science Professor	AB	10%	PCL, NI	All	PROMO
ROCKWELL, GEOFFREY University of Alberta Faculty of Arts Professor	AB	10%	NI	All	HLTHSIM, PLAYPR
SCHAEFFER, JONATHAN University of Alberta Department of Computing Science Professor	AB	10%	TL, PL, NI	All	BELIEVE, MCSIG

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
SEIF EL-NASR, MAGY Simon Fraser University School of Interactive Arts & Technology Assistant Professor	BC	60%	PL, PCL, NI	All	AESTHVIS, AFEVAL, BELIEVE, EOVW, MOTION
SIMON, BART Concordia University Department of Sociology and Anthropology Associate Professor	QC	50%	PCL, NI	All	DIGILAB, EOVW, PLAYPR, PRIVNM
SINGH, KARAN University of Toronto Department of Computer Science Professor	ON	35%	PL, NI	All	AESTHVIS, MOTION, SKETCH
STROULIA, ELENI University of Alberta Department of Computing Science Professor	AB	20%	PL, PCL, NI	All	HLTHSIM, MEOW
STUERZLINGER, WOLFGANG York University Department of Computer Science & Engineering Associate Professor	ON	35%	PCL, NI	All	ENCAD, HLTHSIM, HSCEG, PROMO
SZAFRON, DUANE University of Alberta Department of Computing Science Professor	AB	25%	PL, NI	All	BELIEVE, EOVW
TERRY, MICHAEL University of Waterloo School of Computer Science Assistant Professor	ON	25%	PL, NI	All	AMBAID, HDVID, PERUI
TIDAFI, TEMI University of Montreal School of Architecture Professor	QC	65%	PL, NI	All	ENCAD

Name, Organization, Department & Position	Province	Salaried Time	Network Role	Research Themes	Project(s)
TOMS, ELAINE Dalhousie University Faculty of Management Associate Professor	NS	20%	TCL, PL, NI	All	NEWS, NGAIA
TROSOW, SAMUEL University of Western Ontario Faculty of Law, Faculty of Information & Media Studies Associate Professor	ON	35%	TL, PL, NI	All	DIGILAB, DINS, PRIVNM
VAN DE PANNE, MICHIEL University of British Columbia Department of Computer Science Professor	BC	35%	PL, NI	All	MOTION, SKETCH
VERTEGAAL, ROEL Queen's University School of Computing Associate Professor	ON	10%	NI	All	NGAIA
WAKKARY, RON Simon Fraser University School of Interactive Arts & Technology Associate Professor	BC	40%	PCL, NI	All	DIGLT, INCLUDE, PLAYPR
WELLMAN, BARRY University of Toronto Department of Sociology Professor	ON	35%	PL, PCL, NI	All	DINS, EOVW, INCLUDE, NAVEL, PRIVNM
WOODBURY, ROBERT Simon Fraser University School of Interactive Arts & Technology Professor	BC	20%	DR, PL, NI	All	ENCAD, HCTSL, PERUI
WYVILL, BRIAN University of Victoria Department of Computer Science Professor	BC	40%	NI	All	PLATFORM, PROMO, SKETCH

5. Network Vision

Canadians will enrich their lives by harnessing new opportunities, increasing productivity, decreasing cost and waste, and connecting, collaborating, buying, and selling globally. The GRAND vision is to create capacity for Canada to further develop and enhance its position as a global leader in new media, animation, and games. The national scale and scope provide a diversity of academic and industry expertise and a greater capacity to integrate that expertise with the needs of partners in the private and public sectors.

The advantage of the GRAND Network is its ability to mobilize existing centres of excellence, thereby reducing risk and accelerating innovation through access to enabling technologies and methodologies, increasing capacity to train highly qualified personnel through direct participation in research and commercialization activities, providing greater and more immediate access to state-of-the-art research results and expertise, and overcoming barriers of scalability for content generation, selection, and delivery.

The concept of new media historically referred to any digital, interactive application. Today, practically everything is digital. We envision applications that comprise significant multimedia elements founded on innovative gaming, simulation, animation, and graphics principles that may be integrated with rich text and enabled for delivery using a range of platforms from mobile devices to large screen displays.

Expected outcomes from our research will ultimately contribute new games for single- and multi-player environments, novel social media such as a next-generation privacy-aware Facebook, e-learning and edutainment environments for personalized learning in schools and corporate environments that enhance knowledge acquisition and skill development, information appliances that support a range of information-intensive applications for delivery of news and social commentary, digital books, and virtual museums and galleries. Specific objectives include enhancing Canada's ability to innovate in the growing cultural industries sector, providing exemplary showcases of how new media can foster better understanding of sustainability issues, using new media technology to improve training for health-care and other professionals, and stimulating and informing public discourse over the next decade on important policy issues surrounding new media. Our core work will enhance user experience with innovative functionality that addresses the social, legal, economic, and cultural perspectives of new media.

Our vision-within-the-vision – itself a contribution that will have a significant impact on Canada's ability to compete globally – emphasizes the role of Design within every step of the innovation chain, starting with basic research that takes a user-centered approach to developing new technology within socio-economic contexts and progressing to early-prototype and late-stage commercialization linkages with industry partners. This will impact partners and the user sector over the next five to ten years by providing a generation of highly-qualified personnel who have experienced first-hand the benefits of this approach and who are ready and able to put their skills into practice to create new wealth and a better quality of life for Canadians.

The strength GRAND brings is a rich, interconnected collaboration that crosses disciplinary boundaries, geographic boundaries, and private-public sector boundaries. The GRAND team and its many partners combine domain expertise, scientific method, humanistic inquiry, engineering knowledge, and design flair to conduct unique research and build exemplary prototypes useful to Canada.

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6. Strategic Plan

GRAND's integrated research and business management strategy is designed to augment and extend existing research capacity by providing a well- considered framework for integrating expertise from a number of disciplines to focus on key problems in the sub-priority research area of *New Media, Animation, and Games* within the *Information and Technology* priority area identified by the *Science, Innovation and Technology Council (STIC)* in its 2008 report. We present our response to the NCE Program's call for proposals and outline how we will achieve the desired outcomes.

How to Read this Document

This application is organized according to the guidelines set out in the NCE's *2009 Full Application Guide* and *2009 NCE Networks Program Guide*. We have used the suggested section ordering and headings.

The one deviation from the guidelines is that we have added Section 6.8 to discuss the budget, rather than include additional pages elsewhere. The expanded Section 6 is still within the allowed 85-page limit.

References to projects proposed in the application use *ACRONYMS* available in Section 8.

Audio Enhancement to this Document

The PDF version of the Executive Summary (Section 3) has an embedded audio file that can be used by those who are unable to read the written text. This illustrates how new media technology can improve the quality of life for Canadians by providing more equal access to information for those with vision impairments or low reading ability. More generally, new media offers numerous opportunities to empower segments of society who have been disenfranchised because of their physical, cognitive, or social situations. We note this here because it highlights the importance of the proposed research.

One-size-fits-all solutions to achieve universal accessibility are not realistic. There are significant research questions that must be answered before the full power of new media can be brought to bear on inclusive solutions. Simple text-to-speech translation is not adequate. The appositive in the paragraph at the top of the second column in Executive Summary (Section 3) demonstrates this. When heard verbally, the dashes that visually set off the explanatory text are not apparent. Short of a Victor Borge-style auralization of punctuation marks, it is necessary to re-order the material to best convey the intended meaning. When you listen to the audio file, you will hear this.

The *INCLUDE* project, described in Section 6.3, builds on efforts already underway to understand and overcome these barriers to equal access. Along with other projects such as *AMBAID,* it will examine ways in which new media can be used to support an inclusive society that enables each person use his or her abilities to best advantage. One of the research challenges is to figure out how to support this process in a semi-automated way so it is not prohibitively expensive. Another challenge – one we think may be easier – is to ensure there are no unintended differences between the written and verbal versions. Did you detect the one place where a significant word was inserted into the audio file that was not present in the text?

Letters of Support

In some cases letters of support had not been received from partners, usually due to vacation schedules, at the time the documents were prepared for duplication (one week prior to the NCE Program's submission deadline of August 11, 2009). In cases where we were confident that letters would be available by the site visit (August 24,

2009), we included "placeholder" letters in Book 2 to indicate that letters will be available at the site visit.

Signatures have been removed from letters to comply with privacy concerns. The original copies that are being submitted to the NCE Program will have signatures.

On-line Version of this Document

PDF versions for Book 1 and Book 2 of the application will be available for download at the following website.

http://www.grand-nce.ca/application/

A userID and password are required to ensure privacy. The generic userID "reviewer" and password "sesame" will provide access to the files.

As additional letters of support are received, the placeholder letters will be replaced in the on-line versions of the Book 2.

The website also provides links to the public portion of the GRAND wiki that was used to organize the application, and to selected internal pages to provide further information on the process that was undertaken.

6.1 General Context

GRAND is a proposed Network of Centres of Excellence that responds to the need for research and innovation in areas related to new media.

The following statistical information demonstrates the economic importance of New Media. The Entertainment Software Association's annual report for 2009, and the Canadian report for 2008 provide the following statistics.

Nine out of 10 Canadian households own a computer. Four out of 10 Canadian households (43%) own a video game console. Seventy-five percent of all Canadian adults have played a video game at least once, while nearly two thirds (64%) have played in the last year. The average age of the adult gamer is 40 years. Of gamers surveyed in Canada, 49% are female and 51% are male. Action, family, and sport games were the best selling game genres of 2007 and 2008. Ninety-two percent of parents report that their children are gamers; 55% of parents have played a game in the past four weeks; and 6 of 10 parents (57%) play video games with their kids.

U.S. computer and video game software sales grew 22.9 percent in 2008 to $11.7 billion – more than quadrupling industry software sales since 1996. Sixty-eight percent of American households play computer or video games. The average game player is 35 years old and has been playing games for 12 years. The average age of the most frequent game purchaser is 39 years old. Forty percent of all game players are women. In fact, women over the age of 18 represent a significantly greater portion of the game-playing population (34%) than boys age 17 or younger (18%). In 2009, 25 percent of Americans over the age of 50 play video games, an increase from nine percent in 1999. Thirty-seven percent of heads of households play games on a wireless device, such as a cell phone or PDA, up from 20% in 2002. Eighty-four percent of all games sold in 2008 were rated "E" for Everyone, "T" for Teen, or "E10+" for Everyone 10+. Ninety-two percent of game players under the age of 18 report that their parents are present when they purchase or rent games. Sixty-three percent of parents believe games are a positive part of their children's lives.

These statistics give testament to the growing importance of the game industry in North American. Similar data exists for many other parts of the world. More broadly, industries built on New Media are becoming an important sector of the global economy. In Section 6.4 we provide a more complete picture of the socio-economic importance of the New Media, Animation, and Games sectors.

Complementing and building on other initiatives and explanation of overlaps in funding

In the follow subsections we briefly describe a number of initiatives with previous or current funding that support or partially overlap with the proposed research program. We outline the differences and identify ways in which each contributes to the other.

All of the Network Investigators have funding from other sources on which GRAND will build. For NSERC-eligible researchers this includes Discovery grants and often Strategic Project or Network grants, as well as Research Tools and Instrumentation (equipment) grants. The research proposed in this application augments, extends, or otherwise complements those current initiatives. Funds requested from the NCE Program will not displace current funding, but will accelerate the pace of the research and permit a networked-approach to innovation and exchange and exploitation of new knowledge and technology within Canada.

Collaboration is a new frontier and a key element of new media research, and a hallmark of the NCE Program. Various supporting infrastructures on which GRAND will build range from NSERC, SSHRC, and CFI initiatives to Quebec's Hexagram inter-university institute. We briefly describe these. Further descriptions on Networking and Partnerships are in Section 6.5.

CANADIAN FOUNDATION FOR INNOVATION (CFI) –Specific CFI-funded labs and other infrastructure that will be utilized by the GRAND research program are enumerated later in the *Labs* subsection of Section 6.4.

HEXAGRAM

Based in Montreal, Hexagram is an inter-university Institute that promotes new media research and technology transfer. Over 80 of its members are researchers in the areas of media arts, interactive performance, design, communication studies, and computer science. Hexagram's researchers are based in and collaborate with others across the region's universities: Concordia, UQAM, the University of Montreal, McGill, the University of Laval, ETS, and the University of Sherbrooke. Researchers in GRAND projects led by a Hexagram member will have access to Hexagram's funding opportunities, its extensive inter-university infrastructures, and the support of its two industrial research and transfer arms.

NECTAR: NETWORK FOR EFFECTIVE COLLABORATION THROUGH ADVANCED RESEARCH

NECTAR was a five-year NSERC strategic research network (2004-2009) whose focus was on developing and evaluating a variety of tools for collaboration. Many of the fourteen researchers who participated in NECTAR are Network Investigators in GRAND, including the Scientific Director and three of the Theme Co-Leaders. Some of the proposed projects are the outgrowth of new problems or opportunities that arose from research conducted under NECTAR, and many of the research partnerships on which GRAND is built were initiated or strengthened during the five years that NECTAR was funded.

ISSNET: INTERNETWORKED SYSTEMS SECURITY NETWORK

ISSNet is a five-year NSERC strategic research network (2009-2014) whose focus is computer and network security emphasizing computer systems research, with an experimental or observational approach. ISSNet's self-described "hands on" research is directly related to the Internet wherever possible. This makes it an ideal source of new knowledge about one of the key infrastructures on which the new media, animation, and gaming technologies and practices being explored within

GRAND will build. The synergy between ISSNet and GRAND is recognized by the *PRIVNM* project in GRAND, which has one Network Investigator and one Collaborating Researcher who are also members of ISSNet. We expect to have an on-going relationship with ISSNet that includes cross-network workshops on privacy and security that address both technical and public policy issues that impact the adoption and use of new media technology within the Canadian economy.

PISA: PERVASIVE INFRASTRUCTURE, SERVICE AND APPLICATIONS

This is a proposed NCE in the subarea of wireless networks and services. As with ISSNet, this will investigate another key infrastructure on which the new media, animation, and gaming technologies and practices being explored within GRAND will build. ISSNet's focus on Internet technology and PISA's focus on wireless transmission each highlight the critical need for solution-focused research that will lead to applications that appropriately utilize the extensive bandwidth and service coverage that already exists for these two supporting technologies.

The importance of the GRAND Initiative

The multidisciplinary approach inherent in the SSHRC-NSERC partnership within GRAND is uniquely poised to take on this challenge. Leveraging Canada's past success in both Internet and wireless technology, and the fact that world-wide there is already a strong research community engaged in further advances in both fields. Thus the anticipated incremental value of the proposed GRAND research program is that it tackles tough problems that are impediments to further commercialization and social and cultural exploitation of the advances already made in wireless and broadband communications.

GRAND builds on a strong history of collaboration between university researchers and the animation software industry, dating back to the 1980s, the gaming industry dating back to the 1990s, and more recently the burgeoning new media and cultural industries.

The Broader Context

New media is an enabler. In the sections that follow, we will describe various ways that the GRAND research program will have a positive impact on Canada. We mention here just three examples.

Sustainability is a global concern. The *HCTSL* project with industry partners Autodesk and BC Hydro, researchers in Architecture, Computer Science, Engineering, and Interactive Arts and Technology, the City of Vancouver, the David Suzuki Foundation, and others is developing new media solutions to support and encourage "green homes." Nobel Laureate Dr. John Robinson is one of the Collaborating Researchers in *HCTSL*.

Education, especially for science and mathematics, is important in a knowledge-based economy where technological innovation is a major driver. The *SHRDSP* project is examining novel solutions to improve classroom learning utilizing large shared displays reminiscent of traditional blackboard techniques, but augmented with new media technology. This collaboration includes Nobel Laureate Carl Wieman's Science Education Initiative at the University of British Columbia.

Healthcare costs are a significant public expenditure. The *GAMFIT* project is using game technology to motivate people of various ages to engage in fitness activities. The *CPRM* project is investigating how new media and virtual reality technology can help manage chronic pain at lower cost and with less use of opiates. The *HLTHSIM* project is developing more effective training for healthcare professionals based on multimodal

interactive simulations, with the goal of improving clinical outcomes for patients.

How the GRAND Application was developed

The NCE Program announced the 2009 Competition on December 1, 2008. A Letter of Intent was submitted on March 2, 2009, by the GRAND researchers. There were five primary contributing partners representing the key industries in the receptor sectors who provided letters of support (the NCE Program limited us to five letters). We had similar commitments from approximately another dozen partners.

On May 7, 2009, we were invited by the NCE Program to submit a full application. Comments in the reviews we received concerning our Letter of Intent suggested that we consider additional Canadian researchers. We added three researchers who had been on a competing Letter of Intent to join the GRAND Team. We also added a number of partners.

The prototype projects that had been the basis for the Letter of Intent were further developed into project proposals. Sixty project proposals were reviewed by the ten theme leaders (Cooperstock, Heidrich, Middleton, Schaeffer, and Trosow) and co-leaders (Gromala, Gutman, Mandryk, Poulin, and Toms), the three directors (Booth, Goodrum, and Woodbury), and the director of research partnerships (DiCiccio). Thirty proposals were selected, in addition to two Special Projects (*MEOW* and *NAVEL*) that are part of the management strategy for GRAND. The same process resulted in the selection of the 50 Network Investigators who are co-applicants for this proposal.

The 32 project proposals were then refined to form an integrated research program that addresses all of the criteria of the NCE Program, and approximately 40 Collaborating Researchers were identified to round out the research team. Further details are provided in Section 6.3.

The full application was reviewed by the researchers, and also by the partners, prior to its submission to the NCE Program on August 11, 2009. A site visit has been scheduled in Ottawa on August 24, 2009, to answer questions from the Expert Panel about the proposal.

Throughout the eight-month process, over 120 researchers and partners coordinated their efforts using a wiki established for this purpose, supplemented by email, teleconferencing, and other new media technologies. This approach will be continued during the lifetime of the Network as we continue to explore innovative ways to manage the distributed research program.

6.2 Socio-Economic Context

This proposal responds to the 2009 NCE Competition in STIC's sub-priority area of New Media, Animation, and Games within the area of Information & Communications Technology (ICT). Among the goals of the NCE Program are to accelerate innovation as a trigger for economic development and to improve the quality of life for all Canadians. In this section we explain how GRAND will meet these objectives.

Technology Ubiquity & Adoption

The widespread use of Information and Communication Technologies (ICT) is having a major impact on every aspect of media production, communication, business, design, and entertainment. Ubiquitous wireless networks, next-generation mobile communications/ display technologies, locative/physical sensing, virtual social worlds, and innovative software applications herald the approach of pervasive computing embedded in every aspect of our lives. Beyond console- and computer-based activity, game-related and goal-oriented media

are being integrated into education, advertising, and broadcast media. A new generation of hybrid applications is being researched and developed, one that marries game-like experiences with the practices of engineering, education, design, the arts, and media production. These new media ICTs will not be desktop-based but ubiquitous, always on, converged, and seamless. They will require flexible production and distribution processes based on open, distributed, and mobile architectures.

Growing Canada's Economy

With the right safeguards in place, quality of life can be greatly enhanced by creating, adopting, and using new media in its various forms. Economic development will progress as Canadian companies commercialize the research output from higher education and the industrial sector in order to develop innovative new products and services, foster a highly skilled labor force, create jobs, and contribute to the economic base of their local communities.

The GRAND initiative is timely. Information-intensive industries, including those powered by new media, are leading the growth of the services sector in Canada in job creation, R&D investment, and average wages. Knowledge-based economies increasingly rely on information-intensive industries, which in turn rely on innovation to acquire, manipulate, represent, and understand highly complex information that is critical to success. Canada has long been an international leader in new media, animation, and games – in large part because of the historic strength of its cultural industries and its international competitiveness in key enabling information, and communication technologies.

During the 1980s and 90s, many companies – including Waterloo-based Open Text, Toronto-based Alias|Wavefront and Side Effects Software, and Montreal-based SoftImage and Discreet Logic – were able to commercialize emerging computer graphics technologies to create worldwide markets. This hinged on key collaborative relationships with Canadian universities that provided research innovation and training of highly qualified personnel (HQP). Open Text and Side Effects remain Canadian-based. The other three companies are now units within Autodesk – one of our industry partners – with core R&D operations in Canada.

In the 1990s, the success of animation companies formed a springboard for a second wave of growth in games development, triggered in part by innovation capacity built up for animation software. This was subsequently exploited in a third wave as the World Wide Web leap-frogged "old" new media and as almost-universal network access added a new dimension to software development – a dimension that incorporated elements of animation and gaming technologies with core database and information retrieval technologies.

In the new millennium, widespread adoption of wireless-enabled, always-connected platforms made Internet-based delivery the platform of choice for personal and business applications, providing new opportunities for new media innovation. Serious gaming and experiential design not only entertain – they have become key international economic drivers. In the business sector, rich media and highly interactive tools are a primary focus for business information systems. New media is an important and vibrant industry in Canada, which has traditionally been a leader in the adoption and application of leading-edge technologies for media content production. In this, as in all revolutionary technological change, advantage will accrue to those first in, provided they are positioned to weather initial risks. The GRAND NCE will benefit the Canadian media production communities by advancing and enhancing their exposure to new

technology, while minimizing risk by expediting the identification and development of methods that exploit new media technologies for artistic and creative gain. According to the 2006 Government of Canada report "Invest in Canada," there are over 2,300 firms involved in multimedia R&D in Canada. They employ about 18,000 people and have annual revenue of about $3 billion, with an impressive annual growth rate of 20%.

According to the 2009 report prepared by the Entertainment Software Association of Canada, the gaming software industry in Canada employs over 14,000 people, most of whom are highly skilled, and the industry now generates more than $1.7 billion in knowledge-intensive economic activity across Canada. This economic activity is expected to increase further at an annual growth rate of 29% over the next three years, building on the annual growth of 23% experienced over the past three years. In the last ten years, the productivity of Canadian industry has been governed by the uptake of ICT. The next wave of digital media ICT is poised for even greater impact, with the potential to drive industry to even higher productivity.

These are the more visible examples. There are others that are perhaps less obvious, but in many ways more compelling, where companies are increasingly moving to incorporate new media technology into their core products. For example, Business Objects/SAP, whose core competence is business intelligence software, could be considered an emerging new media company. Its products support interpretation of business data through careful attention to user interface design, and through increasing support for visualization and collaboration within its suite of products. Add to this the growing number of companies whose products promise, in one way or another, to provide a good "user experience" for their customers (banks, telcos, and other service-based industries). These companies now have a web-presence that is often the primary "customer-facing" entrée to the company's products and services. This is likely to be a major economic growth area for those who understand the potential for exploiting new media technologies.

Regaining World Leadership

Unfortunately, Canada's rankings, based on the World Economic Forum's statistical data, have dropped over the past decade, putting it well out of range of the top ten. Canada needs to turn this trend around in order to regain and maintain its leadership position in this rapidly expanding segment of the global economy. The proposed NCE provides a solutions-based response. The long-term benefit will be the creation of greater economic resilience through cross-disciplinary, cross-sector and cross-Canada initiatives, stimulated by the network's research programs, knowledge mobilization, and policy/regulatory inputs.

Innovative and Agile Networking

The Network is designed to bridge traditional boundaries among academia, industry, and government and NSERC/SSHRC. It brings together those who create technology, those who study and critique the impact of technology on society, and those who use the technology as practitioners. It will increase Canada's capacity to deploy ICT infrastructure with new technologies and methods within creative industries, service sectors, and novel Web 2.0 and 3.0 areas not yet mapped by Statistics Canada. The ability to harness strengths across sectors and to build on diversity – rather than relying upon one sector to carry the economy – will contribute significantly to this resiliency.

Creating Efficient & Effective Tools

A key focus for GRAND is the creation of efficient and effective tools. Technologically innovative tools enable industry to do more for less, thus

reducing financial risk while increasing the creative range that can be explored and exploited in new media. For example, better tools allow more novel approaches in creating, deploying, and updating games and animation. Short development cycles decrease design risk, produce products faster, and enable Canadian companies to profit in small niches as well as in large markets. This will stimulate what Richard Florida identifies as the "creative class." These workers have high-autonomy occupations and bring innovation to neighborhoods where they live and work, increase productivity, and have positive economic impact. Evidence indicates that there are six times more patents in cities with a high creative class density (*Fripp, 2008*).

The need for better tools is especially apparent for user experience design. A number of the researchers in GRAND projects are looking at different aspects of user experience. The *PERUI* project is tackling the problem of user interface design and testing for Open Source software, a rapidly emerging field that lacks many of the mechanisms that are commonplace for user interface development within traditional software environments. This is an example of an area where GRAND could contribute new methods that reduce development time and improve the quality of the experience for end-users.

Social Context

Historically a leading-edge new media adopter, Canada stands to benefit by providing better access to education, government, health care, and entertainment for its citizens. A richer multi-cultural environment will also be enabled by social networking, and by access to global information, media-enhanced museums, art galleries, and cultural archives that extend beyond the walls of the physical institutions to greatly enhance our understanding of our past, our present, and our future. Research to be conducted in GRAND is focused on the premise that the technologies and practices of new media, games, graphics, and animation do not exist in a vacuum.

Another area of profound importance to the welfare of Canadians is in the application of digital media, including computer games, to critical issues in health. Applications to health motivate three GRAND projects: *CPRM* — Confronting Pain Redefining Mobility, *GAMFIT* — Gaming for Fitness, and *INCLUDE* — Accessibility of New Media for Disabled, Elderly, and Vulnerable Individuals.

Progress on these projects can benefit millions of Canadians. *CPRM* is relevant to the one in five Canadians who suffer from persistent, chronic pain (Boulanger, 2007). According to the Canadian Pain Coalition, chronic pain is a pressing "silent epidemic." Those who have chronic pain suffer from progressive rates of immobility, social isolation, disability, depression, and unemployment. *CPRM* offers new ways to treat, manage, and cope with chronic pain, initially among those who are 60 years old and older. This research closely relates to other projects in terms of accessibility, mobility, aging, and wellness.

GAMFIT's primary stakeholder group is the approximately one in two adults in industrialized countries who are physically inactive, that is, performing less physical activity than required to derive health benefits (Salmon, 2003). This physically inactive lifestyle contributes to dramatically increasing rates of obesity and to related diseases such as Type 2 diabetes. *GAMFIT*'s work on cognitively stimulating games is important to Canada's rapidly aging population. By 2036, 24% of the population will likely be over 65, nearly doubling from 2005. Currently, 1 in 11 seniors suffers from Alzheimer's disease (AD), which suggests that by 2036 there will be on the order of 1 million Canadians suffering from AD unless we develop effective pharmacological or lifestyle interventions. There is increasing evidence that

cognitively stimulating games represent such an intervention (Stern, 2002).

The importance of *INCLUDE* goes beyond compliance with new accessibility legislation discussed in section 6.6, allowing specific groups of individuals to use digital media heretofore inaccessible. Examples include senior citizens living alone, homebound caregivers of individuals with chronic disease, and individuals in long-term hospitalization and isolation.

Letters from our partners Coole Immersive, Saskatchewan in *motion*, and Toronto Rehabilitation Institute suggest that work in this area will also lead to new entrepreneurial ventures that will further strengthen Canada's position as a world leader in gaming technology.

Examples of how the GRAND research program will be grounded in problems of social and economic importance are the *INCLUDE* and *News* projects. *INCLUDE* will develop techniques for building new media applications that provide equal access to those with disabilities. Easily adaptable, multi-modal interfaces will flex to the needs of individual users. News will examine the challenges and opportunities that face Journalism as it moves from traditional print and broadcast to any-time, any-where, any-way new media delivery and participation.

Technological innovations in these areas create opportunities, tensions, and challenges in all aspects of our lives, and interrelate to their social, cultural, economic, political, and legal contexts. An overarching objective of the research is to ask hard questions about how the fruits of the research generated throughout GRAND will be relevant and beneficial to Canadians in all walks of life, as well as to policymakers who need to now how to best adapt the legal and regulatory processes towards these ends.

Information and communications technologies can have profound, and often unsettling effects in areas such as (1) education, teaching, and learning, (2) health and fitness, (3) business and commerce, (4) sustainability and the environment, (5) art, culture and entertainment, and (6) law. In all of these areas, digitalization has serious implications for the continued viability of established business models, the nature and security of employment for those who work in these areas, and for the security and privacy of the end-users of information systems. In each of these areas, information and communications technologies challenge us to rethink our understanding of the roles of intellectual property, jurisdictional boundaries, and other legal concepts.

Exposing Assumptions

The positive social and economic results from investment in new media research are real and achievable, but to assure that benefits accrue to as many Canadians as possible, certain underlying assumptions must be identified and addressed. For example, if Canadians are to gain from using new media in beneficial ways, they must have access to appropriate digital infrastructures, and must have the capacity to engage with the infrastructure in ways that do actually result in socio-economic benefits.

Questions that GRAND projects address include: accessing healthcare information and services, online learning, games, culture, entertainment, and using digital technologies to support democracy, build communities, and encourage sustainability for positive environmental outcomes. Likewise, in order for Canadians to compete on the world stage – with innovative new media, animation, game technologies, products, and services – they must be able to use digital technologies to support collaboration and to reach new customers in new markets.

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entrepreneurs in new media industries.

Short & Long Term Goals

In the short-term, GRAND will facilitate inter-connection among researchers from all across Canada. This will hone existing faculty strengths, foster new research agendas, facilitate new collaborative research initiatives, enrich knowledge, and spur curriculum growth. By strengthening relationships amongst researchers and developing a strong social network, GRAND will build an identity and voice for new media, animation, and games researchers, thereby eliminating some of the intellectual isolation that exists between these disciplines. GRAND will function as a "think tank" that studies how shifts brought by new media translate into emerging technical, creative, and design discourses, aesthetics and practices. These are the short-term gains. The real socio-economic benefits will take place over the medium- and long-term (5-10 years).

The groundwork is already laid. Within five years, GRAND will have built a productive network that joins together industry, society at large, and academia. The links in the network will be of two types: research and people. The research links will be both specific and general. Long-term projects with GRAND partners will result in new knowledge, HQP development, and knowledge & technology exchange & exploitation. Widespread dissemination of research results within both scholarly and popular venues will ensure general uptake of GRAND research. Links through people and organizations will build the lasting relationships needed to jointly address contemporary new media issues and foster robust and healthy production of HQP able to contribute to this rapidly changing, knowledge-intensive sector.

6.3 Proposed Research

The thematic organization of the research program acknowledges the equal importance of the NSERC and SSHRC components of the research. To maintain a proper balance, there will be a DIRECTOR FOR SCIENCE AND ENGINEERING RESEARCH and a DIRECTOR FOR SOCIAL SCIENCES AND HUMANITIES RESEARCH. At any time, one will serve as the SCIENTIFIC DIRECTOR and CEO for the Network.

As a further guarantee that the research program will strike the appropriate balance between its SSHRC and NSERC components, the "classic" hierarchical organization of subprojects within projects within themes will instead be a 5x30x50 matrix of five THEMES. Thirty PROJECTS span the themes, and 50 NETWORK INVESTIGATORS each participate in roughly three projects. (For math buffs: 30 projects each, with an average of five Network Investigators, equals 150 project-investigators; the product, if one multiplies 50 Network Investigators by three projects each, is again 150 project-investigators.)

The decision to not have projects contained strictly within themes was a deliberate choice made after considering a number of factors. The primary reason was to avoid the "silo" effect, where each theme focuses too narrowly on a particular aspect of the research but misses opportunities to bridge across themes. By bridging across themes, we will find more fully integrated solutions to problems that may require significant expertise from multiple disciplines.

Unlike some NCE programs that have loosely connected themes with narrow interfaces between them, the nature of new media research, and the tight coupling between every aspect of animation and games components, dictates that researchers be able to apply their specialized knowledge across the board wherever they are needed within the

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Chair: TBD

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R. Woodbury

Research Partnerships
Director:
V. Diciccio

Tech Transfer & Commercialization
Director:
A. Livingstone

GRAND NCE Staff
Admin, financial, communications, clerical, technical

Private/Public Sector Partners & Receptors
Industry, Government Organizations, Non-Profits

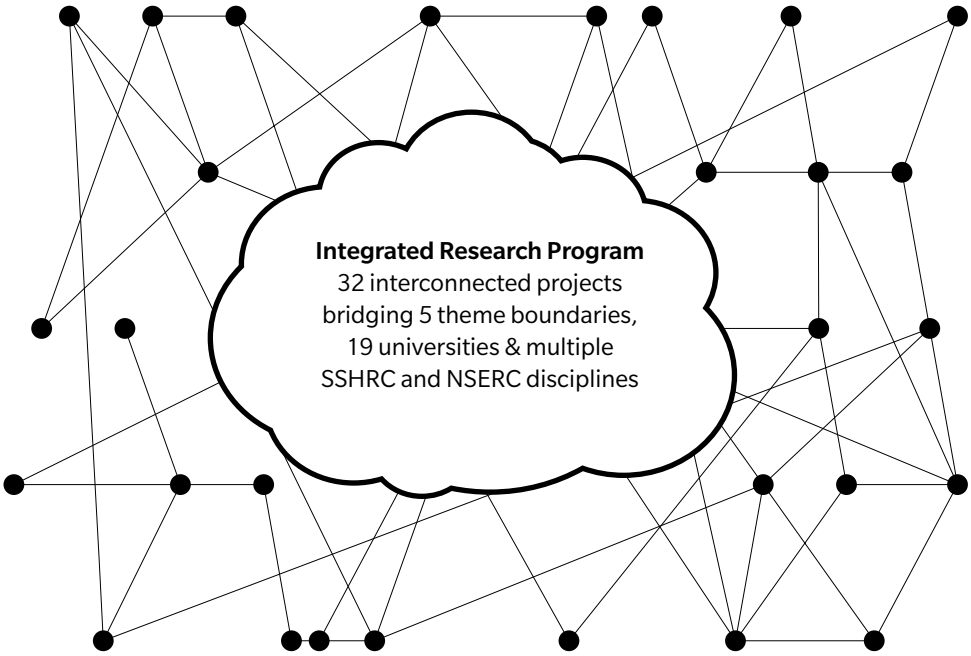
Theme 1
C. Middleton & D. Gromala
New media challenges & opportunities

Theme 2
J. Schaeffer & R. Mandryk
Games & interactive simulation

Theme 3
W. Heidrich & P. Poulin
Animation, graphics & imaging

Theme 4
S. Trosow & E. Toms
Social, legal, economic & cultural perspectives

Theme 5
J. Cooperstock & C. Gutwin
Enabling technologies & methodologies



Researchers	Postdoctoral Fellows	Technicians & Research Staff	Students
50	12	5	140
Network Investigators	NSERC and SSHRC	FTE	PhD, MSc/MA, BSc/BA

FIGURE 1: THE GRAND ORGANIZATIONAL CHART

There has been much discussion in the past about the "information highway'' and various metaphors about on-ramps, traffic congestion, and the like. These are real issues, but they are issues that are largely behind us. It is true that many challenges remain, even in Canada, to universal access to the physical infrastructure on which new media relies. But decades of telecommunications research, along with recent significant advances in wireless technologies, have paved the way, leaving us facing four important questions: Which applications will use this infrastructure? How will those applications be developed? What impact will deploying those applications have on our social, legal, economic, and cultural lives? And when can we expect these changes to take place?

GRAND responds directly to the challenges of re-establishing Canada as a leading digital economy –an objective recently reiterated by federal Industry Minister Tony Clement – and acknowledges that a multimedia-based, digital economy has much higher infrastructure requirements than earlier, primarily text-centric views of the information society.

First, GRAND will benefit existing Canadian media production communities by advancing and enhancing exposure to experiential media, while minimizing risk by experimenting with the technology within a Canada-wide testbed. GRAND will provide excellent opportunities to investigate new media platforms, designs and applications, software, interfaces, and technologies for graphics, animation, simulation, games, and a broad range of new media. GRAND will enable co-operation among researchers in Canada to exchange ideas and to leverage their technical strength. The team's technical strengths in engineering, computer science, sociology, media production, journalism, management, design, and education – as well as the experience and expertise of industrial partners – will be fully leveraged.

Second, GRAND will provide new knowledge about practices of new media creation, which will be essential in the evolution of new job creation as well as the establishment of a digital, new media cultural production industry.

NEW HQP Opportunities

Funding of GRAND will go a long way in developing a national reputation in Canada for new media research and creation across the fullest possible spectrum, and will create the social networks necessary to develop and maintain Canadian leadership in this industry. Having access to deep talent pools in Canada is a key factor supporting industry growth. New training programs established through the collaboration of institutes of higher education with industry will guarantee that talent. These programs will provide skills that are both technical and creative. According to the 2009 report prepared by the Entertainment Software Association of Canada, for Canada to maintain its current competitive advantage, educational institutions will need to create more programs that bring together hard programming skills with artistic and creative skills.

The impact of government policy and support is widely cited as being a critical factor in the success achieved in the games industry in Quebec. The critical mass and international reputation of game development in Quebec is almost universally attributed to prescient and timely policies of the provincial government. Its attractive labor tax credits brought Ubisoft to Montreal in 1997 (ESAC, 2009). Many countries that rank ahead of Canada provide similar economic support and have had comprehensive digital media economy policies in place for many years.

Our provincial partner, the British Columbia Innovation Council, will be working with us to accelerate commercialization opportunities and develop a better understanding of the role of

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research program. This is not possible without an agile organizational structure.

The matrix organization of themes and projects is ideal for achieving this agility. The five themes provide a unified conceptual framework on which the entire research program is based. Each theme has a THEME LEADER and a THEME CO-LEADER. Within this scaffolding, the approximately 30 projects provide a coherent research program that easily integrates the true collaboration that is absolutely essential to achieving the goals of the GRAND NCE. Most projects span several themes; all will produce results used by other projects to achieve a solution-oriented, multidisciplinary research program. Each project addresses a distinct set of research questions that arise from the conceptual framework and that have the potential to develop new knowledge and techniques that can be successfully transferred to and exploited by the non-academic partners.

In many cases, the research will produce new insights that inform public policy and decision-making; the research will be conducted from multiple cultural perspectives. This cannot be done without having both SSHRC and NSERC components in many of the projects, hence the non-hierarchical matrix of themes and projects. The pairing of a DIRECTOR FOR SOCIAL SCIENCES AND HUMANITIES RESEARCH with a DIRECTOR FOR SCIENCE AND ENGINEERING RESEARCH further emphasizes the importance of an integrated, multidisciplinary approach to research. A third researcher will serve as DIRECTOR FOR ART AND DESIGN PRACTICE. This ensures that the research program is fully informed by current thinking in the art and design communities, both from an academic perspective and from the perspective of the various receptor communities with the broad spectrum of Canada's creative industries. These three key researchers will be responsible for maintaining an appropriate balance within the research continuum in terms of disciplines and between pure and applied research, leading to solutions that can be exploited by network partners and other receptors.

Key Research Personnel

The SCIENTIFIC DIRECTOR is DR. KELLOGG BOOTH, Professor of Computer Science at UBC. Working in computer graphics and human-computer interaction since 1968, he has extensive research and administrative experience leading distributed, multidisciplinary teams. He publishes extensively on human-computer interaction, visualization, computer graphics, user interface design, and collaboration technology.

DR. ABBY GOODRUM is DIRECTOR FOR SOCIAL SCIENCE AND HUMANITIES RESEARCH. She is the Velma Rogers Graham Chair in News, Media and Technology and Associate Professor in the Schools of Journalism and Management at Ryerson University, and in the joint program in Communication & Culture at York University. Her research in Media Informatics intersects media content, media technology and media use. Exploring image/video retrieval to identify and exploit image attributes for the practice of journalism, she couples conceptual and theoretical analysis with empirical research.

DR. ROBERT WOODBURY is DIRECTOR FOR ART AND DESIGN PRACTICE. He is Professor in the School of Interactive Arts and Technology at Simon Fraser University. Trained as an architect, he has graduate degrees in computational design, and extensive experience in the theory and practice of design with research interests in modeling, visualization, visual analytics, and research methods for design.

DR. CATHERINE MIDDLETON is THEME 1 LEADER. She holds the Canada Research Chair in Communication Technologies in the Information

Society at Ryerson University's Ted Rogers School of Information Technology Management. Her research focuses on adoption of new communication technologies, with specific interests in mobile devices and fixed and wireless broadband networks. She is also interested in how Canadians use (or don't use) the Internet in their daily lives. Her research is revealing shortcomings in current Canadian approaches to telecommunications policy development.

DR. DIANE GROMALA is THEME 1 CO-LEADER. She is Canada Research Chair and Associate Professor in the School of Interactive Arts and Technology at Simon Fraser University. Her research as an artist, designer, and theorist has been at the forefront of emerging technology, from the earliest forms of multimedia at Apple Computer to artistic and explorations of virtual reality. Her current research work on physiological computing and pain is used in over 20 hospitals and clinics worldwide.

DR. JONATHAN SCHAEFFER is THEME 2 LEADER. He is Canada Research and iCORE Chair and Professor of Computer Science at the University of Alberta. For over 30 years, he has developed and applied innovative artificial intelligence techniques in games-related research. He authored the checkers program *Chinook*, the first computer program to win a human world championship in *any* game. He successfully commercialized this technology in *Poker Academy* and he has developed technology that shipped in three commercial games for Relic Entertainment and BioWare. He is a Fellow of the Association for the Advancement of Artificial Intelligence, co-founder of WestGrid and Compute Canada, and a former NSERC E.W.R. Steacie Fellow.

DR. REGAN MANDRYK is THEME 2 CO-LEADER. She is an NSERC University Faculty Award recipient and Assistant Professor of Computer Science at the University of Saskatchewan. Her multidisciplinary background enabled her innovative research on using physiology to mathematically model emotion during computer game play. A rising academic star, her research focuses on modeling user engagement with games, designing interaction techniques and games for emerging technologies, and creating persuasive games.

DR. WOLFGANG HEIDRICH is THEME 3 LEADER. He is Dolby Research Chair and Associate Professor of Computer Science at UBC. His research is in computer graphics and aspects of computer vision, especially image-based modeling and acquisition. His current focus is on high-dynamic range imaging and display, image-based measurements, photorealism and global illumination, as well as interactive rendering using graphics hardware, and image-based rendering techniques.

DR. PIERRE POULIN is THEME 3 CO-LEADER. He is Professor of Computer Science at Université de Montréal. His graphics and animation research covers image synthesis, illumination, image-based modeling and rendering, simulation of physical and natural phenomena, and real-time rendering. Co-founder of SIGGRAPH Montréal, he serves on the editorial board of the francophone journal REFIG, and has served on program committees of more than 30 international conferences. His research has been used by Montreal companies including Electronic Arts, Taarna Studios, and Autodesk for game, animation, and computer-aided design software.

DR. SAM TROSOW is THEME 4 LEADER. He is Associate Professor in Law and in Information & Media Studies at the University of Western Ontario. His research focuses on the intersections among law, technology, and social theory, and on how these factors come together to inform public policy analysis. Formerly a practicing lawyer in California and a Law Librarian at UC Berkeley, Trosow brings to his research and teaching a strong foundation in professional practices in law, administration, and librarianship, which informs his work in a

wide range of information policy issues including intellectual property, privacy, censorship and intellectual freedom, and international trade in services and IP. He is internationally known for his work on copyright and the changing face of intellectual property rights in the digital age.

DR. ELAINE TOMS is THEME 4 CO-LEADER. She is Canada Research Chair and Associate Professor of Business Administration and Computer Science at Dalhousie. She examines how information systems fail users by understanding how people work with and use information, and by evaluating novel tools for accessing information. Her research on how people browse digital newspapers, and the integration of user context in search engines, has advanced our understanding of new media. Current research focuses on social, economic, and cultural factors such as rich media webcasting interfaces, workplace interruptions, and measuring reputation, and engagement in on-line settings.

DR. JEREMY COOPERSTOCK is THEME 5 LEADER. He is Associate Professor of Electrical and Computer Engineering at McGill University. A researcher in the Centre for Intelligent Machines and the Centre for Interdisciplinary Research in Music Media and Technology, he directs the Shared Reality Lab and the technical development of the Ultra-Videoconferencing system, recognized for Most Innovative Use of New Technology by ACM/IEEE Supercomputing and a Distinction Award from the Audio Engineering Society. His research focuses on computer mediation facilitate high-fidelity human communication, and on underlying technologies such as the Intelligent Classroom, a videoconference environment that reacts intelligently to activity of users.

DR. CARL GUTWIN is THEME 5 CO-LEADER. He is Canada Research Chair and Professor of Computer Science at the University of Saskatchewan. Director of the Interaction Lab, his research focus is computer-supported cooperative work, information visualization, and information retrieval. He is internationally known for his groupware software development kits, and for evaluative studies of collaboration tools.

The Research Team

In addition to the 50 NETWORK INVESTIGATORS who are co-applicants, up to 40 COLLABORATING RESEARCHERS will participate in the research program. They are from a diverse set of disciplines, including: animation, business, cultural studies, computer science, electrical and computer engineering, education, film, fine art, human-computer interaction, interactive arts and technology, journalism, law, library/information/archival sciences, music, psychology, sociology, and theatre. Among these will be researchers from art and design universities, who bring a unique perspective on the social, artistic, and cultural facets of new media. The mixing of researchers from the social sciences and the humanities with those from science and engineering is a distinct strength of the research team, one that will be mobilized in a network-wide, multidisciplinary research program focused on solutions-based approaches.

Problems, Challenges and Opportunities

The technologies and practices of new media, animation, and games do not exist in a vacuum –they intertwine with each other. Because they create opportunities, tensions, and challenges in all aspects of our lives, they must be examined as an integral part of the research. One of the biggest challenges for animation, games, and special effects is content creation. This encompasses geometric models of objects or scenes, motion for virtual humans and other characters, character behavior, and appearance. Computer graphics and human-computer interaction are required for applications that support interactive creation and access to media content, and for advances in

media data management, information retrieval, and data visualization. Networks and distributed systems are also necessary enabling technologies, and privacy, security, and information filtering are important to support users' desires for choice and personalization.

Many questions have social, legal, economic, and cultural perspectives that cannot be divorced from their technical solutions. This requires innovative and multidisciplinary approaches, as well as a research environment that facilitates information exchange between communities looking at new media problems from different disciplinary perspectives: How are new media technologies changing workflows? How is aesthetic output influenced by these changes? What creative endeavors are hindered, enhanced, or reconfigured by new media technology? How have new media technologies over the past decade changed the ways people entertain, inform, and educate themselves?

Adoption and use of new technologies has dramatically altered the way that content is created, shared, accessed, stored, managed and re-purposed. This has had wide reaching impact on the quantity of content available and the diversity of distribution channels, interfaces and work processes. These in turn have exerted immense influence on cultural, legal, and business aspects of multimedia creation and use.

Conceptual Framework for the Proposed Research Program

We briefly describe the five themes and the state-of-the-art and new challenges for each. We then describe projects that build upon the framework, and how each project contributes to the goals of the Network and to the various themes.

Theme 1: New Media Challenges and Opportunities (nMEDIA)

Catherine Middleton (TL), Diane Gromala (TCL)

The underlying concept in *nMedia* is the development of new ways to create and integrate content directed towards one or more modalities of human perception. New media not only affect lifestyles and entertainment, but also impact the ways people interact with business, governments, healthcare providers, and with each other as an integral part of everyday life. To improve Canadians' capacities to engage with, and to benefit from new media, the theme's researchers will identify, develop, and evaluate the tools, skills, and methodologies needed to advance the next generation of new media applications and distribution channels.

The full range of new media has yet to be defined. Traditional media such as music, film, photography, sculpture, theater, the written and spoken word, performance and installation art are all morphing as digital technology presents new opportunities. Emerging hybrids blur distinctions and pose new challenges. Delivery and distribution options, including mobile platforms, continue to emerge.

The promise of ubiquitous access brings with it questions surrounding the provenance, trustworthiness, and archival nature of new media that will necessitate social and political dialogues based on deep understandings of the many conflicting and often tangled interdependencies inherent in the technology. Innovative and multidisciplinary approaches to the study of cultural industries, media production, human-media interaction, and media management are required, in a research context that can facilitate extended, ongoing information exchange among communities looking at new media problems from different disciplinary perspectives.

Development of new media technologies over the past ten years has changed the way that people have entertained, informed, and educated themselves. In many cases, the adoption and use of these new technologies has dramatically altered the way that content is created, shared, experienced, stored, managed, and repurposed. We have seen wide reaching impact, not only in the quantity of content available, but also in the diversity of distribution channels, interfaces, and work processes. These in turn have exerted immense influence on cultural, legal, and business aspects of multimedia creation and use, as new media experiences evolve beyond TV and computer screens to allow fully interactive physical, emotional, and sensory engagement.

In spite of the enormous effect that new media technologies have on users, human behaviour and human-media interaction are often not considered in the technologies' design. Moreover, research in human-media interaction (or, more often, its enabler: human-computer interaction) has not taken place within an environment that tracks the entire life cycle of media content, from production to archiving. This has resulted in media research that focuses on technology R&D alone, and in human interaction studies that focus on content only as a product for consumption after its creation, or only as an artifact for retrieval.

The Grand Challenges in new media research are complex and can only be addressed within an environment that provides opportunities for multidisciplinary exploration across the entire life cycle of media content. An innovative approach to media research that explores human interaction with media from its genesis, and that tracks the changing interactions among users is essential, as content is created, distributed, experienced, understood, shared, archived, and then repurposed and reshaped over time. This requires research incorporating diverse community perspectives from the arts, social sciences, computer science, engineering, and humanities. It requires a flexible research environment that mimics everyday life yet is simultaneously production studio, screening room, interaction laboratory, and digital library – a crucible where the requirements and capabilities of each discipline can inform, and be informed by, the others. This research will have direct application to the design and accessibility of innovative digital media environments, interfaces, and systems, as well as to the processes for the management of media assets and of media production, benefiting the growing Canadian media economy.

Research activities in the *nMedia* theme are clustered around two broad sub-themes: New Media Creation and New Media Analysis.

New Media Creation

nMedia focuses on new media creative processes in the context of a distributed workflow that is mediated by social practices in global, high-speed networks. At one level, the research will address the creative process itself, analyzing activities (*HDVID*), workflows, and requirements for successful collaboration in pre-production design and planning, in production and post-production, and in distribution. At another level, the research will address the infrastructure (*DINS*), knowledge, processes, and protocols (*PERUI*) necessary to support such activities effectively in a distributed, high-speed, socially networked environment.

These research initiatives focus on the need to develop a global cyber-infrastructure suitable for the professional production, distribution, display of, and interaction with digital media. Of particular interest is developing an understanding of the relationship between technological innovation and production: How will new media change formal production and post-production work flows (*MEOW*)? How is aesthetic output influenced by these changes (*AESTHVIS*)? What creative

endeavors are hindered or enhanced by new media technologies? How are the roles of traditional media and cultural institutions such as journalism (*NEWS*), museums, libraries, archives, and art galleries, changing or being changed by new media technologies, and how are citizens becoming more engaged in production?

New Media Analysis

Research in *nMedia* focuses on how users consume, represent, select, and retrieve new media and its derivatives and how this should inform creation, delivery, archiving, retrieval, and repurposing (*DIGILAB*). At one level, it addresses viewers/consumers/users and their reactions and consumer behaviour. At another level, the research addresses the infrastructure, processes, and protocols needed to optimize consumption and to enable engagement and interaction with new media (*NAVEL*). Research initiatives in this theme are focused on how humans acquire, experience, and interact with media in various situations and environments, how they conceptualize their needs for media, and how they internally represent media. Research in this area will draw upon research in audience studies, information-seeking behaviour, and human-computer interaction. It will distinguish itself by its broader coverage of the consumption of media for entertainment, and to enhance physical well-being (*GAMFIT, CPRM*) as well as for information (*NGAIA*). As such, interactions under investigation will extend beyond human-computer interaction to include: the study of human engagement and reactions to new media in theatres, galleries, museums, libraries, homes, and on the street (*PLAYPR*) as well as the study of human engagement across diverse delivery and consumption environments, such as personal mobile devices.

The unifying vision of the *nMedia* theme is to foster emerging new media research across diverse research communities with diverse methodologies. GRAND's multiply webbed network will enable the flexibility necessary in conceptualizing research goals and approaches, leveraging new disciplinary perspectives, and exploring emergent, unanticipated areas of media interaction research.

Theme 2: Games and Interactive Simulation (GamSim)

Jonathan Schaeffer (TL), Regan Mandryk (TCL)

Computer game production has become an important global industry worth C$50 billion annually, historically experiencing double-digit annual growth. Canada is an important global leader in this industry, with an estimated 20% of the top-selling games in North America originating in Canada. In fact, Canada is home to two of the largest game development studios in the world – Electronic Arts (Burnaby) and Ubisoft (Montreal). British Columbia alone has more than 180 game companies. BioWare (a subsidiary of Electronic Arts) is located in Edmonton and is the industry leader in story-based games: nearly all of its releases have received critical acclaim and achieved financial success. The impact of gaming technology extends beyond the entertainment industry and youth culture. Serious applications use interactive gaming technologies to improve education and training, and to enable political commentary and social change. For example, new serious games and simulations are expected to transform how doctors and nurses train in medical ethics, cultural competencies, and the conducting of patient interviews and healthcare assessments.

We use the term 'game' to refer to video games, such as those played on a computer or video console, as well as online games, multiplayer games, and mobile games. Indeed, almost all forms of new media can be used for gaming or in support of gaming. In this theme, we will use games to make

progress in Game Development itself, creating the technology to support the game-development process and to enhance the gaming experience in education – including K-12, university, and skills development – and in applications, as games are a fundamental technology in many areas, including computer science, economics, biology, and defense.

The *GamSim* theme will have a transformative impact across a broad range of fields, and will ensure that Canada leads the revolution in gaming technologies. The notion that game development is all done by computer programmers is out of date: modern games are built by multidisciplinary teams; computer programmers typically comprising less than 20% of the team. Advances in gaming and simulation will require not just the skills of computer scientists, but also of interface designers, creative writers, artists, musicians, and domain experts. In cooperation with industry partners, we will bring these groups together to serve as a catalyst for creating new technologies to advance the state of the art in gaming and simulation, building proof-of-concept games (which may themselves have commercial value), and developing novel components to give Canadian game companies a competitive edge. Critical to our success is a multidisciplinary approach.

The development of complete games is a key element of our proposal because games research cannot be properly evaluated outside of the context of a finished game, but creating complete games for every avenue we explore is well beyond the scope of our research. Thus, we will also build prototypes and test-bed environments for experimentation and assessment. These prototypes will be useful to our partners in the game industry.

The *GamSim* theme covers a broad range of research in the construction, use, and understanding of games. The following highlights each of the main areas under investigation.

Game Development Technologies

Modern games require the use of numerous technologies across a wide variety of fields. A massively multiplayer online role-playing game such as the World of Warcraft, a game with over 11 million subscribers – is a good example. These games exist as self-contained worlds where hundreds or thousands of players interact, socialize, and in almost every sense, lead lives parallel to those in the "real" world. Recent research in human-computer interaction (HCI) highlights the importance of careful game design when the goal is to encourage active collaboration and competition. As part of the motivation of data-driven content generation, understanding the ways that game players interact in virtual worlds (*EOVW*) is critical for game developers to refine and enrich the game playing experience. This is but one benefit that HCI brings to gaming (*VIRTPRES*). Another is the design of appropriate evaluation methods (*AFEVAL*) for evaluating the usability and playability of games.

Intelligent and adaptive user interfaces are also critical to new generation games. An example is modeling and adapting to game players' complex cognitive processes and emotional states (*SIMUL*). This is an exciting area of overlap between HCI and artificial intelligence, with intriguing applications to problems with high social relevance such as physical fitness (*GAMFIT*). Enhanced artificial intelligence technology is regarded by industry as essential for developing the next generation of computer simulations and games (*MCSIG*) and for enhancing the believability of non-player character behaviors in story-based games (*BELIEVE*), such as those created by our partner Bioware – the world leader in digital story-based games.

Education

Another important research direction examines the divide between entertaining games and educational games. Modern games are

characterized by their capacity to capture a player's attention for hours on end and are generally considered to be entertaining. In contrast, educational games are often described as boring. Research within GRAND will gain a better understanding of student learning in the context of games, building prototyping environments for creating entertaining educational games and assessing the benefits of computer-game-supported learning (*DIGLT*).

One example is the role of simulation in training the next generation of surgeons. There is strong evidence that surgeons tend to perform better after playing video games. The question is not *whether* interactive multimedia exercises improve surgical performance, but rather how multi-modal training can best be designed for a range of surgical training. A variety of simulators are today available to train surgeons, including trainers that provide realistic haptic feedback, and Virtual Reality (VR) or Augmented Reality (AR) simulators (a combination of virtual simulation with real-world physical objects). Research on understanding these tools and their effect on surgical training is fundamental to enhancing and developing the pedagogical value of the experience, and is sorely needed but has not yet been fully conducted with the necessary rigor. The project (*HLTHSIM*) will do just this, combining medical knowledge with research expertise in experimental psychology and cognitive science.

Applications

Games are most often associated with recreation; however, the use of games is much more pervasive in research and society. GRAND has several projects that involve building games to support societal benefits. One application area is to develop and evaluate games for people with sensory and motor disabilities (*INCLUDE*). The input, output and processing requirements and interpersonal interactions in game play include elements of a user's physical, perceptual and cognitive processes that may have certain limitations. It is important to develop systems that support these limitations and to use an inclusive development and evaluation framework.

Another important area of social concern that can benefit from game research is sustainability, as games can be used to train people to modify their energy usage (*HCTSL*). Living in a sustainable house has been described as "piloting a ship," demanding constant monitoring, course correction and reconfiguration, and strategies for understanding how occupants' behaviors interact with desired outcomes such as a reduced ecological footprint – in short, learning to play a sophisticated game.

Theme 3: Animation, Graphics, and Imaging (AnImage)

Wolfgang Heidrich (TL), Pierre Poulin (TCL)

The artistic and technological components of animation range from traditional techniques to leading edge digital tools used for creating animated content and special effects for film, video, games, and websites. One of the biggest challenges in animation and games is content creation. This encompasses static and animated geometric models of objects or scenes, appearance properties, physical properties, motion for virtual humans and other characters, and character behaviour and believability, to name a few. These are commonly designed by expert artists and programmers essentially "by hand" in an ad hoc process with tools that provide little more than raw capabilities. Because this is time and labor-intensive, it sets up barriers to scalability for companies and also to the possibility of amateurs engaging in creation.

Note, for example, that the development time and budget of a major game now is in the same range as the biggest films. In both games and film, the

economics of this process frustrates the demand to go further. In contrast, the emergence of a Web 2.0 demonstrates the desire of non-experts to engage in content creation. As these users create, in essence, a culture of consumer-as-creator – new media (such as video blogs) and creative/participatory games (such as Spore) become a major cultural force. In response, the field of computer graphics research has begun to shift from investigating raw capabilities towards more scalable methods to create content and build interactive worlds.

GRAND's *AnImage* theme will not only tackle the question of *how* to create content, but will also question *what* to create, including ways to intuitively guide creators toward the details that matter. This is not just a question of economic scalability, but furthers the impact of this research in terms of social foundations and quality of life by integrating interactions with other GRAND themes. Areas of focus include the following.

Animation

A prominent approach for generating animation in both games and movie special effects is to simulate the laws of physics in order to generate realistic results. This approach is suitable for generating a wide range of different effects, ranging from the simulation of natural phenomena (such as liquids, gases, and fire) to human (and other) characters, as well as passively deforming objects such as garments or plants. A central research topic is the analysis of human motions (*MOTION*) and understanding how these can be controlled and edited in physical simulation environments (*CAPSIM*). Another focus is the augmentation of simulators for fluids and other natural phenomena with models derived from real-world observations.

A complementary approach to physical simulation is evolving in the form of methods for effectively exploiting cameras and other sensors to acquire or measure real-world motions or performances. The goal is to extend traditional motion capture to include full characters, with garments and detailed characteristics such as facial models and hair, as well as to capture natural phenomena such as liquids interacting with each other and with solids. The captured data will then be analyzed to derive computational models for phenomena that are difficult to simulate (*PROMO*). The resulting models can then be integrated into simulation frameworks. This goal involves subfields such as computational photography (extending the capability of cameras to capture more data), vision-based model reconstruction, and learning compact-but-flexible models of human motion from captured motion and deformation data.

Scalable Content Generation

Another topic of this theme will be the development of algorithms that leverage computational power in order to extend the ability of a user to create compelling animation, character behaviours, geometric models, and so forth. A central technique for generating such scalable models is procedural modeling (*PROMO*). Understanding how to control procedural modeling and to generalize it to different scene contexts is key to the automatic creation of complex, detailed, and potentially infinite worlds. Moreover, by augmenting procedural modeling to estimate visual and game-play impacts of scene elements not yet created, procedural modeling allows to handle scene elements on demand and at the appropriate level for any viewpoint.

Effective and Intelligent User Interfaces

The work on simulation and capture is complemented by research on novel user interfaces for manipulating or creating content. Of particular interest are new ideas in sketch-based modeling, interfaces using the sense of touch (*SKETCH*),

and intelligent editing tools. Examples include tools that can automatically segment a model into semantically meaningful parts, so that an edit in one region can propagate to the rest of the model appropriately. Design of effective user interfaces is also crucial to provide user-control to procedural modeling, allowing some creative freedom in this traditionally one-way scene generation. These interfaces also consider using real data taken from photos, and using its extracted information to control content creation, or motion and deformation.

Human Perception

Finally, it is mandatory to understand the parts of a digital experience as they are perceived by humans in the context of different game genres or films. For example, the limitations of the human visual system must inform decisions of which effects to simulate, capture, or design interactively. This understanding is crucial for developing compelling animations, virtual worlds, and special effects that can communicate an artist's intent more effectively. It is also critical to the inference of meaningful semantics in geometry and motion. The perceptual research in this theme will therefore be tightly integrated with the development of novel user interfaces (*AMBAID*), and new capture and simulation techniques.

This theme will therefore not only result in new knowledge and technology, but also in new visions of creating content that is adaptable to the desires of a scene designer or animator. As such, providing mechanisms for effective feedback and for editing will be a fundamental aspect of our approach.

Theme 4: Social, Legal, Economic and Cultural Perspectives (SocLeg)

Samuel Trosow (TL), Elaine Toms (TCL)

Research conducted in the *SocLeg* theme focuses on the need to recognize that the technologies and practices of new media, games, graphics and animation do not exist in a vacuum. Technological innovations in these areas create opportunities, tensions, and challenges in all aspects of our lives and are interrelated with their social, cultural, economic, political and legal contexts. An overarching objective of the research is to ask hard questions about how the fruits of the research generated throughout the GRAND project will be relevant and beneficial to Canadians in all walks of life, as well as how policymakers could best adopt legal and regulatory processes towards these ends.

Information and communications technologies can have profound, and often unsettling effects in areas such as education, teaching and learning, health and fitness, business and commerce, sustainability and the environment, art and culture, entertainment, and in the law. In all of these fields, digitalization has serious implications for: the continued viability of established business models about nature and security of employment for those who work in these areas, and for the security and privacy of the end-users of information systems. In all of these areas, information and communications technologies are challenging us to rethink how we understand the roles of intellectual property, jurisdictional boundaries, and other legal concepts.

Education and Learning

New media, graphics, and animation are changing educational process by providing new mechanisms for knowledge discovery and presentation, both in traditional institutional settings and for independent, life-long learners. These advances are accompanied by the need for changes in

educational practices and processes to insure that everyone involved in the educational process – teachers, students, administrators, researchers, parents, and librarians – are able to take full advantage of the new learning opportunities enabled by new media in an equitable manner. Some of the projects concerned with education, teaching, and learning include *assessment methodologies (EOVW), pedagogical design and interactive media (DIGLT), next generation information appliances (NGAIA), and shared displays (SHRDSP)*.

Intellectual Property

Rapid technological changes are forcing a rethinking in our understanding of the roles of copyright, patents, trademarks and other forms intellectual property. Open source and transnational co-development and deployment raise issues of what constitutes ownership and where jurisdictional boundaries lie. The intellectual property policy arena is where some of the strongest challenges and most acute tensions in the digital environment are becoming are becoming evident.

Privacy and Security

Privacy and security are increasingly implicated by emerging information and communication technologies which have the potential to capture personal information about users of information systems and enable other forms of surveillance. Given Canada's strong regulatory regime in the area personal privacy protections, it is important for new systems to be designed with privacy and security issues in mind. Such Privacy Enhancing Technologies (PETs) need to be considered at all stages of the design process. These issues will be addressed by the *Usable Privacy and Security in Online Environments* (*PRIVNM*) project.

Business and Commerce

Digital networks and the new interconnectivity is creating new business models and markets, but at the expense of traditional notions of trust, reputation, and accountability. Fundamental changes in banking and retail practices are transforming not only how commerce is conducted, but also expectations of privacy and confidentiality that cannot always be aligned. Emerging information and communications technologies are challenging established business models, notably in the software, entertainment and publishing industries.

Sustainability and the Environment

The *Human-Centered Technologies for Sustainable Living* (*HCTSL*) project will seek to provide residents with better information tools and interfaces for making decisions about energy use, guidelines on the design and location of particular displays and control systems in the home, and validated processes for incorporating occupant energy awareness into new home design and existing home retrofits.

Arts and Culture

The rapid infusion of new information and communications technologies are transforming the traditional relationships between producers and consumers of cultural goods, and between producers/creators and consumers/users. In addition, the creation, ownership and distribution of cultural products is creating special challenges for the traditional copyright system.

Health and Fitness

New applications in graphics, animation, and new media are enabling patient-centered approaches to healthcare that promote prevention-based strategies. These strategies are enabled by access

to rich media information derived from evidence-based medical research and publicly available health information resources. Moreover, healthcare professionals increasingly rely on information technology for training (*HLTHSIM*), including immersive surgical simulation environments, as well as for managing patient care in a variety of settings including the home as well as traditional institutions. Projects concerned with medicine, health, and fitness include: *Confronting Pain: Redefining Mobility* (*CPRM*), and *Accessibility* (*INCLUDE*).

Labor and the Workplace

Digitalization is creating fundamental shifts in the organization of work processes and in the workplace itself. Thus, the implications and tensions of emerging digital labour need to be better addressed in practice and policy. While new digital technologies may define the workplace in terms of greater surveillance and control, at the same time, new possibilities for greater collaboration are enabled from digital innovation. The *Digital Labour: Authors, Institutions and the New Media* (*DIGILAB*) project will address these issues, initially in the domains of the game production, music production, education, and libraries.

A consistent thread running through all of these interconnected areas are concerns with accessibility for all of society (DINS), and the need for the legal and social systems and its institutions and infrastructures to keep up with the rapid pace of technological, social, cultural and economic changes that are increasingly evident. An overarching objective of the research in this theme will be to generate information which is relevant to policy-makers and stakeholders in the policy process as they grapple with these challenges.

Theme 5: Enabling Technologies and Methodologies (TechMeth)

Jeremy Cooperstock (TL), Carl Gutwin (TCL)

In the last few decades, our society has leapt from passive consumers of pre-packaged information and entertainment to more active participants in the production, selection, and consumption of such content. At the heart of this shift, the transformative media applications that have become commonplace in recent years (such as online games, electronic mail, voice over IP, Internet search, wikis, media-sharing sites, mobile devices, and social networking systems) were possible only because of numerous technological advances. These technologies – including standardized network protocols, new rendering algorithms, publicly available application programming interfaces (APIs), methods for evaluating web usability, and the increasing availability of broadband connectivity – enable designers, developers, and content producers to capitalize on the potential of interactive media-rich applications. The areas of computer graphics, human-computer interaction, networking and distributed systems, and information retrieval represent important infrastructural areas that support the interactive access to media content by a large population of users.

Over the coming years, we expect that the amount of geographically distributed digital media content, already massive, will continue to increase. Media data will be stored in machines with a wide variety of capabilities, from personal digital assistants to laptop computers to powerful servers. The capability of database management systems used will also be wide-ranging. Next, we anticipate growing interest in service models with increased support for choice, personalization, and differentiation. In addition, users will demand improved levels of privacy, security, and information filtering. Finally, important issues

in new media research include high quality presentation for images, audio, and video; support for a range of end-user equipment, from cell phones and laptops to high definition displays; high quality animation and multi-user online games; scalable system architectures that can support additional users without degradation in performance; and quality of user experience.

Building on past successes and looking forward to these trends, the goal of GRAND's *TechMeth* theme is to identify the necessary advances in architectures, techniques, methods, and tools that will enable the next generation of graphics, animation, and new media applications.

Although the existing infrastructure has supported an impressive number of developments in these areas, applications are reaching hard limits in all of the projects proposed for this NCE. New technologies are clearly needed. For example, as video games become increasingly realistic, the limitations of current techniques for computer control of characters is evident; the game industry requires new solutions to the problems of creating and controlling believable, natural characters. Similarly, interaction between distributed musicians or actors in a computer-mediated performance suffers from the limited quality of the media and the constraints imposed by the technology. And in our information-driven society, as data visualization becomes an increasingly important tool to facilitate understanding, the role of aesthetics in the visual presentation must be considered. Other examples can be found in graphics, animation, information retrieval, and content production. The invention of new forms of interaction and new types of applications requires that the limitations of current technologies be overcome.

This research theme is concerned with the identification and development of the building blocks that will be used to invent, design, produce, and evaluate the next generation of media applications. An important underlying objective of the theme is *reuse* – that is, knowledge and understanding about new media applications that can be encapsulated and passed on to others in both research and industry. This ensures that the outcomes of our work will have powerful lasting value beyond the confines of the NCE.

Broadly speaking, the theme will concentrate on four categories of reusable knowledge that will be produced in the NCE: architectures, specific techniques, methods and methodologies, and tools.

Architectures and Frameworks

High-level conceptualizations of a design space provide application developers and content producers with a structure that organizes thinking about the domain, and that helps guide the search for solutions to novel problems. These structures can have revolutionary effects on productivity and access for an application area. For example, the concept of tiered architectures has had enormous impact on modern interactive systems, and the web services model has transformed and facilitated the development of software that involves the participation of multiple machines. There are similar needs, and similar opportunities, for high-level structures (*ENCAD*) in the next generation of graphics and new media domains. Several projects will contribute new or refined architectures and frameworks–conceptual frameworks of privacy and security (*PRIVNM*), new conceptualizations of design for assistive technology (*INCLUDE*), and theories of digital infrastructures (*DINS*).

Specific Techniques

The variety of problems encountered in GRAND's research related to the design and development of new graphics and media applications will result in many solutions that are specific to these challenges. Examples include new techniques

for personalization to enhance the usability of media-rich applications, network techniques for minimizing latency and enriching the possibilities for coordinated interaction (*HSCEG*), graphics algorithms for improved models of human motion (*MOTION*), techniques for improved search in games, and new artificial intelligence strategies for more believable characters in computer games (*BELIEVE*). These techniques will be of enormous value for researchers and industrial partners; all of the technically-oriented projects in the NCE will contribute techniques to this theme.

Methods and Methodologies

Many forms of knowledge that will be created in the NCE's research can best be captured as processes. Examples of these include evaluation methodologies and development processes or design approaches that encapsulate a successful way of arriving at a solution to a problem. Several projects will emphasize the development of such methods and processes: from methodology for evaluating affective user experiences (*AFEVAL*) or the qualities of virtual worlds, to a process for modeling natural phenomena, and new methods for the development of serious games.

Tools

Tools are the most concrete form of reusable knowledge that will be created in the network. In this subtheme, our products will include reference implementations, toolkits, libraries, engines, and development environments. In all projects, researchers will work with industrial partners to develop reusable tools where appropriate to the products. Examples include a development environment for exercise games, a library for Monte-Carlo search techniques (*MCSIG*), techniques for parallelization of videogame platforms (*PLATFORM*), reference implementations for human motion models, and models of natural phenomena.

The industrial focus for much of GRAND's research means that infrastructure and reusable technical knowledge will be a vital part of our success. Our multiply interrelated network approach is a vital part of this theme, allowing for both a multiplicity of new techniques and methods from the thirty research projects, and the opportunity to share and test reusable technology across multiple sites.

Project Summaries

We provide additional detail on the proposed research program by listing the 32 projects that will initially be undertaken. Many are expected to continue for the initial five-year term of the Network; all will be pursued for at least the first two years. Mechanisms for reviewing projects to ensure that adequate progress is being made, and to redirect Network resources when new opportunities arise are explained in a later section.

Each project description lists the PROJECT LEADER and CO-LEADER, summarizes goals and objectives, states the project's relevance to partners and the larger community, and outlines a research plan. Each project meets all of NCE criteria 2, 3 & 4. Sections 6.4-6.6 address these criteria across projects and for GRAND as a whole. At the end of each description, we state its single most significant and/or exemplary contribution to the NCE criteria.

AESTHVIS — AESTHETICS AND VISUALIZATION

Sheelagh Carpendale (PL), Lyn Bartram (PCL)

This research expands the bounds of interactive visualization, exploring aspects of aesthetics in data abstraction, representation, presentation, and interaction to improve the competitive edge through enhanced appeal and usability. Research into information aesthetics and the manifestation of aesthetics in interactive visualization recognizes the growing importance of information in our society,

and investigates the development of technologies that have appeal, are engaging, and can operate in harmony with our daily lives, our interests, and our needs. This requires exploration of the ways in which aesthetics can enrich and refine information visualization and the richer communicative scope of information, meaning, and affect when aesthetic and artistic practice are properly employed.

We will study the interplay between aesthetics and visualization through a variety of perspectives including research to expand our understanding of the subtleties in maintaining balance during interactive manipulations and animations, the fundamentals of motion in relationship to visualization, use of simple and complex symmetries, and the impact of aesthetics when presenting information visually in public spaces or casual settings (Card et al., 1998; Thomas & Cook, 2005; Ware, 2004; Schneiderman, 1996). Aesthetics of visualization can be thought of as spanning a gamut from explicit to implicit, frequently exhibiting aspects of both. Explicit visualization involves the direct mapping of representational attributes to convey specific information properties. Use of representational attributes such as spatiality, colour, and repetition of necessity has a huge impact on aesthetics, and potentially influences appeal, attractiveness, and other practical aspects such as readability and interpretability.

This project will help the National Film board understand the scope of information, meaning, and effect that aesthetics can communicate in interactive digital media.

AFEVAL — EVALUATING AFFECTIVE USER EXPERIENCE

Regan Mandryk (PL), Jeremy Cooperstock (PCL)

Evaluation methodologies in human-computer interaction research (HCI) originated in Psychology, Human Factors, Engineering, and Computer Science. Evaluation of user experience from an emotional or affective perspective — which is equally important to design — is still not well understood, especially when the primary goal of a technology is to entertain or to invoke an emotional experience (Norman, 2002; Pagulayan et al., 2002). Traditional measures of user behaviour developed for evaluating productivity technology (such as task performance) are not always applicable to computer games, animations, or new media environments that provide emotional experience, regardless of user performance. Development of entertainment technologies is a risky and expensive undertaking, as significant time and resources are often devoted to products that are never released because they do not provide an effective emotional experience for end users. Our research will yield significant benefits for our partners by reducing their risk of investing time and resources into products that will not get to market, reducing the development cost and time of those that do, and improving the final products by ensuring a compelling user experience.

The goal is to develop and validate a suite of reliable, valid, and robust methods for evaluating affective user experience in computer games, animations, and new media environments that address the unique challenges of these technologies. Building on previous work and expertise of project team members, we will build affective evaluation methods based on users' physiological signals, including their cardiac activity, galvanic skin response, brain activity, eye gaze and blink patterns, pupil diameter activity, and muscular response. We will also integrate less-

invasive approaches, including facial expression image recognition, thermographic imaging, interactive behavioural measures, and subjective responses.

Our models of user affect will be built and validated in both laboratory and real-world settings to ensure scientific relevance and applicability to our industry.

AMBAID — AMBIENT INFORMATION DISPLAY

Karon MacLean (PL), Ravin Balakrishnan (PCL)

Current technology relies on graphical displays as the primary mechanism for communicating information to the user. This can overwhelm the user's visual channel, and does not adequately leverage the other sensory channels that humans use to communicate in the "real world." In particular, modalities such as the haptic (touch) and auditory senses are well suited to enable humans to process background, ambient information (MacLean, to appear in 2009; Chan et al., 2008). Sighted people use touch this way in non-digital environments: even when the information collected is dynamic and essential to a task at hand, touch is usually a supporting player rather than the explicit focus. Similarly, much of our non-speech listening is devoted to background processing of environmental sounds, which impinge on attention as they become relevant. Today's computer-enabled environments do not handle these nuanced, ambient aspects of human communication well, if at all.

The goal of this project is to assemble a knowledge base and develop user interface solutions for situations that could benefit from additional modalities of information display in a variety of contexts. The research will focus on four primary themes: (1) using haptics and audio to provide guidance to users in performing tasks, (2) using haptics for low-attention background information display, (3) determining how the various modalities can contribute to displaying non-verbal social cues in the context of technologically-mediated human-human collaborative activities, and (4) using haptics and audio as a persuasion agent to support desired user behaviour.

Immersion Canada will track and potentially adopt new applications using haptics derived from this project.

BELIEVE — BELIEVABLE CHARACTER BEHAVIORS AND STORIES IN STORY-BASED GAMES

Duane Szafron (PL), Magy Seif El-Nasr (PCL)

Our industrial partner, BioWare, is the world leader in story-based computer/video games, such as *Neverwinter Nights* and *Star Wars, Knights of the Old Republic*. One of the major bottlenecks in computer games workflow is scripting. Scripts control the interactions of objects (content) in a computer game, similar to the way that a movie script dictates character actions and stage directions in a movie. As the complexity of game production has increased, specialization of skills has occurred in the industry. Most game story authors today have little or no computer programming or scripting skill. Scripts dictate game agent behavior. Our first goal is to discover new mechanisms that allow game designers to create helpful allies and challenging opponents by generating scripts automatically in an environment where authors provide creative high-level direction to agents. We propose a multi-queue behavior architecture that provides support for prioritized, interruptible-resumable, independent, and collaborative behaviors. We will construct a prototype implementation that uses a commercial game, BioWare's *Neverwinter Nights*. We will then conduct a series of user studies to discover whether non-programmers can quickly and reliably produce believable behaviors.

Scripts are essential for controlling the plot in story-based games. Thus, our second goal is to ensure that game designers can use this creative environment to generate scripts that ensure that

player actions influence the plot, and that the plot points occur in a rational order during the story. Our approach will be to provide authors with a library of high-level behaviour and plot patterns (game story idioms) that they can adapt for the story at hand. We will use and adapt the latest techniques from machine learning, natural language processing, visual programming languages, software engineering, human computer interaction, game studies, perception, and cognition (Cutumisu et al., 2008; Gorniak & Davis, 2007).

It is the novel interaction of these techniques that provides the greatest opportunities for new research insights. We will develop an environment that can be used by game designers, professional or amateur (such as high school students), who can use this environment to focus on the creative aspects of constructing believable characters and stories. We will validate this environment, both with user studies and feedback from our industrial partner, BioWare, in the context of commercial games.

BioWare will adopt scripting innovations from this project to improve predictable character behaviour and advancement of plots.

CAPSIM — FROM CAPTURE TO SIMULATION

Wolfgang Heidrich (PL), Eugene Fiume (PCL)

Over the past two decades, the computer graphics community has made great strides in visually realistic, physics-based simulation of natural phenomena such as smoke, cloth, and fluids (gases and liquids), to name a few. Unfortunately, while physical simulation can help us visualize phenomena we could not reproduce in real life (such as large explosions), the realistic simulation of many everyday phenomena is hitting a computational "brick wall." The main cause is the complexity, multitude, and interaction of the physical processes involved. Indeed, common events such as the lighting of a match, the burning of a sheet of paper or some other solid fuel, or the flow of water in a shallow, rocky stream are simply too complex to model computationally using today's methods. Similarly, simulations of human facial motions still suffer from unrealistic artifacts and fail to express the range of human emotions in a believable fashion. A key goal of this project is to tie together the capture (imaging) of natural phenomena with the physics-based simulation of such effects.

Research has demonstrated that the visual realism of virtual environments can be improved significantly by capturing and analyzing data from the real world using photographs, 3D range scans, textures, and lighting models (Ihrke et al., 2008). No attempts have been made, however, to "import" these measurements into a computation simulation environment. Such a capability would enable interactive editing of previously-captured phenomena, would lead to creation of new simulation models, and would bring a new level of realism to existing systems.

This project is the first systematic attempt to tackle a tight integration of visual measurement and physical simulation. Research into new methods for capture, processing and mesh generation, and simulation will all be combined. Over the first several years, the focus will be on individual phenomena that are of strong importance to both the game and animation industries. These include volumetric effects such as fluids, fire, and smoke, as well as moving surfaces such as expressive faces or flowing garments.

Autodesk and Pixar can adopt the results from this project to enable their designers and animators to interactively capture, edit, and analyze scenes and objects in animations and simulations.

CPRM — CONFRONTING PAIN REDEFINING MOBILITY

Diane Gromala (PL), Chris Shaw (PCL)

This project addresses long-term issues (Melzack, 1990) faced by an estimated 1-in-5 Canadians who suffer from chronic pain (Boulanger, 2007), in three synergistic initiatives. This work is unique in its integration of technologies, its longitudinal focus, and the depth of involvement of a Canadian physician who is an acknowledged expert in complex pain.

VR as Therapy and Training: Immersive VR has proven to be effective for treating acute pain (Hoffman & Patterson, 2005; Hoffman, et al. 2004a, 2004b). We extend this research into the long-term arena of chronic pain by investigating what makes VR an effective, non-pharmacological analgesic, and by training patients to modulate their perceived pain (Kabat-Zinn, 2006) by developing integrated VR and biofeedback technology (Shaw, et al., 2007). We will examine to the degree to which users can learn to lower their pain thresholds in VR, as measured by DNIC (Loeser, 2001), how much of that ability persists over time, and if it can be reinforced through desktop and mobile technologies.

Self-Assessing Over Time. We will examine issues that unfold over many months and years through information design and visualization: complexities of patient-physician communication, unaddressed ways to self-assess over time (Farrar, et al., 2006), understanding how the type, location and intensity of pain changes over time, and patients' ability to self-manage information with diverse care providers (Canadian Pain Society, 2007).

Keeping Socially-Connected & Mobile: In the third initiative, we will examine progressive social isolation and immobility common to chronic pain sufferers (Gatchel, et al., 2007). Experts in the area of Communication, Sociology, Computer Science, and Interaction Design will explore ways in which mobile technologies (Crow, et al., 2008) may enable those who suffer from chronic pain to remain as mobile and socially connected as possible. Initially, studies will be with users who are 60 and older.

This project s involvement with Themes 1 and 4 along with the healthcare and wellness areas, and associated international labs provide a distinctive synergy of disciplines and influences. Non-profit organizations and the growing number of virtual clinics will benefit from this research, while those trained in this area will have a unique impact on society and the quality of life of Canadians.

DIGILAB — DIGITAL LABOUR: AUTHORS, INSTITUTIONS AND THE NEW MEDIA

Samuel Trosow (PL), Bart Simon (PCL)

DIGILAB addresses the accelerating and interrelated changes in the organization of computerized and networked work, and the institutional settings in which it takes place. It examines how these changes affect the creation, production, distribution, and re-use of intellectual goods within a variety of domains, and how the individuals, groups, organizations and institutions involved in these processes fare (Huws, 2003, 2008; Mosco & McKercher, 2007, 2008). The project will initially study four domains of digital labour: (1) Game production — the domain of programming and design in game development, (2) music production — the domain of creating, performing, recording and distributing musical works, (3) post-secondary education — the domain of teaching and course development in higher education, and (4) librarianship, which is undergoing changes associated with the increased digitization of collections and services.

One goal of *DIGILAB* is to highlight and call special attention to the changing nature of the labour process in all four of these domains. These issues often remain hidden in academic and policy-related

discussion. While digital innovation can bring about benefits for workers in the workplace and for citizens in the broader public, these changes can also produce precarious conditions that may affect people's sense of viability as citizens. Similarly, changes brought about by digital innovation may be disruptive for institutions.

Along with the diffusion of new technologies, the old dichotomies between the author-creator-producer and the consumer-user-audience are breaking down as more people now have the potential of becoming creators. These developments challenge old business models, established organizational forms, and the rules themselves governing the ownership and control of intellectual creations. This accounts for much of the tension in contemporary intellectual property policy debates.

This project's emphasis on Themes 4 and 1 makes it unique among GRAND projects. Training developed within this project will therefore contribute to the broader exchange of social scientific and humanistic knowledge and create HQP with a unique blend of skills.

DIGLT — DIGITAL GAMES FOR LEARNING AND TRAINING (DIGLT)

Cristina Conati (PL), Jennifer Jenson (PCL)

Digital games are one of the most promising media for the development of innovative educational content (de Castell & Jenson, 2003, 2007; Gee, 2005; Reiber, 1996; Ruben, 1997). Game-based learning integrates game design concepts with instructional design techniques in order to better address the learning needs of this generation. This generation highly regards "doing rather than knowing," making interactive, experiential learning a necessity for their educational success. While there is ample evidence that GLTs are more appealing than traditional learning environments, there is still little direct, empirical research that supports evidentiary claims about what is learned through play. To date, most of the design and development in this area has been 'ad hoc' at best. Few, if any "lessons learned" have been shared among developers, and very little coordination of methods to best approach the development of GLTs have been attempted. Evaluation of these environments has varied so widely methodologically that it is nearly impossible to compare similar kinds of GLTs played in similar contexts. This projects brings together an interdisciplinary team of researchers to develop formal knowledge and methods for the design and evaluation of GLTs. Project outcomes will include: (1) the comprehensive construction of a learning design framework for understanding the learning and new media constructs that are required to design games that teach, (2) the development of detailed methodologies for evaluating educational outcomes in learning and training games, and (3) the application of the design and evaluation frameworks to devise and empirically validate new GLTs that explore the role that learning and new media constructs play in effective GLTs, and provide test cases for the outcomes of the first two objectives.

Researchers on this project are partnered with public school boards in Toronto, Vancouver, and elsewhere.

DINS — DIGITAL INFRASTRUCTURES: ACCESS AND USE IN THE NETWORK SOCIETY (DINS)

Catherine Middleton (PL), Barry Wellman (PCL)

Among the objectives of the NCE program are economic development and improving the quality of life for Canadians. In the context of graphics, animation, and new media research and development, quality of life can be greatly enhanced as new media in various forms are used to build and sustain a "networked society." Economic development will occur as Canadians

commercialize the research output of industry and the higher education sector, develop innovative new products and services, foster a highly skilled labour force, create jobs, and contribute to the economic base of their local communities.

To achieve these desired outcomes, three major challenges must be addressed: (1) Canadians must understand what infrastructure is needed to participate in a networked society and have access to it, (2) we must have the capacity for, and interest in, using new media technologies to engage with each other and to support economic activities, and (3) we must understand the social implications (both positive and negative) of living and working in a networked society (Wellman, 2001, 2009; Middleton & Sorensen, 2005). *DINS* project will explore these challenges.

Research questions include: (1) What are the embedded assumptions about availability of, and capacity to use, the infrastructures on which new media and related technologies are deployed? (2) How do Canadians actually use new media to develop and sustain their social networks and to support their daily activities (that is, what is the role of new social networking tools, and do those "born digital" differ from other demographic groups)? (3) What are the anticipated and unanticipated impacts of living in a networked society? (4) What are the gaps in infrastructure availability, required skill levels, and individuals' current capacities to use digital media, and how can they be narrowed or eliminated? (5) What are the specific concerns and issues that must be addressed to ensure digital infrastructures are accessible to all Canadians?

The project will offer a detailed consideration of the social, cultural, and technological infrastructures and networking practices required to enable Canadians to receive socio-economic and cultural benefits from the widespread adoption and use of new media technologies.

A highlight of the project will be a white paper identifying the types of infrastructures needed to support a networked society in a digital economy. This will offer a high-level assessment of how such infrastructures have been developed internationally, and consider policies and actions needed to ensure that Canadians have access to internationally competitive, enabling digital infrastructures.

ENCAD — ENABLING TECHNOLOGIES FOR CAD SYSTEMS

Temy Tidafi (PL), Wolfgang Stüerzlinger (PCL)

Computer-aided design systems have matured into comprehensive environments that enable users to efficiently work with their designs. This project focuses on three related complexes to support long-term productivity for CAD users. The first is constraint and simulation modeling, enabling designers to create designs adapted to context and to the physical forces acting on a design. This project will explore methods of simulation that can encode higher level goals such as sustainability, energy minimization, system-wide optimization, and real usage. We plan to develop frameworks that enable multiple simulators to work together as co-operative solvers on these domains, researching techniques for open interfaces and common simulation frameworks.

The second focus is on histories and alternatives, enabling the known problem solving strategy of problem space exploration. We plan to research systems that enable the user to browse and manipulate significant steps of a design's history, revisiting and evaluating earlier design decisions. We will thus develop powerful mechanisms for design re-use, communication of the design to stakeholders, and documenting the design process.

The third focus is on simpler user interfaces for modeling. Constraints and simulation establish a new design space, in which histories and alternative

enhance the ability to explore new alternatives for new designs. The third enables rapid, interactive exploration of the design space, which is essential to match all desired outcomes.

Autodesk, which seeks thought leadership in simulation to enable greener design, will adopt the encoding of higher-level goals in simulations from this project.

EOVW — DEVELOPING METHODS FOR EVALUATION OF VIRTUAL WORLDS AND UNDERSTANDING USER EXPERIENCES

Magy Seif El-Nasr (PL), Regan Mandryk (PCL)

To develop a good interactive virtual world, a multi-player game or a single-player game, developers need to (1) understand the target market and (2) establish a good pipeline and development cycle that integrates testing and iterative design (Fullerton, 2008; Schell, 2008). This is crucial because interactive entertainment products are no longer developed for a small market composed of people who are very similar to designers. More time and more money are being spent to (1) develop better ways of evaluating interactive entertainment products for a target market and (2) understand target markets' tastes, behaviors, motivations, perceptions, hobbies, and habits, to mention a few variables. This project targets these two problems. We will develop novel evaluation methods for measuring success of virtual worlds. We also aim to run studies to understand users' activities, motivation, attentional patterns, perceptions and attitudes (Nacke, Ambinder, Canossa, Mandryk, & Stach, 2009). We focus on the evaluation of persistent interactive experiences, such as virtual worlds and massively multiplayer games. Such interactive experiences are developed for more than one user – often thousands of users. And they are considered persistent; that is, the world or game continues to exist even after the user logs off. While there are many evaluation methods developed by research and industry, these methods and tools have several shortcoming: they are time consuming, they need experts to draw conclusive results, and they need to be adapted to work for persistent worlds. In this proposal, we tackle these problems by building an automatic, statistical metrics tracker for user behavior, and user trails within a virtual world, and a visualization system that allows designers and developers to conduct fast and easy analyses of their designs. We will integrate these techniques within a virtual world company, Bardel Entertainment, which currently has a virtual world under development. This will allow us to evaluate our methods and validate industry integration. An important goal of the project is to model users by collecting and analyzing information concerning their habits, perceptions, motivations, attention patterns, attitudes, and emotions (Thawonmas et al., 2008). Such models will help entertainment companies develop better design models that target their audiences.

This project will help the Communication Research Centre's Networked Media Laboratory evaluate the human-computer interface aspects of collaborative virtual environments in the context of virtual worlds. Bardel Entertainment and Electronic Arts will benefit from an integrated model of cooperative multi-player games and virtual worlds for children, including a study on engaging play for children.

GAMFIT — GAMING FOR FITNESS

Nick Graham (PL), Regan Mandryk (PCL)

The primary goal of *GAMFIT* is to determine whether video gaming can be used to help motivate people to begin and maintain a program of physical activity. While there are an increasing number of commercial products that aim to do exactly this (e.g., Wii Fit, EA Sports Active), relatively little is known about the principles of how to design

effective exercise video games. We will address the questions of what design elements in games increase peoples' motivation to become and remain physically active, and of whether these actually provide sufficient exercise to produce health benefits (Graves, 2007; Warburton 2007, 2009).

A secondary goal is to address the problem that exercise video games (henceforth "exergames") are difficult to create, which has inhibited research and experimentation. Exergames are based on a profusion of special-purpose hardware devices, ranging from exercise bicycles, accelerometer-based devices such as the Wii Remote and vision-based devices such as the EyeToy, to the newly announced Xbox Natal. We will develop tools to assess common styles of input in exergames, allowing game programmers to focus on the game itself rather than on low-level input capture. We will also examine technical challenges related to representing exercise through direct and indirect sensor measurements to provide more accurate and reliable representations of player fitness in digital media.

Games to promote fitness are not limited to physical fitness. We will also test whether cognitively-stimulating games can aid mental fitness specifically whether they help delay or ameliorate the expression of Alzheimer's disease. Work in this area will share tools, infrastructure, and methods for evaluation with the physical fitness research.

To meet these goals, we will examine core questions in current game design: evaluating effectiveness of games for fitness, and selection of proper tools and infrastructure for constructing and evaluating game prototypes.

Results of *GAMFIT* will be of value in Saskatchewan's plan to aid volunteers in increasing physical activity by children. Industry partner Coole Immersion will improve its games' ability to change user behaviour, and will learn ways to assess the degree of change and communicate the effectiveness of games to users.

HCTSL — TECHNOLOGIES FOR SUSTAINABLE LIVING

Robert Woodbury (PL), Lyn Bartram (PCL)

Effective energy reduction programs necessitate not only efficient buildings, but approaches that aid occupants in modifying their energy use behaviour. This project addresses several major issues in the design of information systems for technologically-enabled, sustainable home design: appropriate interface design for in-home technological ecosystems that support sustainability; exploring the impacts of awareness, understanding, practical action, data logging and community interaction on energy use decisions; and improving design practice, including the tools and methods used by architects, engineers, developers, and policy makers to explore design space from the perspective of occupant behaviour. The research scope includes both new technologies related to green buildings and alternative energy sources, as well as information tools for encouraging energy conservation in more traditional residences (Chetty et al., 2008; Wood & Newborough, 2007).

Several research questions will form the basis of our investigations. Some are concerned with the technological infrastructure in the house itself: what we term the occupant's "digital ecosystem." Others focus on incentives, models for motivation, and models for the interplay between personal goal-setting and community interaction that have been shown effective in changing energy conservation habits. We propose to address these problems as one of system design in which a variety of display, control, and tracking tools work in concert with the home occupant, or home "user." We posit the following major aspects in the design of better digital ecosystems: awareness, monitoring, sense-making, and control. These

activities need to be supported at different levels of detail, varying degrees of attention, and in contextually appropriate ways. The cumulative impact of small, beneficial decisions can make a substantial contribution to the current, and urgent, society-wide changes needed. The project aims at an empirically justified basis for design and implementation of usable and effective home systems.

This project supplies new interfaces and tools that can change consumer behaviour and educate consumers about conservation to BC Hydro Power Smart. Autodesk will adopt techniques to explore the design space from the perspective of occupant behaviour.

HDVID — NEW INTERACTIONS AROUND HD VIDEO

Edward Lank (PL), Lynn Hughes (PCL)

While high video resolution is an important aspect of the Blu-Ray standard, three additional attributes of modern HD video systems present opportunities for the design of new interactions with media. These attributes are: significant surplus storage capacity; support for BD-J, a specification of the Java ME XLets standard that allows disks to include software that creates dynamic behaviours; and network connectivity to allow devices to interact with one another remotely. While past research exists on television viewing, interactive television, and on-line gaming (Flynn, 2003; O'hara et al., 2007; Szentgyorgyi et al., 2008), it is only peripherally applicable to interactive HD video devices. Past research in television viewing ignores how ownership of physical media content delivered by BluRay players, DVD players, and VCRs transforms the viewing experience. Television research has explored enriched viewing experiences, but typically views interaction as bounded by the physical household unit. On-line gaming research has explored networked audio-video experiences, but, unlike passive video content, the nature of on-line games frequently requires collaboration and interaction.

This project will address the shortcomings of past research by delivering: (1) ethnographic studies of the unique nature of physical media ownership and its impact on the viewing experience, (2) participatory design artifacts and cultural probe results obtained from prototyping studies of new applications which overlay the video viewing experience and enhance the value of content ownership, and, (3) case studies of applications bundled onto commercial Blu-Ray disks (through support from Deluxe), and the use of these applications by real-world purchasers.

Industry partner Deluxe will develop new applications to create and share user-created content on networked Blu-Ray players. Industry partner Rogers will gain insight into new means of delivering content.

HLTHSIM — VIRTUAL REALITY SIMULATION AND COLLABORATIVE GAMES FOR HEALTHCARE TRAINING

Roy Eagleson (PL), Eleni Stroulia (PCL)

In this project, we will develop methodologies and tools for the design, development, and evaluation of augmented reality-based, educational, game-like, collaborative simulations. The power of play to motivate, inform, educate, and entertain has great potential to enhance collaborative learning environments (Collins, 1991; Duffy et al., 2004; Jarvela, 1995). In our project, we will develop platforms integrating sensing devices to perceive the real world, virtual-reality tools to simulate environments and phenomena, and novel interfaces through which to change the state of the real and virtual worlds for training for health professionals. We have chosen to address two kinds of training scenarios with these platforms: surgical training and inter-professional health team problem solving. We have chosen these tasks because of

their impact on Canadian Healthcare and because they span a broad set of applications and research questions within a single project.

Research has shown that surgeons tend to perform better after playing video games. Indeed, the interesting question is not "whether" interactive multimedia exercises will improve surgical performance, but how can multi-modal training exercises best be designed for a range of surgical procedures? On the other hand, health-care delivery is becoming increasingly team-based: medical diagnoses can be made by a team of specialists, and epidemic tracking and containment can be managed using online collaboration between front-row health teams and researchers. Realistic virtual-world scenarios will train future health professionals to effectively communicate and collaborate to solve problems.

Through CSTAR and HSERC, we will evaluate our tools by introducing them in the current curriculum of the relevant health disciplines and measuring their impact on student skill acquisition with standard instruments, i.e., Fitts' law (surgical training), and communication task checklist (collaborative simulations).

HSCEG — HIGH-SPEED COORDINATION IN ELECTRONIC GAMES (HSCEG)

Carl Gutwin (PL), Nick Graham (PCL)

Many games in the real world, such as team sports, involve closely-coupled, interdependent, and high-speed coordination. When expert teams play hockey, basketball, or soccer, players interact with their teammates at the split-second level, maintaining awareness of where people are and predicting what people are about to do next.

The immense popularity of team games and sports in the real world has led to the production of several analogues in the electronic world. However, the high-speed interaction and coordination that is evident in real-world games is missing from their electronic counterparts. This is largely due to the fundamental limitations of computer networks, which require tens of milliseconds to transfer messages between computers over a local-area network. Since coordination of actions may require several such message interchanges, performance of computer games typically lags well behind human speed.

The goal of this project is to improve support for high-speed coordination in electronic games, and to thereby make it possible to build true, high-speed versions of high-speed team games and sports. Our approach is to first understand human limits on team coordination, through collaboration with kinesiology researchers. We will then use this knowledge to invent and evaluate techniques for supporting coordination in online environments, through several mechanisms such as novel latency-reduction techniques, temporally-sensitive consistency maintenance algorithms, and visualization techniques that maximize people"s abilities to adapt to the constraints and capabilities of the online environment (Heath et al., 1995; Heath & Luff, 1991; Orton & Weick, 1990).

There will be two main products of the research. First, we will develop knowledge – an understanding of the critical factors governing the performance of high-speed coordination in networked systems. Second, we will invent specific interaction techniques and design approaches that can be used to support high-speed coordination in these systems. Third, we will develop system-level tools – such as toolkits, architectures, design patterns, reusable code and reference implementations – that can be used to test our solutions and serve as the building blocks for novel games that enable high-speed play.

INCLUDE — ACCESSIBILITY OF NEW MEDIA FOR DISABLED, ELDERLY, AND VULNERABLE INDIVIDUALS

Deb Fels (PL), Ron Baecker (PCL)

Digital interactive media systems are now pervasive in society, from email to web access for citizen information, from application-rich mobile phones to complete virtual societies such as *Second Life*. In principle, these systems could support access by users who find it hard to fully participate in society; for example, people with disabilities, senior citizens, and individuals in situations of vulnerability such as being isolated in long-term hospital care, and recovering from trauma. Yet access to new media is almost always difficult because of the physical, sensory, motor, cognitive, emotional, and social assumptions made in technology design and deployment (Petrie et al., 2005; Mihailidis & Fernie, 2002).

The goal of this project is to explore, develop, and evaluate innovative sensory substitution technologies and alternative techniques to improve access to new media systems for seniors, vulnerable individuals, and people with disabilities. For example, providing access to non-speech audio for television requires new approaches that involve visual and/or tactile stimulation. We will employ novel technologies including vibro-tactile systems, "social TV" systems, inclusive audio/video providing alternative methods of access, speech recognition tailored to voice patterns of seniors, and new media art forms providing support for social re-enactment. Examples will include systems for multimodal communication, social interactions, and especially "serious games" designed for health purposes. Each system consists of input, output, and processing requirements that depend on interactions with people. We must design for users' exceedingly variable motor, sensory, cognitive, and emotional processes that often are seriously impaired, and we will test systems in the laboratory and in field studies, in order to derive useful principles for future new media design. These experimental studies and our past work will then help us produce an inclusive system development and evaluation framework for users with disabilities or impairments, informed by Universal Design Theory – a deliverable that will be put forward for use by the other projects within the NCE.

Toronto Rehab is watching this project for valuable results on rehabilitation, social TV systems, and games to combat isolation and promote cognitive health. Furthermore, this project will provide media access solutions needed to comply with the Ontarians with Disabilities Act (anticipated in 2010).

MCSIG — MONTE-CARLO SEARCH IN GAMES

Jonathan Schaeffer (PL), Holger Hoos (PCL)

Achieving intelligent behavior of artificial characters and opponents is a key challenge of interactive entertainment. Traditional methods for building high performance systems that exhibit such behaviour, in real time, have been limited by the knowledge acquisition bottleneck. Monte-Carlo Tree Search (MCTS) is a relatively recent and very successful approach that sidesteps this bottleneck. It uses statistical methods based on sampling and building a selective search tree. It has been shown to work much better than previous approaches in challenging domains such as Go and General Game Playing, while requiring comparatively very little domain-specific knowledge.

This project aims to advance the state of the art in MCTS methods, to generalize them to new application domains, and to push the performance of existing applied systems (Kocsis & Szepesvari, 2006; Enzenberger & Mueller, 2006). Key to this approach are combining the automated algorithm design techniques contributed by Prof. Hoos' group at UBC, with the experience in building game-playing systems at University of Alberta. In order

to demonstrate the generality of the methods, our applications are in varied games domains. Games provide the advantage of virtual worlds with clear rules and boundaries, and controllable complexity. Improving the decision-making ability of programs in such domains can serve as a stepping-stone to tackling less well-defined, real-world applications. One important question to be addressed in this research is how to integrate the best existing approaches, such as inference and domain knowledge, into an MCTS framework. Another goal of the project is to harness massively parallel AI aims, to exploit the demonstrated scalability of MCTS with increased computing power.

Industry partner BioWare looks forward to GRAND enhancing the research capacity of its university collaborators in this project. Monte Carlo tree search techniques will help achieve more sophisticated, intelligent behavior for game characters.

MEOW — MEDIA ENABLED ORGANIZATIONAL WORKFLOW

Eleni Stroulia (PL), Kellogg Booth (PCL)

This Special Project will use new media technologies, such as tools for web-based collaboration, web syndication and social networking, to support the recording of information regarding the mini-projects research activities, to appropriately disseminate this information across the network researchers — thus enhancing the cohesiveness of the network, and to use it as necessary for financial and reporting functions. The objective is to simplify the network reporting processes, as well as improve their quality, by making the collection of the necessary information a natural by-product of the primary research and collaboration activities of the network researchers.

We will investigate the following research questions: (1) Which new media technologies can be used to support research, and what are the "best practices" in identifying and adopting such a technology? (2) How might such technologies support knowledge translation across research disciplines, and what are the processes by which the information disseminated across the network researchers can advance the development of common vocabulary and methods? (3) What types of information can be recorded through the use of each such technology, and how relevant is this information to managing the research activity within a research network such as GRAND? (5) What are the cost-benefit tradeoffs between the effort required by the network researchers to use each such technology, and are there measurable improvements from using the technology in network management? (5) Are there legal, policy, or regulatory issues that arise because these technologies were adopted in the context of a research network, and if so, what might be some technological or practical methods to address them?

Throughout the life of the network, we will explore a variety of new media technologies, wikis, blogs, RSS feeds, collaborative tagging, social-networking tools, web-based conferencing tools, and virtual worlds, just to name a few of the technologies we envision. Wikis seem to be the first candidate to explore: we have already adopted a wiki to support the process of preparing the NCE proposal and we have gained some experience with respect to the types of support they can offer to research and reporting activities.

We will work closely with our industry partner, Precision Conference Systems, to adapt their commercial conference submission and review product for use in our research reporting, and also in a novel, peer-review process that will allow graduate students to assist each report on their research activities.

MOTION — MODELING HUMAN MOTION

Michiel van de Panne (PL), Paul Kry (PCL)

Realistic and flexible models of human motion have a truly diverse range of applications. Games, animation, and scenario simulations need rich and interactive depictions of human behaviour. At the same time, they are also key to interpreting human movement as seen by cameras. As such, it is a critical component in developing the next generation of user-aware interfaces for games, assisted living, and other context-aware applications. Models of human motion are also useful for understanding human biomechanics, human motor control, and extending the abilities of humanoid robots. The goal of this project is to develop and exploit new models of whole-body human motion with application to animation, games, e-commerce, interfaces for new media, modeling and tracking for healthcare applications, and entertainment robotics (Beaudoin et al., 2008; Wang et al., 2008).

Significant progress has been made in developing models based on motion capture data; however, scalability remains a core problem. As a result, more abstract models are needed which can generate motion according to the intent and context. Many existing models of human motion are focused heavily on flexible walking skills. However, they fail to model the full agility of human motion, and the rich repertoire of movements unrelated to locomotion. They are not sufficiently rich to support general vision-based, marker-free motion capture.

This project brings together investigators with significant expertise in computer animation, computer vision, games, interactive storytelling, physics-based simulation, robotics, machine learning, and perception. The project is structured around four research themes. (1) Authoring and Editing: the exploration and evaluation of new representations of motion at various levels of abstraction. (2) Perceiving Human Motion: examining how motions are observed by humans and computers, including motion sonification. (3) Large Motion Repertoires: investigating models of climbing, grasping, and manipulation – all of which are involve complex, force-based interactions with the environment – with applications to training simulations, robotics, ergonomics, and healthcare. (4) Motion Models for the Real World: developing techniques to control more biomechanically-faithful simulations and humanoid robots.

Models of human motion will help CMLABS build better models for operator performance from data captured in digital simulation.

NAVEL — NETWORK ASSESSMENT AND VALIDATION FOR EFFECTIVE LEADERSHIP

Barry Wellman (PL), Abby Goodrum (PCL)

The Special Project will self-reflect on our successes and failures as an NCE, measuring our performance against our own goals. This complements MEOW, which focuses on operational issues. NAVEL is about ensuring that we meet the objectives of the research program. It also offers a case study that should be useful to others engaged in similar initiatives by providing insights and understanding of how collaborative research can be effectively managed. This supports the fundamental strategy of the NCE Program in fostering innovation and knowledge transfer: a shift from formal structures to networks. Instead of relying on traditional research institutions, an NCE is based on networks of informal professional ties. An NCE such as GRAND creates a loosely connected network of academics, government and industry decision-makers and researchers, NGOs, and other stakeholders. This network functions as an "invisible college" (Crane, 1972; Price & Beaver, 1966). Networked organizations are particularly suitable for scientific research with its long traditions of informal collaboration and peer-to-peer, egalitarian relationships. However, building such collaborative

networks is not easy. By design, an NCE includes participants with diverse disciplinary backgrounds and institutional affiliations who work across the country.

For researchers in different disciplines, differences in training, publication channels, and scientific forums weaken social bonds and hinder collaboration (Cummings and Kiesler, 2005; Rhoten et al., 2003). Working across institutions is equally difficult: bureaucratic, institutional culture discourages information sharing. In addition, differences in procedures impede shared understanding and common practices (Bos et al., 2009; Dimitrova et al., 2007; Birnholtz, 2005). Such difficulties are compounded by distance: as a recent volume by Olson, Zimmerman and Bos (2008) shows, despite its increasing use, technology often cannot overcome distance in scientific collaboration.

Benefits from NCEs are associated with rapid flow of ideas and innovation. Existing studies demonstrate that the characteristics of a network and the ties within it (such as its level of connectivity, internal groupings and linkages across groupings, and existence of previous ties) shape processes in the network, including knowledge transfer processes (Shrum & Chompalov, 2001; Haythonwhaite et al., 2003). NAVEL will facilitate collaboration by monitoring the developing network of the GRAND NCE, by identifying disconnects and untapped opportunities, and by improving communication and knowledge transfer through targeted intervention. This will be accomplished using a Social Network Analysis perspective.

NEWS — ACCESS TO NEWS MEDIA

Abby Goodrum (PL), Charles Clarke (PCL)

Journalism in Canada and around the world is undergoing an historic upheaval. The last century has witnessed important shifts in the news industry. It has moved from a world where information was scarce, and where commercial and governmental entities controlled access and distribution channels for much of the world's information, to a world of information overload where the public can now generate, access, and distribute news information for themselves. Audiences are fragmented. The Internet and other information and communications technologies have transformed the way in which news is gathered, presented, distributed, and archived. How does an always-connected, media literate, prosumer society inform itself?

Search and retrieval over news sources is characterized by unique problems. News sources are highly repetitious, with different news agencies reporting different versions of the same story, and updates to stories repeating key background information as the story evolves. The inclusion of blogs, tweets, and other social media only compounds this problem, due to their sometimes unreliable or highly subjective content. The presentation of search results must achieve a balance between the ability of multimedia source material to compel and its ability to inform. Doing so while still maintaining the strength of diverse democratic discourse will be an enormous challenge technologically. This research will address questions related to how these competing objectives can best be resolved in multimedia news seeking, retrieval, mining, and sharing. Technology development will focus on: topic detection and tracking, theme or thread identification within news stories, genre classification, aggregation, distillation, real-time update, link identification between text and video, and multimedia summarization (Boykin & Merlino, 2000). As part of the project, we will develop a searchable digital archive of CBC *NewsWorld* broadcasts (Munteanu et al., 2006).

Rogers and Metranome are both interested in the trajectory of video virality, ways users can interpret

the context for videos, and predicting consumer preferences for informing themselves.

NGAIA — NEXT GENERATION INFORMATION APPLIANCES

Elaine Toms (PL), Charles Clarke (PCL)

The use of information has always taken second place to the hard task of locating the right information in the first place. Two people with the same problem might seek different information. Two people might also find the same information useful for different problems, and the same two people may need to scrutinize that same information differently. The challenge lies in the development of new media applications to support the access to and use of information for context specific purposes. This project focuses on the development of different types of tools — new appliances — to support our information processes from exploring and finding information, to examining and using it. The types of tools will differ by work or task domain. For example, what is needed for consumer health information will differ from that used by the citizen in consuming government information, or by the scholar in using published or unpublished research (Hoppe & Shiele, 1992; Toms & O'Brien, 2008; Marchionini et al., 2009).

Our initial project will take place in the scholarly work environment. This is opportunistically taking advantage of a novel, national information network for the humanities and social sciences that will provide a living laboratory, complete with user community, and unconstrained by the conditions typically found within the private enterprise. Over the course of this project, we will work additionally within other domains – including consumer health – particularly for chronic illness, access to and use of government information by citizens, and community-based local information. We envision multiple "appliances" emerging from this research. A core challenge is in identifying the common element while at the same time respecting the distinctions so that we wind up with tools that are fit for purpose. Integral to this project also is a challenge also to our design frameworks and to how we ultimately evaluate these appliances.

PERUI — PERSONALIZED USER INTERFACES IN REAL WORLD CONTEXTS

Michael Terry (PL), Joanna McGrenere (PCL)

Modern new media applications offer an overwhelming number of options and commands. As one example, Adobe Photoshop boasts over 500 commands and options in its application menus. Such sophistication can easily overwhelm both novices and experienced users, especially when learning to perform new tasks.

Given the increasing complexity of applications, new interface paradigms are needed to enable users to effectively and efficiently manage this complexity. Adaptable (user-controlled customization), adaptive (system-controlled), and mixed-initiative (shared user and system control) have all been proposed to address this problem. However, few of these approaches have had much impact due to research and design methods largely informed by relatively brief evaluations in controlled laboratory settings, which, by definition, lack the rich context, constraints, and pressures of day-to-day work. More widespread, long-term, ecologically valid studies of these approaches are thus needed to better inform interface designs in this space (Grossman et al., 2009; McGrenere et al., 2002).

This project will investigate interface personalization techniques to address problems of complexity and learnability in modern interfaces. These personalization techniques will draw upon recent advances in machine learning and statistical inferencing techniques to enable the system to better understand users' tasks, intentions, and

goals, thereby allowing the system to play a role in adapting the interface and teaching the user how to best use the application. To address the need for long-term, ecologically valid evaluations, we will contextualize this work in mature, open source applications. Partnering with this community will not only catalyze design and evaluations of these interaction paradigms, it will also assist in creating corpora of application usage data, vital for evolving models of user behaviors, tasks, and goals.

Technologies that enable personalization in complex interfaces and the creation of corpora of user data for applications will be useful for Autodesk and Side Effects.

PLATFORM — PLATFORM PERFORMANCE

Alexandra Fedorova (PL), Bruce Gooch (PCL)

The goal of this project is to design enabling technologies for high-quality interactive media, and in particular video games. With the current hardware platforms shifting to multicore CPUs and GPUs, video game engines must be parallelized (Borkar, 2007; de Galas, 2007; Ramanathan, 2006). Many design and technical elements of video games, including those involving rendering, collision detection, and gaming physics are naturally parallelizable. However, game developers of today are not traditionally trained to develop parallel code – code which requires suitable design of data structures and multi-threaded algorithms. Thus, the adaptation to the fast-paced developments of multi-core architectures and their increasing capabilities and complexities has not been easy. This necessitates the design of new tools and techniques that simplify the expression of parallel patterns and facilitate their conversion into efficient parallel code.

Our goal is to design a new programming language that will simplify parallelization of video games. To make the implementation feasible to complete within the timeframe of the project, and to facilitate its adoption in the industry, the language will be translated into C++ (or another useful notation) rather than compiled. The new language will be based on the new programming style that compels the programmer to write code as a collection of independent (and thus inherently parallel) transforms. This is very different from the traditional serial programming style, where a program is written as a stream of inherently sequential code; here, extracting parallelism comes as an afterthought. In our approach, the code constructs will be parallel by default; sequential constructs will be added only where absolutely necessary. Unlike functional languages, we will have first-class support for modification of global state.

This project will make platform-independent parallellism on GPUs (and even on heterogenous multi-core GPUs) more accessible for programmers.
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The output of this project will be the design and implementation of a new parallel language targeted at the gaming industry. That is: a collection of linguistic constructs, translators, code analysis tools, and runtime algorithms that will enhance productivity of game developers and result in production of innovative games, whose impact will extend not only to entertainment, but to robotics, multi-agent simulations, and serious games used for education and training.

EA and Intel are both interested in the abstractions and tools devised in this project to address the parallel programming of tasks on multi-core GPUs.

PLAYPR — PLAY AND PERFORMANCE INTERFACES FOR CULTURE AND GAMES

Lynn Hughes (PL), Ron Wakkary (PCL)

Techniques and applications for interfacing with digital media are rapidly expanding. Increasingly, interface controllers for ubiquitous computing technologies for cultural and entertainment

applications raise new questions for critical interface and software design, meanings of technology, and patterns of use. This project addresses questions of interface in the context of game studies/game design and interactive design for museums and related cultural and entertainment contexts (Dourish, 2001; Greenspan & Biddle, 2009). Focusing on the issue of the relation of playability and expression to content, our goal is to integrate the analysis, evaluation, and design of cultural and entertainment applications with the development of interfaces for play, storytelling, and expression, as well as social collaboration and learning. Research and creation will be concentrated along three conceptual dimensions of interfaces: spatial play, gestural play, and vocal/audio play. Spatial play considers bodily movement in physical space in relation to cultural and entertainment applications. How do the physical and material spaces of engagement in museums (and digital media) affect the experiences and understandings of viewers and visitors? Gestural play considers the more discrete movements of bodies in relation to screen-based media, interactive installations, and exhibition environments. This raises questions of how gestural motion and other aspects of the body affect the player's relationship to the primarily visual representations on the screen. Vocal/audio play considers the roles of voice and audio as input and output channels in interfaces. Central to our exploration is a consideration of vocality as a corporeal practice used to affect one's experience and to enhance levels of engagement and interactivity within gamespaces, exhibitions, and interactive installations.

The Canadian Film Centre Media Lab will adopt mobile biometric technology, and other interactive narrative innovations, from this project. Montreal-based GSM Project will adopt ideas and technologies to create new participant interactions with exhibits.

PRIVNM — USABLE PRIVACY AND SECURITY FOR NEW MEDIA ENVIRONMENTS

Robert Biddle (PL), Kosta Beznosov (PCL)

New media environments offer complex opportunities for living our lives online, and for building and leveraging our personal networks. We are invited at every turn to share information about ourselves, and in doing so, we communicate rich representations of ourselves and others. Thus, we may easily overlook concerns about privacy and security. Much work and commerce is now conducted online, including retail, travel, banking and finance, and for managing both business-employee and government-citizen relationships. Increasingly, the environments include social communication and interaction, sharing of information, and play, and involve everyone from children to seniors.

Our project will focus on ways to better support privacy and security by leveraging social science research and by exploring new designs and legal perspectives that work with patterns of online behaviour. We will apply principles of "usable" privacy and security which refine human-computer interaction (HCI) principles, especially for security needs, and which can improve design for privacy and security (Cranor, 2008; Cranor & Garfinkel, 2005; Kerr et al., 2009). We will conduct social science research on "networked individualism" by charting how online behaviour resembles well-understood social patterns, while taking advantage of the reach and distribution of online worlds. And we will identify, articulate, and inform the legal perspectives on privacy and new media environments, especially the call for "privacy by design." The overarching idea of this project is to involve all three perspectives in symbiosis: in particular, social science will inform usable design and legal policy scholarship, and they will feed back issues that arise in technology and law. We will consider new media environments for information

sharing and discussion (such as forums, blogs, micro-blogs, wikis, social networking), media sharing and commentary (photo and video sharing), and virtual worlds (*Second Life*, and social games such as *World of Warcraft*). We will address both workplace and personal usage, noting that the distinction between the two is becoming less clear as people multiplex their lives online.

Ann Cavoukian, the Information and Privacy Commissioner of Ontario, is interested in following the ways this project will achieve usable design for privacy, which aligns with her philosophy of privacy by design.

PROMO — PROCEDURAL MODELING

Pierre Poulin (PL), Przemyslaw Prusinkiewicz (PCL)

Procedural models (PM) offer an unsurpassed capability of synthesizing complex scenes (such as plants and ecosystems with L-systems, terrains with fractals, or buildings and cities with grammar-based methods). Until now, however, PM have been used successfully in a relatively small number of well-crafted, special cases. We propose to extend PM to reduce or eliminate their limits in order to respond to more general needs. The key challenges include: (1) design of multi-scale, view-sensitive PM, (2) lazy evaluation of PM, (3) user control of PM, and (4) extension of the range of current PM, as well as the introduction of new ones.

We propose to address these challenges with (1) diverse forms of deterministic tiling design to avoid solving complex, constraint-based satisfaction problems, (2) an extension of L-systems allowing for the specification of multi-scale plant models, (3) memory management techniques compatible with the lazy evaluation and hierarchical organization of large PM, and (4) new interfaces for effective and intuitive interactive-procedural modeling. Our project will bridge the gap between interactive and procedural methods, and will result in tools and techniques adapted to the creation and management of unlimited size virtual worlds. The scope of our project will range from an advancement in the understanding of fundamental problems of PM to practical solutions for the next generation of video games.

Side Effects, whose Houdini product depends on world-leading procedural modeling, will watch the results arising from this project.

SHRDSP — SHARED DISPLAYS

Sid Fels (PL), Ravin Balakrishnan (PCL)

Large screen displays are becoming ubiquitous and appear in many different environments. These displays offer the ability for people to work together in a common space and use the screen real estate in novel ways. Likewise, small, mobile displays are also ubiquitous and offer new challenges and opportunities to work within shared environments as input devices and private displays. When using these shared display environments, the roles people play within the environment have a significant impact on the interaction techniques that are appropriate.

This project investigates a variety of shared display environments to develop new metaphors, interaction paradigms, and mechanisms for effective sharing of displays appropriate to the form factors and affordances of the displays, the tasks being pursued, and the roles of the various people who are engaged in those tasks (Shoemaker et al., 2007; Tang et al., 2008).

The term display is meant to have a broad meaning. It is not restricted to just visual displays such as computer monitors, screens with projected digital images, or hand-held devices such as cell phones or PDAs. It covers the full range of display modalities including visual, audible, haptic, and olfactory. While there has been significant research on each of these modalities, and some on cross-modal or multi-modal displays, in the context of single

users, to date most research on shared displays has focused on visual displays and, to a lesser extent within the new media research community, audible displays. The initial emphasis during the first two years of this project will be on shared visual displays, but from the outset attention will be paid to all of the sensory modalities and to the possibility of enhancing existing shared display technologies by incorporating additional modalities that either augment or substitute for the current modality used by the display. An especially important example of this will be efforts to support communities of participants where some in the community have sensory deficits in one or more modalities, so that redundant multimodal display of information may be necessary to equally support all of the participants.

The researchers have collaborated extensively with Smart Technologies through the NECTAR NSERC strategic network (2004-2009). They will continue their history of student exchanges between sites, as well as explore opportunities for graduate student internships with Smart Technologies and other partners.

SIMUL — ENHANCED COMMUNICATION IN SIMULATION AND TRAINING

Gerald Penn (PL), Carl Gutwin (PCL)

Immersive simulation and training environments increasingly involve groups of people acting in dynamic domains. For example, a military simulation might require members of a platoon to coordinate their actions during changing battlefield conditions. Such environments, particularly when carried out by distributed participants, often fail to capture the range of communication available to people carrying out a real task in a physical setting. Furthermore, synthetic actors (characters controlled by artificial intelligence) are now often part of these simulation environments. Here, the communication problems are even more evident: these synthetic actors often communicate in jarring or cumbersome ways. Overall, problems of poor communication in simulations reduce the realism of that simulation, at times critically degrading the quality of the training.

To address this problem, this project will explore means of enhancing the richness of communication in immersive simulation and training environments, both verbal and non-verbal, and involving both humans and synthetic actors. Improved realism and richness in communication will in turn enable more natural behaviour on the part of the participants, which is then better predictable by user models developed through observation of human-human interactions (Nass, 2005; Pearson et al., 2006; Stytz & Banks, 2003). In the first five years of the proposal, we will approach this topic through research into richness of communication in gaming, intelligent dialogue modelling in "serious-game" battlefield simulations, and the use of ambient audio for communicating state information in virtual environments.

We will study the most effective ways to convey richness and a sense of immersion through the use of richer dialogue grammars, through richer graphical modes of interaction, and through selectively and automatically transitioning between different levels of richness in interface, each tailored to a participant's available amount of attention.

CAE will adopt technologies from this project to improve the realism of their simulations.

SKETCH — SKETCH INTERFACES

Karan Singh (PL), Faramarz Samavati (PCL)

This project builds upon the convergence of two significant trends. The first is that sketching is a universal metaphor for visual communication, which, harnessed appropriately, can provide a compelling interface to digital content creation by a broader audience. The second is the increasing

emergence of devices and displays that support tactile input. Sketch-based interfaces are thus the natural communion of tactile input and a universally understood medium of visual communication that mimic traditional methods of drawing, painting, and gesturing.

In computer graphics, the creation of digital content and geometric models and animation, have traditionally been the domain of skilled experts interacting with complex software packages that are tedious and challenging to use. With the increasing emphasis on user-driven content creation, computer graphics is changing from a medium which is created by experts and consumed by the masses, to a medium where all aspects of digital content are accessible to a broader public. While "everyone can draw" may not be strictly accurate, there is a universal desire and capacity for visual communication through sketching: a few quick pencil strokes can often convey complex shapes and motion. Coupled with the increasingly widespread use of devices that support tactile input, such as the TabletPC, SmartBoard, iPhone, and NintendoDS, interfaces and algorithms that infer user interaction and the creation of 3D models and animation from 2D sketch strokes, will change the way such content is created and consumed (Nealen et al., 2007; Davis et al., 2003; Lipson et al., 2002; Landay & Myers, 2001).

In a more abstract setting, sketching has the potential for complex gestural communication, especially when combined with the affordances of tactile input such as speed, pressure, or pen tilt. Research on approaches that exploit this information in various contexts will result in interaction vocabularies that are both more powerful and more natural for users than current interfaces.

Autodesk will adopt techniques to provide users a more natural interface to create in 3D.

VIRTPRES — ENHANCED VIRTUAL PRESENCE AND PERFORMANCE

Jeremy Cooperstock (PL), Stephen Brooks (PCL)

Videoconferencing suffers from limitations of fidelity and delay, and often proves inadequate for supporting group discussion or highly collaborative activity, especially between more than two sites. Moreover, existing technologies tend to prohibit or constrain mobility of participants. Similarly, the integration of remote avatars or virtual actors into shared spaces often imposes constraints on the realism, believability, and artistic control of rendered content, while real-time data acquired during interaction and performance is not fully exploited in current post-production systems.

This project will enhance the next generation of virtual presence and live performance technologies in a manner that supports the task-specific demands of communication, interaction, and production. The goals are to: improve the functionality, usability, and richness of the experience; support use by multiple people – possibly at multiple locations, engaged in work, artistic performance, or social activities; and avoid inducing greater fatigue than the alternative (non-mediated experience) (Woszczyk et al., 2005; Cruz-Neira et al., 1993).

Our approach to realizing these objectives entails further development and integration of several enabling technologies, including video acquisition and display architectures, spatially reactive yet controllable lights and cameras, tetherless tracking, video segmentation, multimodal synthesis, latency-reduction techniques, and novel GIS-like production interfaces. Numerous challenges must be overcome, including seamless integration of video display and presentation of 3D content, visible from multiple angles. Spatially appropriate audio is equally important, especially in the context of human-human communication, and the haptic modality (sense of touch) should also be

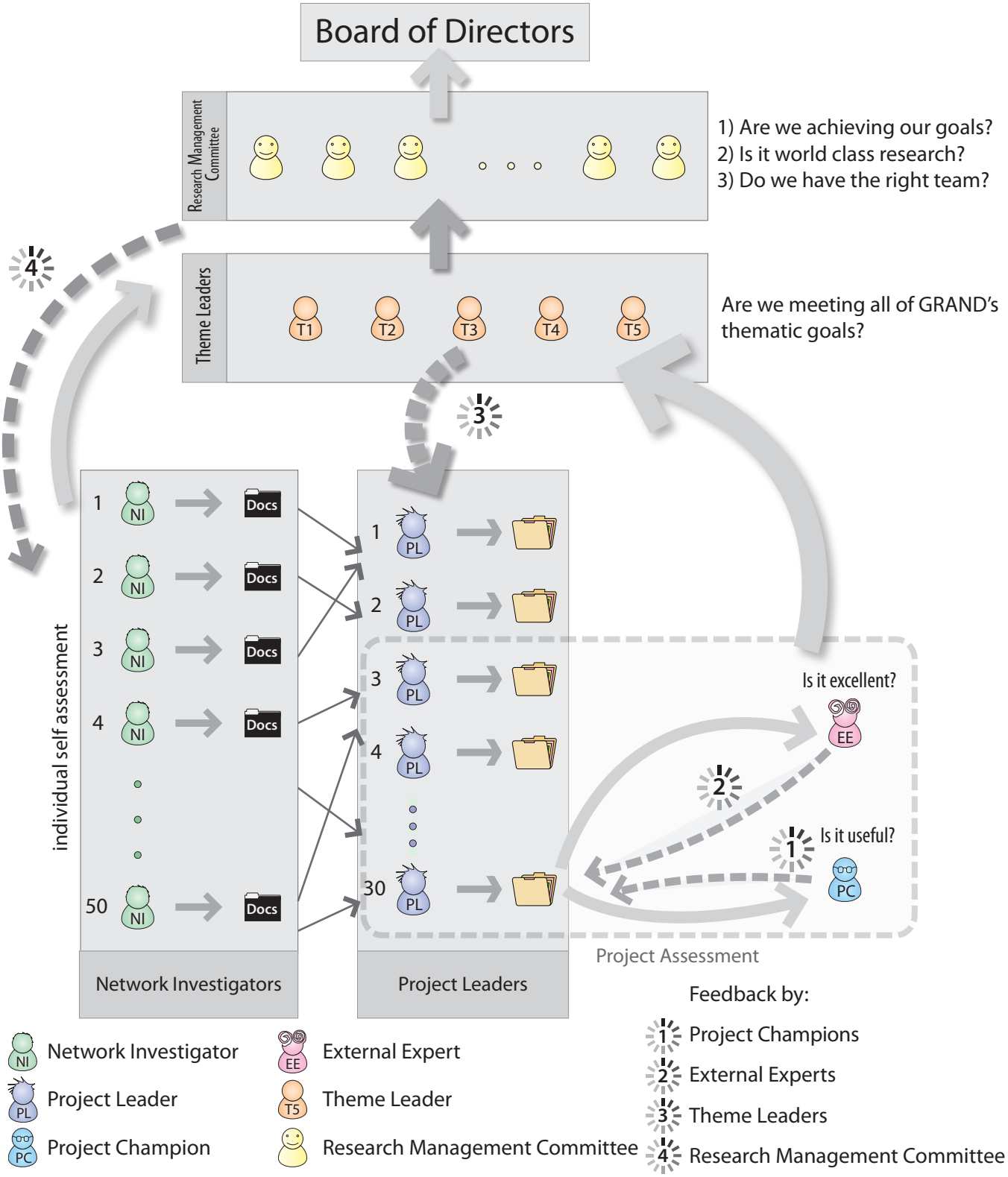

FIGURE 2: THE GRAND REPORTING WORKFLOW

supported. Participants must be allowed to move freely, while continuing to experience the relevant sights, sounds, and ground texture, as they would in a "real," non-mediated environment. Finally, recognizing the importance of delay minimization in distributed complex group activity, the project will investigate several mechanisms to reduce the impact of network latency.

Research Management

The Network's research program will be managed through the RESEARCH MANAGEMENT COMMITTEE, which will develop an annual reporting and research budget allocation cycle. This is illustrated in Figure 2.

All Network Investigators will submit annual progress reports and budget requests that describe their progress during the previous 12 months, their plans for the coming 12 months, the allocation of their actual expenses to each of the projects in which they participate during the reporting period, and their expected budget needs for the upcoming period.

These reports will be reviewed by PROJECT LEADERS (PLs in Figure 2) who will prepare "roll up" reports that provide an integrated view of the project, including interactions with partners, HQP training, knowledge and technology exchange and exploitation, and commercialization activities. In a similar manner, THEME LEADERS (TLs) will prepare "roll up" reports for each theme that identify significant goals achieved within the theme and opportunities for additional cross-disciplinary and cross-partner interactions.

The reports will be submitted in late Fall or early Winter each year so they can be reviewed by the Research Management Committee, which will then make recommendations to the Board of Directors for funding allocations to be approved prior to the start of the fiscal year. The exact dates for the various steps in the reporting cycle will allow a two-week period for PLs and TLs to prepare their roll-up reports, after which the Research Management Committee will have two to three weeks to review those reports and prepare its recommendations, followed by review and adjustment of the allocations (when necessary) by the Board. This leaves enough time to formally notify each partner university of the new budgets and to arrange for timely transfer of funds.

An April 1 – March 31 fiscal year has been chosen to align with universities' normal accounting cycles for Tri-Council grants. Past experience amply demonstrates that any other fiscal year alignment does not work.

The research management strategy is a blend of top-down and bottom-up initiatives. The Research Management Committee, working through the Theme Leaders, sets the high-level goals for achieving the Network's vision, but individual Network Investigator's propose the Projects that will achieve those goals. The three-dimensional grid of Network Investigators, Projects, and Themes is a management tool. Projects focus research threads in a meaningful way to help us steer the Network. Themes connect the research at a higher level to provide a broader view of the Network's overall research program. The tension between focus (depth) and integration (breadth) is always with us. In the same way, bottom-up initiatives by small groups of Network Investigators will keep the research program innovative. The specific mechanism for this is the strategy for adopting new Projects.

Allocation of Research Funds

Funding is allocated to individual Network Investigators, based on the assessment of their research portfolio within the Network and the value of their contributions to the Network. The assessment includes the normal metrics of success:

publications, students graduated, patents applied for, transfer of knowledge or technology to the user sector, additional funding attracted to the Network, and so on. But it also looks at the degree to which each NI collaborates with others across the Network, and how they deploy their resources. This is the basis for how new projects will emerge, and how older projects disappear when their value to the Network has diminished.

Network Investigators will be ranked as making Good, Excellent, or Outstanding progress. Less than Good progress will call into question continued membership in the Network. The expectation for those making Good progress will be a continuation of funding at the 80-90% level. Those making Excellent progress can expect to receive funding at 90-100% of the previous year's level. Outstanding research will be eligible for commensurate increases. The built-in, modest reduction in funding is intended to provide a source of funding to bring new Network Investigators into the Network, and to focus more resources on truly outstanding researchers. Guidelines will be developed by the Research Management Committee to ensure that only a certain percentage of the Researchers can be ranked Excellent or Outstanding each year so that funds are reallocated on a regular basis. Typically, annual funding for NIs will be in the range of $30K–$90K, and for projects $75K– $150K, both with low variance.

There will be an opportunity for groups of NIs to initiate new projects every Quarter, independent of the annual review cycle. A project proposal will identify a new set of research threads that form a coherent project. The NIs submitting the proposal will identify the resources they will bring to the project, and the impact this may have on existing projects. Shifting resources from mature projects that have achieved their goals, or from those that are not likely to achieve their goals, will be encouraged. If a new project is approved, the NIs will be assessed on their revised goals in the next annual review. This strategy allows NIs to take risks and be rewarded when they are successful, without jeopardizing the overall research program. This balances another tension, between agility and stability, something that also must be dealt with in any research endeavor.

In a similar manner, Projects that are not performing up to the standards of the Network may be wound down at any time. Usually this would take place as a result of the annual reporting cycle, but there will be provisions for unproductive research threads to be closely monitored or shut down entirely at any time it becomes apparent that this is in the best interests of the Network.

In all cases where project funding is reduced or eliminated, due consideration will be given to ensuring the continued academic progress of students funded by the Network, especially for doctoral students who have advanced to candidacy. They will be provided up to 12 months of "wind down" funding if they are making satisfactory progress on Network-funded dissertation research associated with projects that are terminated. The funding will come from a special reserve fund administered by the Research Management Committee.

In addition to regular project funding, a portion of the research budget will be set aside for accelerating the transition from research prototypes to technology ready for commercialization. The Technology Transfer and Commercialization Committee will develop policies for this.

Collaborating Researchers

In addition to the 50 Network Investigators, most projects have COLLABORATING RESEARCHERS (CRs) who bring expertise necessary to the project. Usually CRs will play an equal role in the research activity for a project and will contribute to HQP

training, Networking and Partnership building, and Knowledge and Technology Exchange and Exploitation. Frequently they will supervise or co-supervise graduate students.

In most cases the CRs, like the NIs, will have other sources of funding that are being leveraged by the incremental contributions from the NCE Program. In some cases, the CRs will be domain experts who are involved in only a single project. In other cases the CRs will have similar backgrounds to the NIs but with complementary expertise, or they will be providing the base funding that is being augmented and enhanced by the NCE funding. In every case, they will be chosen to strengthen the project team and to increase the probability of the Network achieving its business objectives.

Contributions from Partners

Usually cash and in-kind contributions from partners will be directed to specific projects of interest to the partner. A fundamental principle underlying the allocation of funds is that contributions from partners should not diminish the funds allocated to a project, although a Partner may wish to make arrangements for their contribution to permit new research activity to be initiated (including an entirely new project).

Most research within the Network is considered to be pre-competitive. All Network Affiliates will have access to the results and will be able to negotiate for commercialization rights. In situations where a partner wishes to arrange for pre-specified rights, provisions will exist within the Network Agreement for a range of terms that run the gamut from non-exclusive licenses to exclusive licenses for commercial use. In all cases, the Network will retain a non-exclusive right in perpetuity to use IP developed within the Network for research purposes.

Many of the proposed projects were developed in response to needs that have been identified through existing partner collaborations or through discussions with prospective partners or the user sector. A requirement for every project is that there be a PROJECT CHAMPION for each project. Champions must be from a non-academic partner. In a few exceptional cases, this requirement may be waived, such as for the two special projects, *NAVEL* and *MEOW*. But for most projects there will be direct and on-going involvement with one or more partner organizations.

During the annual reporting period, Project Champions will be asked to provide comments on the reports submitted by the Project Leaders. This will be an additional tool that will be used by the Research Management Committee to monitor the relevance of the research program. Projects that do not retain champions will be subject to additional scrutiny.

6.4 Development of Highly Qualified Personnel

GRAND will provide a novel interdisciplinary research network with capabilities in a fast-paced and technologically advanced arena that will:

- Attract new Canadian and International students and retain HQP in Canada.
- Provide access to a unique research environment and exciting new research areas.
- Train HQP to be highly marketable in the IT, Engineering, and digital media and Communications fields.
- Enhance existing and new graduate research and training through joint supervision of graduate students and increased research, funding, mentorship and training opportunities.
- Combine and integrate interdisciplinary ideas and research for further enhancement of HQP training.

- Attract and leverage the expertise of leading research and design experts and industrial partners that will engage in interaction, collaboration, lectures and workshops.

We are interested in training HQP in three distinct talent pools: engineers involved in building innovation specific to a cultural sector; Individuals involved in creative and or cultural industries who seek to advance knowledge and their applied artistic practices; Individuals interested in developing critical frameworks and production models for experiential and new media within a specific field (art, education, health, sustainability, and so forth).

The Scientific Directors, the NIs, and the theme leaders have a strong track record training diverse HQP, many of whom have gone on to assume leadership roles in Canadian new media companies and public sector organizations. Some examples are given in letters from contributing partners. This builds on a history of research collaboration between the applicants and the industry and other non-academic partners. Michael Century documents the first stage of this uniquely Canadian collaboration that began in the 1970s between the National Film Board and the National Research Council, which culminated in the Cannes Prix du Jury winner and Oscar-nominated film "Hunger/La Faim" in 1974. Shortly after that the collaboration expanded to include researchers in the Computer Graphics Lab at Waterloo, resulting in four students co-trained by NRC/NFB/Waterloo forming the nucleus of the digital animation effort in the NFB French Studio in Montreal in the 1980s. In parallel with this, an informal network of academic researchers at SFU, Calgary, Waterloo, Toronto, and Montreal began working with many of the Canadian start-up companies who designed and marketed many of the leading animation software systems world-wide.

The flow of highly-qualified personnel from these academic programs to the animation companies is well known and continues to this day. As noted earlier, this pattern was repeated in the 1990s when strong ties developed between many of the applicants and the computer games industry, and more recently for companies with new media product offerings. The proposed NCE will build on and strengthen the rich interactions that currently exist by expanding the circle of relationships through joint projects, cross pollination of ideas between sectors, and active participation by non-academic partners in every phase of the research from conception through to dissemination of results and technology transfer. The following sections outline the specific processes and plans of the proposed NCE to recruit, retain, and train students, and the impact that training and development will have on academic research, the Canadian workforce, and Canadian society.

Recruitment

Research personnel supported by network funding will include more than 150 students including 12 postdoctoral fellows, 55 doctoral students, 75 master's students, 10 undergraduate interns, and 5 research technicians at any given time. Because we expect many of the best students will have their own scholarships or external funding, the total number of students and postdoctoral fellows will probably be half again as many, drawn roughly equally from NSERC and SSHRC disciplines including:

- PhD, PEng, MASc and MEng in Electrical Engineering and Computer Science
- MASc and PhMBA and MMSC in Media Management and Information Technology from Faculties of Business & Management
- MEd and Ph.D. in Education.
- MA and Ph.D. in Sociology.
- JD, LL.M., Ph.D. in Law.

- MA in Media Production.
- MFA in Documentary Media.
- MJ and MA in Journalism.
- MA and Ph.D. in Psychology.
- MA and Ph.D. in Communication and Cultural Studies.
- MA and Ph.D. in Media Studies.
- MLIS and Ph.D. in Library and Information Science.

Graduate students will be recruited from the pool of top-ranked undergraduates at our partner institutions in part through undergrad research assistantships and internships and we will also aggressively recruit from other Canadian and International Universities by advertising vigorously at National and International conferences. Furthermore, there will be opportunity for undergraduate students to participate in the proposed NCE, which will give exposure to research projects, ideology and methods, which will entice and prepare many undergraduate students to pursue graduate research.

Retention

Students in GRAND will be engaged in one or more research projects, many of which will span across disciplines and universities. This rich fabric of collaboration will provide a unique environment that will be very attractive to students. Funds will be set aside to allow students and postdoctoral fellows to travel to other sites in the network for extended visits during which they will be exposed to new ideas and ways of approaching the research problems under investigation. In many cases we expect this will lead to partnerships that develop into career-long collaborations as students as postdoctoral fellows interact with each other and with faculty and industry partners across the network.

A Graduate Student Advisory Committee will have graduate students representing the various disciplines and universities involved in the research. Elected members of the committee will serve one-year terms (for a maximum of two consecutive terms) to provide a conduit for direct communication between graduate students engaged in the research program and the Executive and Research Management Committees

Training and Development

The network will enhance existing HQP training opportunities in a number of ways. Each of the industry partners is contributing up to $100K per year to the research program in a blend of cash and in-kind, which varies from partner to partner. The cash contributions support research of direct benefit to the partner and will be used exclusively for student salaries to guarantee a high return on investment in terms of HQP. Partners also anticipate significant benefits from research where they make in-kind investment of their employees' time, which will further enhance the HQP training by offering students an opportunity to work side-by-side with their industry counterparts in "real world" settings.

Highlights of the research and training experience within GRAND will include:

- Access to state of the art research facilities including 18 labs funded by CFI
- Active and experiential learning: students will participate in the act of building and using new knowledge
- Both graduate and undergraduate students as well as postdoctoral fellows participating in research
- Just-in-time learning environments with technology-enhanced knowledge creation, collaboration, and intelligence gathering
- Design studio-style instruction through workshops and Design Summits

- Emphasis on social construction, rich collaborations, knowledge creation, apprenticeships and portfolio building
- Use of resource-rich virtual, physical and hybrid work environments including shared computational resources and specialized digital knowledge exploratoria
- Comprehensive, student-centered research programs that prepare students to be innovative, to excel in their future academic and professional pursuits, and to engage in life-long learning and to make significant, lasting contributions to the knowledge economy
- The opportunity to 'cross-train' and learn how to integrate findings generated through different methodological and disciplinary approaches

Industry Opportunities

A major component of our HQP training will be creating opportunities for graduate students to interact with partners. This will range from short visits to exchange information or discuss directions for research to longer relationships including internships and residencies where students spend extended periods of time working with partners. We will leverage the MITACS ACCELERATE program as one way to encourage this activity. MITACS (Mathematics of Information Technology and Complex Systems) has agreements with many of the provinces for matching funds that are used to support internships funded by industry. Many existing NCEs participate in this program through Memorandum of Understanding with MITACS. GRAND will enter into such an agreement if it is funded. The agreement sets out the terms for MITACS to manage the internship program and to administer the provincial funds, with the NCE (GRAND in our case) working with its partners to identify students and companies. We see this as an excellent vehicle for increasing the interaction between graduate students engaged in the research program and our partners in the private sector. The agreement with MITACS will also provide us access to the network of Business Development Directors that MITACS has established across Canada to facilitate its programs (including ACCELERATE). This relationship will increase GRAND's ability to respond to the needs of receptors in industry through referrals from MITACS of companies in the New Media, Animation, and Games sectors, in addition to its primary goal of increasing contact between graduate students and industry partners. Other forms of internships and residencies will also be encouraged, especially those that provide cross-disciplinary experiences.

Academic Opportunities Afforded by the Network

Each of the initiatives will serve as a node providing collaboration, training, and support for a group of outstanding junior and senior scholars and their students. The domains draw support from world-class faculty. This NCE team is in an excellent position to support both future scholars and future professionals. There will be numerous opportunities for graduate students to be involved in research assistanceships or to do conduct independent research in areas within the scope of this project. The unique interdisciplinary nature of the research teams will expose students to a range of research methods from social sciences, humanities, computer science, engineering and design. This structure will lead to organically emergent lines of education, research inquiry, active entrepreneurial research leading to commercial opportunities, and traditional publication and demonstration opportunities. All of these will arise from academic and research activities offered across the network. An Annual General Meeting (AGM) attended by all NIs and their students will serve as a focal point for the formal exchange of final and preliminary research findings as well as an opportunity for students to workshop new ideas.

A series of Design Summits will be held at the Banff Centre and other locations to bring industry, practitioners, and academic researchers and their students together for focused workshops that will explore targeted advances in new media, animation, and games technology and will examine social, economic, legal, and cultural questions related to those technologies. Design Summits will be multi-way channels for exchanging information that will provide a competitive advantage for companies engaged in commercializing results of the research, and for integrating practitioners and members of receptor communities. These will constitute a new type of HQP training that will extend to the user sector and strengthen networking as well as technology transfer and commercialization activities.

As well as the senior-level summits we will organize two to five day technology workshops on GRAND-related knowledge and technology transfer that facilitates the growth of HQP. For the junior component we will use the structure developed in the Smart Geometry series, which brings partners, designers, developers and researchers together for an intensive multi-day workshop facilitated by a group of lead researchers and practitioners. The participants bring their own problems and work on them throughout the event. Daily presentations and a final plenary session ensure cross fertilization. The role of the lead participants is to facilitate inter-project connections and to provide active guidance to participants. The integration of GRAND academic partners with strong design schools into the student component will mean that workshops have highly skilled practice-based tutors as facilitators. At the same time, this integration will facilitate emerging applications designers, artists and entrepreneurs and emerging new media researchers to share their approaches to product and experience development enabling the emergence of coherent Canadian approach to innovation.

Communication of research will also be supported by on-line access to resources and followed by just-in-time publication as well as paper publication in disciplinary journals. This approach creates a valuable resource for teaching, further research and commercialization or dissemination of results.

Funds will be set aside to encourage exchange visits between nodes for graduate students working within the Network. Access to these funds will be provided based on policies established by the Research Management Committee. Students who receive these funds will be expected to give one or more presentations on their research at the host node, and to give a "how I spent my summer vacation" presentation at their home node that summarizes the research activities in which they were involved during the exchange visit. Special encouragement will be given to exchange visits that bridge disciplinary boundaries. Funds will also be set aside to support student collaboration on a single project across institutions.

Labs

HQP will be further enhanced by access to state of the art research facilities including 18 CFI funded labs:

- Alberta has been awarded $1,195,064 for "Canadian Writing Research Collaboratory" –CFI Lead Applicant is Susan Brown and Eleni Stroulia is a co-investigator.
- Carleton was awarded $1,888,907 in 2002 for the HCI Institute: a building and equipment for HCI research, completed in 2008. PI is Gitte Lindgaard. Brian Greenspan and Robert Biddle are also involved in the project. The lab facilities will be used for GRAND projects.
- Calgary was awarded $85,570 in 2008 for a Leaders Opportunity Fund grant - Funding for infrastructure associated with a Canada Research Chair: UbiC Tele-Arts Lab: Ubiquitous Creativity on E-Arts Grids. The PI is Kenneth Fields.

- Calgary was awarded $293,000 in 2002 for a Collaborative Visualization Laboratory and $182,020 in 2004 for Innovations in Visualization Laboratory. Sheelagh Carpendale is PI for both.
- Concordia's Hexagram Institute for Research-Creation in Media Art and Technology was awarded $4,586,426 (total LEF award) in 2009, Lynn Hughes PI, as a follow up to the $21,963,639 (total) CFI award five years earlier (with UQAM, PI Barbara Layne).
- Dalhousie Graphics and Visualization Lab has been awarded $633,324 by CFI and Nova Scotia's NSRIT for new laboratory space and equipment. The portion of the award that is applicable to the proposed research is $338,093. PI's Stephen Brooks and Dirk Arnold. In addition, a second CFI equipment grant was awarded to the Faculty of Computer Science at Dalhousie University. The facility, entitled the Dalhousie Distributed Research Institute and Virtual Environment (D-Drive), was purchased in 2006 and offers collaborative technologies for research. The awarded value for D-Drive that is applicable to the current research is $310,927.
- Dalhousie Information Interaction Lab has been awarded approximately $320,000 by CFI and Nova Scotia's NSRIT for three facilities: Usability Lab, GroupWork Lab and R&D Lab. PI Elaine Toms.
- Queen's Human Media Lab has been awarded 897,000 by CFI and Ontario's MRI for a new laboratory in Human-Computer Interaction. PI Roel Vertegaal.
- Ryerson has been awarded Experiential Design and Gaming. Co-investigators on this lab are Deb Fels and Abby Goodrum.
- Ryerson was awarded in 2007 approximately $500,000 by CFI and the Ontario Research Fund for research infrastructure to build the "Digital Cinema Research Laboratory at Ryerson." PI Abby Goodrum.
- Saskatchewan has been awarded a Human-Computer Interaction Laboratory for Sensing User Context and Adapting User Interfaces in December 2008 (total $179,000). PI is Regan Mandryk.
- Toronto has been awarded $2.4M by CFI with potential matching from ORF for a digital media centre. PI is Eugene Fiume.
- Toronto has been awarded $6.1M by CFI with potential matching from ORF for an Inclusive Media Design Centre. Co-PI Deb Fels.
- UBC has been awarded $5.177M by CFI with potential matching from BCKDF and additional IOF for "Expansion of ICICS Facilities". One of the five themes for the new facilities is Human Sensorimotor Systems, led by co-applicant Dinesh Pai.
- UVic was awarded CFI/BCKDF $127,700 Computer Graphics Research Laboratory April 2007 PI is Brian Wyvill;
- UVic has been awarded CFI/BCKDF $173,000 for Colour Science for Computational Photography, in November 2008. PI is Amy Gooch.
- UVic was awarded CFI/BCKDF $147,884 for Large Screen Visualization Laboratory in 2008. PI is Melanie Tory.
- Western has been awarded $2,577,602 for "Image-Guided Minimally Invasive Intervention and Simulation" – CFI Lead Applicant is Terry Peters and Roy Eagleson is a co-investigator.

Outreach and Community Impact

HEALTHCARE

Training for students also includes work with disabled and senior citizen user communities and becoming knowledgeable about and sensitive to inclusive design and research practices. Students with disabilities and seniors will continue to be actively recruited to participate in the projects of the researchers. At the University of Toronto

qualified trainees may also participate in the Health Care, Technology, and Place program, a CIHR-sponsored graduate training program (PI: Peter Coyte, Toronto) that simultaneously focuses on the social, spatial and technological configurations that characterize health care, and the NSERC-funded CREATE: CARE program (PI: Tom Chau, Toronto) that trains students to be interdisciplinary rehabilitation scientists, Robarts Research Institute (VASST group – Virtual and Augmented Simulation for Surgical Training), Canadian Surgical Technologies and Advanced Robotics (CSTAR), and UoA's HSERC (Health Sciences Education Research Commons). The proposed NCE project's involvement with healthcare and wellness areas, provide a distinctive synergy of disciplines that will enable students involved with the project to be trained in an area that will have a unique impact on society and the quality of life of Canadians. We expect that students will be able to do internships in collaboration with healthcare professionals or the Canadian Pain Society, to better educate the student on the important issues facing people with chronic pain. Similarly, internships are possible as part of the effort to gain an understanding of maintaining social connections for people 60 and over.

CULTURAL HERITAGE

The importance of the impact of digital technologies on Canadian culture is evident in the Canadian Government's response through programs like the Canadian Culture Online Program and Canadian Heritage Information Network, both targeted at promoting and supporting digital strategies for Canadian heritage. While the research program proposed here is complementary with the efforts funded by these programs it also holds distinct advantages. Students and faculty will have the opportunity to investigate the challenges and potential benefits of new media in the cultural heritage sector through interaction with the McCord Museum, Museum of Anthropology, and Telus World of Science: Science World. The beneficial impact of researching heritage institutions and technology can be viewed economically and socially. Economically, Canadian heritage institutions earned $1.05 billion in revenues in 2006 (Stats Canada). Arguably more important, heritage institutions have been central to communicating Canadian heritage and ensuring its preservation. In this respect the cultural and social impact on Canadians is immeasurable and the ongoing vitality of Canadian heritage institutions is invaluable.

JOURNALISM

The 2006 Final Report on the Canadian News Media issued by the government of Canada identified a number of areas for concern, including the effects of technology – seen as both catalytic and disruptive – and called for increased support for both research and education in journalism. The report recommended that "there be established a permanent, full-time research centre devoted to the study of the Canadian news media."

Ryerson's School of Journalism is the largest in Canada and more than half a century old. The proposed NCE will provide an opportunity for researchers and graduate students from Schools of Journalism and Communication as well as researchers and industry partners from the Institute for Innovation and Excellence in Journalism, the CBC News World Archives and the Infoscape Lab to work together with journalists and news media producers to explore the impacts and design of technologies to support a free and democratic news media in Canada.

A Day in the Life of GRAND Students

The proposed NCE represents a new way of thinking about research, development and design practice, education and the development of theory

and policy across graphics, animation and new media As such it will require new ways of utilizing existing programs and resources. This section is an attempt to envision the operational and practical aspects of the proposed NCE in terms of curricula, research, resource requirements and administration. We do this by envisioning some of the typical activities that might take place for students engaged in GRAND.

Mary Bishop, a doctoral student in Interdisciplinary Design Studies (Engineering specialty) program is arriving for her 8:30 a.m. meeting at her University. She wants to make sure that the latest models of the prototype voice synthesizer (PVS) she and her team have been working on are ready for today's critique. She sees two of her team mates, Julian and Rod (the team's Information Systems specialist and Industrial Design specialist respectively) have a table littered with numerous brightly colored squares. They're examining swatch samples of various finishes and textures which might be applied to the PVS.

The PVS is one part of a large project that began two and a half years ago. At that time, the GRAND Student Advisory Committee had been approached by an industry partner and several Network Investigators who recommended that faculty and students begin to examine the design of Human Performance. That broad mandate quickly sorted itself into a collection of unique interdisciplinary projects. One proposal came from four faculty members with appointments at different Universities, who proposed creating an opera for people with missing or damaged vocal chords. Ron Farr, professor of Industrial Design, was the lead investigator on the proposal. He held a number of patents in technology used to convert sub-sonic vibration into musical tones, and quickly saw how a similar technology could be used to generate voice-like sounds. When he took the idea to a colleague at the Banff Center she suggested that rather than simply try to replicate speech, they go for something more ... dramatic. As a result of their collaboration, the idea for extending human physical performance within an artistic performance took shape, and the final presentation form—an opera—was conceived.

In addition to the students working on the project this morning, there are a few professors taking a look at the work in process and on display. The HD monitors that line the walls are tuned to various channels and a few show live links to other GRAND sites around the world. In one of these—the monitor linking them to Strasbourg—Mary sees a chapel in a medieval cathedral where one of the team is working on sabbatical.

But right now the commotion is around Julian and Rod. Several students and a couple of faculty members are gathered around the table looking at three delicate objects. Looking like various subspecies of an alien arthropod, the red plastic models are actually working prototypes of the PVS. The plastic is a conductive material that uses the body as a battery. The PVS is a prosthesis, worn like a necklace that wraps up around the lower jaw. The models everyone is looking at are the result of many hours of student and faculty time in collaboration with their industry partner. They contain the latest cellular telephone technology, but Mary has added a chip that allows the prosthesis to communicate in a portion of the spectrum just below that which is normally reserved for educational and public radio. This chip is the focus of research for another team within GRAND that specializes in understanding the legal, political, and societal impacts of new technologies.

The four students in the New Media Policy team (everyone calls them the Policy Wonks) have been researching policy relating to Industry Canada Interference -Causing Equipment Standards and CRTC policy in an attempt to reserve public spectrum for Communication-disabled Canadians. Their past efforts involved trying to work with the CRTC to reserve the spectrum required for the big project. If they are successful, their next stops will be to go to Ottawa where they will present their report. Their hope is to

align the design of new policy with the possibilities engendered by the work of the PVS design team.

There are lights moving around in one of the mounted monitors, and Mary knows that this is the local techs in Strasbourg preparing for the meeting and demonstration today. Another monitor displays the avatar of Carol Bean, a team member in Sydney who is coordinating participating in the demonstration via Second Life. Carol is a graduate student with a degree in Exercise Physiology, and she kicks the meeting off by asking if the physiological telemetry application she e-mailed to the server has compiled. In answer, Julian holds one of the finished models in front of his WebCam and gently rubs one of its spidery legs. In response, a complex wave form that rumbles and quakes appears next to Carol's avatar in Second Life.

"The software is fine, our only problem" says Julian, "is whether the musicians will think the prosthesis is still too 'Sci-Fi' for the performance. Today's critique could be painful."

The remainder of the meeting is devoted to a systems check of the PVS, a review of the presentation slides, and final tweaking of the order of presentation. The meeting ends with a sound check in the Strasbourg chapel. Mary and her team connect with Fr. Paul Dominique, the prior of the monastery. He has coordinated with the faculty member on sabbatical there to test the acoustic range of the PVS and its compatibility across various amplification systems. The chanteuse has volunteered to lead a matin Mass rehearsal with a PVS prototype that will send physiological measurements for analysis by Carol and her faculty advisor.

At 9:30 a.m., the group takes a collective breath and moves toward the auditorium. Their presentation and critique will be attended by many of the GRAND students and faculty both locally and via Second Life. As well, there are rumours that the industry partner will be present and is bringing angel investors. The design of the group's performance, as well as their Human Performance Design Prototype, is about to undergo a rigorous review. The live review of the PVS performance telemetry will begin soon after, and Professor Farr will help the team through one more round of refinements.

The essential efforts of these teams are replicated across a number of disciplines. Teams led by a visiting music faculty member are engaged in writing the multi-mode opera that incorporates the range of sounds that can be generated by PVS devices. Another team, led by a doctor with a joint appointment at a local Medical Center, is leading the design of the medical testing protocols for the device.

The work undertaken by the students and faculty is intended to lead to successful patent applications and the establishment of satellite businesses. The PVS will also be demonstrated and critiqued at the Annual Conference to be held in Banff the following summer. This Conference has become an increasingly important event for the new media design community occupying the niche once held by the TED conferences and the students know that a successful demonstration of the PVS there can lead to lucrative post graduate employment offers as well as opportunities to pursue doctoral or postdoctoral work or faculty appointments.

6.5 Networking and Partnerships

GRAND's research program is based on an agile matrix organization of researchers working across themes and projects and universities, to combine into dynamic, multidisciplinary teams that address specific projects (initially 32 projects) each organized around a core challenge. This multidisciplinary approach was designed after much consultation with companies and our experience with the NSERC Strategic Research Network in collaborative technologies, NECTAR. It is a mirror for the needs of our partners in the private and public sector; they require multidisciplinary knowledge and experimentation to innovate and grow. We have

built multidisciplinary collaboration with our partners right into GRAND from the outset, in the definition of GRAND's themes, research projects and partner networking events. This section outlines our approach, linkages and incremental value for partners.

Addressing the Needs of Canada's Digital Media Industry

It is often stated that Canada "punches above its weight" in digital media. Much of the animation and digital effects software used in Hollywood was created in Toronto and Montreal, in partnership with Canadian universities. Open Text in Waterloo, Canada's largest Canadian software company, has a significant fraction of the worldwide market for enterprise content management. Our partner Deluxe runs its analysis of movie piracy, and its forensic solutions to thwart piracy, from its Toronto studio, which is one of the three largest Deluxe studios worldwide. Vancouver and Montreal have vibrant computer games clusters, with several important game titles and brands. Ubisoft is opening a major games studio in Toronto to benefit from expertise in Ontario's film and television industry, which employs an estimated 267,000 Ontarians.

Many of Canada's digital media companies are relatively small and very focused, characteristics that have contributed to their success. However, they increasingly sell products or services into a marketplace that is speeding up and is impatient for convergence. Workflows need to be made more efficient, more automatic, yet more easily tailored and more capable of delivering content to multiple platforms for media consumption. Consumers are used to an accelerating pace of new platforms with new features and are eager for experiences that use those features to delight while informing or entertaining them. Creators are struggling to understand how to employ new media enabling technologies, such as large displays in public spaces, or projectors in distributed theatre (or cell phones), or GPS in short video on mobile devices, to create emotional beauty and universal connection.

As our partner companies and public partners create new services and improve their products, they are impacted by issues of speed, convergence and multi-platform delivery. These often require expertise outside their competencies or they require more long-term experimentation and investigation than the organization can easily accommodate. GRAND has been designed to address these problems. Our multidisciplinary teams bring researchers with the expertise (or connections to other researchers with the expertise) to address all aspects of the company's idea. Researchers and graduate students may have the luxury of persisting with an interesting problem or candidate solution longer than possible for company experts.

Interestingly, the knowledge flows in both directions, because the companies, for example, software tool building companies, often have a very high level of scientific knowledge in specific areas and can transfer this knowledge to university researchers and graduate students.

As Michael Lee, Rogers' VP and chief strategy officer frequently observes, "The barriers to the introduction of innovative new services has never been lower. Wireless delivery is almost free and new companies can run their systems in the cloud." The main missing ingredient is broad expertise to ensure that new services are designed to succeed. Our researchers will include producers of content, experts in media studies, human computer interaction specialists, researchers in experience design, computer scientists, engineers, and experts in new media business and policy. This broad expertise can help partners and users cope with the quantity and diversity of digital content,

its distribution channels, interfaces and new work processes.

Ensuring Effective Partnerships

GRAND researchers chose to get involved in the network based on previous positive research collaborations with companies or other user partners. So, most projects initially have some partners collaborating with the researchers, based on existing linkages, providing equipment or facilities, hiring graduates and adopting results. These companies are GRAND partners and typically have already seen their networking increase to include researchers from other schools with related expertise join into the project on which their initial interest is focused.

However, as we were forming the research program and growing GRAND's set of university partners and researchers, we held a series of half-day meetings with several large new media companies. We discussed their successes, needs and relationships with our researchers. These companies immediately saw the potential of partnering with the entire network and are among our larger partners in terms of level of support.

GRAND's workshops, annual meetings, project interactions and briefings and other events are designed to have value for both types of partners, to enlarge the numbers of projects of interest to the "single project focused" partners to grow their participation and benefits from GRAND. For the larger GRAND partners our networking and partnership activities will ensure that their involvement in GRAND is broadly-based and delivers value for their investment.

Evolution of the research program and the formation of deeper synergies will enrich the project outcomes and the networking capability of GRAND researchers. Partners will benefit from quick introductions to Canada's premier academic expert in topics of interest to them. As GRAND transfers more knowledge and technology, and fosters innovation that spins off campus, successful partner relationships will provide a springboard for getting new private and public sector partners involved.

Public Sector Partners

Our definition of public sector partner is quite broad, to include user groups and information providers who are not private companies. The public sector partners include:

COMMUNICATION RESEARCH CENTRE NETWORKED MEDIA LABORATORY

The Communications Research Centre is a research agency in Industry Canada that provides knowledge and new communications technologies to industrial clients and the government of Canada. The Networked Media Laboratory is especially interested in new technologies to deliver rich experiences on mobile platforms such as smartphones and netbooks. Initially, researchers there will provide $75,000 per year of time spent collaborating with the EOVW project which develops methods for evaluating social play for kids in the context of virtual worlds. CRC's Networked Media Lab has been conducting research in collaborative virtual environments, especially their human computer interaction aspects.

NATIONAL FILM BOARD

The National Film Board is Canada's producer and distributor of distinctive and audacious audiovisual content that engages Canada and the world in stories of social relevance that provoke reflection and social dialogue. These are often documentaries and the NFB is moving aggressively into digital media to expand its creators beyond filmmakers to include visual artists, photographers, web developers and others. Filmmakers are encouraged

to create digital media companion pieces that are seen before the film, to understand how digital media can change the way stories are told in film, and to experiment with stories that can only be experienced online. The NFB is looking to GRAND to help discover what kind of storytelling works as digital media, and which aspects of an interactive digital media experience work as meaningful interaction, creating deeper connection, emotional satisfaction and community. How do specific device characteristics and mobility change the way people connect to the content? And how can producers invest time or effort with creators to get meaningful digital content?

While the NFB has not declared a specific amount of support committed to GRAND at this time, it has identified four projects for collaboration and will allocate resources if these projects can be linked to NFB collaborators or productions. These projects focus on: *AESTHVIS* and visualization, persistent interactive experiences (*EOVW*), and interactive behaviours beyond HD video and gaming (*HDVID*).

TORONTO REHAB

Canada's largest rehabilitation hospital, Toronto Rehab, is collaborating with GRAND researchers to advance its project iDAPT, Intelligent Design for Adaptive Participation and Technology. Initially Toronto Rehab experts will work with Prof. Deborah Fel's *INCLUDE* project to advance rehabilitation including Prof. Ron Baecker's research on social TV systems to combat isolation and gaming for cognitive health. These latter two initiatives address Toronto Rehab's mission to enable healthy aging by Canadians. Toronto Rehab will provide access to patients as subjects for research and will host student internships. Although GRAND has other broad commercialization partners, Toronto Rehab has a lot of experience in the commercialization of rehabilitation products. Traditionally academics in technology areas have found commercialization in health fields fairly challenging, so we welcome Toronto Rehab's domain expertise.

BRITISH COLUMBIA INNOVATION COUNCIL

BCIC is a strong proponent of BC's computing technology industry and new media cluster, and it supports the commercialization of innovation in large part by expanding the entrepreneurship infrastructure to enable the uptake of innovation. BCIC strongly supports the objectives of GRAND and has committed their director of ICT, wireless and new media, Dean Prelazzi, to help GRAND commercialize results arising from its research and to serve on GRAND's Technology Transfer and Commercialization Committee.

CANADIAN DIGITAL MEDIA NETWORK

The Canadian Digital Media Network is an NCE Centre of Excellence for Commercialization and Research, centred in the Waterloo Region, working to connect researchers and innovators across all of Canada to create technology and content for Canadian businesses to export to the world. CDMN will help GRAND researchers transfer their knowledge, results, intellectual property and HQP to industry and can help researchers and students form new companies or partner with existing companies.

BC HYDRO POWER SMART

BC Hydro Power Smart's goal is to create a culture of conservation that leads to the incorporation of the use of power-efficient technologies in everyday life. To this end, it is interested in GRAND's efforts on new interfaces and interactive alternative energy controls to provide consumers with new tools and opportunities for learning about behaviour and conservation of energy. BC Hydro Power Smart will continue to host graduate student research interns from relevant projects such as the *HCTSL* project led by Profs. Bartram and Woodbury, and looks forward

to other research relevant to Power Smart's role.

VANCOUVER CHAPTER OF SIGGRAPH

The Vancouver Chapter of ACM SIGGRAPH (Association of Computing Machinery's Special Interest Group for Computer Graphics) is one of the most active SIGGRAPH chapters in the world. Besides graphics, gaming, animation and digital effects, interest in SIGGRAPH grows as technologies from graphics and animation become increasingly the basis for interaction between people and software. The Vancouver chapter of SIGGRAPH helped attract Pixar to open a development studio in Vancouver and has secured Vancouver as a venue for SIGGRAPH 2011, which along with ACM CHI 2011 (Computer Human Interaction), will attract more than 25,000 new media experts to Vancouver.

The Vancouver chapter of SIGGRAPH will host GRAND researchers as speakers at chapter meetings to connect with local developers and creators to seed research ideas and get artists thoughts. SIGGRAPH members will be involved in GRAND's Keystone workshops and other events such as the Annual Meeting to see research results and provide feedback about creators' needs. Vancouver SIGGRAPH will also help us achieve our objective of linking new media clusters by connecting Vancouver's new media cluster through SIGGRAPH to clusters in Toronto and Montreal, among others.

INFORMATION AND PRIVACY COMMISSIONER OF ONTARIO

Ann Cavoukian, the Information and Privacy Commissioner of Ontario, supports the GRAND project *PRIVNM* on usable privacy and security for new media environments. *PRIVNM* applies social science research to online, new media interaction in order to inform usable design for privacy and security, and legal scholarship. Dr. Cavoukian will meet with the researchers periodically to discuss *privacy by design* and research results.

PRECISION CONFERENCE SOLUTIONS

Precision Conference Solutions provides a secure and user-friendly online publication submission and review system for academic and research conferences. PCS is willing to provide its system to GRAND to improve GRAND's own workflow and communication with network partners. The system will also be available as a testbed for research to glean social interaction data and to make improvements that can become enhancements to Precision Conference Solution's product.

SASKATCHEWAN IN MOTION

Saskatchewan in *motion* is a movement of volunteer leaders and champions aimed at increasing physical activity. They support GRAND's *GAMFIT* gaming for fitness project because it aligns with their goal of encouraging physical activity for children.

Principal Private Sector Partners

Our five principal private sector partners are companies that immediately saw a value to interaction with several of the projects and sites in our network. Typically, when meeting with these companies during our consultation phase prior to developing the application, they volunteered to play a role in defining the research projects and want to participate in the ongoing evolution of the research program. Each of these companies is a stakeholder in a broad spectrum of digital media and exports, or in Rogers' case, is seeking to export, products and services worldwide. These companies strive to innovate constantly and want to engage their customers and stakeholder communities at a range of levels, from individual to corporate customer, from amateur to expert, from pilot experience to heavily invested, and from thought leadership to deep engagement.

Our principal private sector partners look to GRAND as a source of: international awareness of new ideas and trends; advanced research and technology experimentation; reduction of ideas to practice on problems relevant to the partners; prototype software embodying new technologies; and HQP bringing deep capability in technology development, social sciences and design together with knowledge about issues relevant to the partner's advanced technology focus.

GRAND's five principal private sector partners are: Autodesk, Side Effects Software, Deluxe, Electronic Arts and Rogers Communications Inc.

AUTODESK

New media companies are working to accomplish 3D integration into modeling, animation, simulation, games and rendering. At Autodesk, 3D capabilities are more broadly applied to engineering design to achieve 3D digital prototyping of mechanical, environmental, transportation or architectural designs, so Autodesk's software provides digital prototyping to enable designers to visualize, simulate, and analyze. GRAND's new media focus will help Autodesk in several ways:

Models of virtual humans and human motion research underway at Toronto, UBC and McGill will incorporate biomechanics, human trajectories and distributions of human shapes and sizes into simulations of industrial designs such as chairs.

GRAND *CAPSIM* project, at UBC, Toronto and elsewhere, which investigates automatically importing 3D measurement, lighting and texture into 3D models and simulations, can help Autodesk enable users to capture, interactively then edit and analyze scenes and objects from the real world.

The GRAND sketch-based interface project, *SKETCH*, will help Autodesk provide a more natural interface that achieves the fluidity of paper while inferring 3D models from 2D pen strokes.

GRAND's *HCTSL* sustainable living project will help Autodesk enable users to explore the design space from the perspective of occupant behaviour, which will improve the performance and reduce waste in designs.

Autodesk Research encourages thought leadership in technologies to achieve greener buildings, including simulation and design tools, as principal organizers of the Symposium on Simulation for Architecture and Urban Design (SimAUD). This work is very relevant to GRAND's *HCTSL* sustainable living project and the *ENCAD* project on enabling technologies for CAD systems. Autodesk Research scientist (and GRAND collaborator) Azam Khan is the general chair for SimAUD 2010. Autodesk and GRAND will attempt to co-host the symposium in Canada to increase GRAND's connection to this design community.

Autodesk is providing $50,000 per year cash, to fund relevant research, and a further $50,000 in-kind including the time of three Autodesk Research scientists in collaboration with GRAND researchers. One of these, Jos Stam, is an adjunct professor in the Department of Computer Science at University of Toronto. Autodesk will also help identify new research problems and participate in GRAND research management and selection. Autodesk anticipates it will benefit from the results of research by adopting ideas in the public domain and hiring HQP trained by GRAND researchers.

SIDE EFFECTS SOFTWARE

Side Effects is a world leader in 3D animation and special effects software for film and game development, including modeling, rigging, animation, particle effects, channel editing, compositing, and integrated rendering. New features such as Digital Assets enable the management of repetitive effects by providing an environment setting to give creators access to the

cameras, models and animation required for a shot, avoiding costly communications delays.

Side Effects is located in Ontario to benefit from the talent available from government investments in relevant research and training at universities and colleges. While Side Effects has benefited from university-based innovation, and looks forward to the research results and innovative applications arising from projects in GRAND, its primary goal is to support the capacity of the universities to educate students in digital media, computer science and international business to fuel Side Effects' growth. It is relying on its relationship with GRAND to broaden that interaction to many other universities in Canada.

Side Effects is providing $100,000 per year cash to increase the interaction between its experts and GRAND NCE researchers by funding research of immediate value to Side Effects. In particular, the *PROMO* project has the potential to generate new ideas in procedural modeling of interest to Side Effects, and the ENCAD project has the potential to generate new ideas about structuring mechanisms for design alternatives.

DELUXE

Deluxe Toronto Ltd. is a unit of Deluxe Entertainment Service Group, the leading provider of entertainment industry services and technologies, including film processing and distribution, and digital services. Digital services include: digital scanning and intermediate services, including colour management and transfer back to film; digital postproduction including HD dailies, sound mixing, digital asset management and delivery in multiple formats worldwide; DVD encoding, mastering and authoring (world's largest); and forensics for detection of film piracy and tracing leaks.

Deluxe is challenged by the increased use and speed of 4K digital processing, where a typical full length feature film generates 2,000 TeraBytes of data and metadata. GRAND will help Deluxe grapple with issues of storage and compression, and investigate issues in creating a secure digital content workflow management system that combines forensic technologies. GRAND's researchers will address the interaction design for the authoring and sharing of end-user created content on network-enabled Blu-Ray players in the *HDVID* project. What applications are attractive to users and how will the content be shared in a way that preserves copyright? Experts from HCI, experience design, legal implications and social networking are all needed for this problem.

To fund these particular research initiatives and broaden their overall connection with GRAND researchers, Deluxe is providing $50,000 per year of cash and $50,000 per year in-kind in the form of collaboration with experts.

ROGERS COMMUNICATION INC.

Rogers is Canada's largest wireless provider and the operator of the country's only national GSM and HSPA based network, with LTE coming in the next few years. Rogers Cable provides television services, high-speed Internet access, telephony services and video retailing. Rogers Media does radio and television broadcasting, televised shopping, magazines and trade publications, and sports entertainment. Rogers is challenged by the transition from household-based consumption to the provision of individual-based service and scope for enabling personal behaviour. New media, new Web services and well-designed user experiences will drive more use and growth, perhaps even extending the Rogers growth beyond Canada's borders.

At OCAD and elsewhere, Rogers seeks insight into the design of user experiences to reason about consumers' reactions to devices and applications. Rogers is working with researchers at Ryerson,

Waterloo and elsewhere in the *NEWS* project to understand the trajectory by which video media "goes viral", to better understand consumer behaviour and deliver higher-value services. What compelling services will address users' needs, both at home and in mobile applications, when users have smart phones, set-top boxes, Blu-Ray players and game consoles providing simultaneous access to multimedia content and broadband Internet connectivity for social networking? (This is similar to Deluxe's interest in new Blu-Ray authoring features.)

Rogers has responded to the challenge of innovation by investing in early stage innovation, both inside and outside the company so the potential for benefit from these research collaborations is high.

Rogers looks forward to broadening its research collaboration with others in the NCE, and hopes to benefit from ideas and interaction with innovative companies that are NCE partners. Rogers is investing $50,000 per year cash and a further $50,000 per year in-kind contribution to GRAND.

ELECTRONIC ARTS

Electronic Arts Inc., the world's leading interactive entertainment software company, has three wholly owned Canadian subsidiaries organized in five development studios, two located in Burnaby, one in Edmonton, and two in Montreal. The BioWare subsidiary in Edmonton was one of the five primary contributing partners for GRAND in the Letter of Intent. The remaining EA studios in Canada would like to join as a partner as well to increase the scope of our involvement and lend more a more significant level of support to this application. BioWare will continue its focused relationship with the researchers in Edmonton at the University of Alberta.

EA studios in Canada have hired graduates, interns and co-op students broadly across Canadian universities and seek to build the research capacity in the universities in GRAND, to ensure the investigation and creation of innovative technologies, to increase the HQP training capacity, and to provide forums for interaction and networking. Interacting with students engaged in the network is a competitive advantage for EA, and GRAND hopes EA experts can co-supervise graduate students, meet with them in network events such as the Annual General Meeting, and participate in regional workshops, open houses and knowledge exchange activities. EA is also interested in networking with students, researchers and other companies supplying technology to EA, such as Side Effects, Autodesk and Intel.

Of particular relevance to EA are the *PLATFORM* project led by Profs. Fedorova and Gooch on performance of video games on multicore GPUs and the *EOVW* project led by Profs. Seif El-Nasr and Mandryk on interactive virtual world games.

EA and BioWare will continue to interact and hope to be in a position to provide resources beyond in-kind support in the future. More details of BioWare's partner interactions are provided below.

Other Private Sector Partners

Our Principal Private Sector Partners often have large development teams and the luxury of advanced technology. However, smaller companies, or companies whose primary focus is not digital media, benefit from access to the high level of investigation and research in GRAND that would not be possible for them to afford internally on an ongoing basis. Other benefits include networking with companies that might become strategic partners, and belonging to a community that gives more mass and focus to the need for investment in the digital media industry. Here are our other private sector partners:

IMMERSION CANADA

Montreal-based Immersion Canada is part of Immersion Corp. which creates haptic technology now incorporated in over 70 million devices including video console gaming systems, medical training simulators, car driver controls and mobile phones. Immersion Canada is collaborating with GRAND's *AMBAID* project on appropriate-modality bases for ambient information display in order to track new applications highlighting the advantage of haptic communication. In addition to $8,000 in-kind support for people from Immersion to collaborate (approximately one week per year), Immersion is reviewing the potential for a financial contribution in next year's budget.

PIXAR

Pixar is soon opening a new studio in Vancouver, their first outside the Bay area, based partially on the strength of the Canadian academic institutions in computer graphics and new media. In Vancouver, Pixar hopes to copy their successful U.S. internship program for computer science and film students to establish close relationships with talent individuals to hire after graduation. Also, Pixar values the "one-stop shopping" aspect of Canada's best new media researchers being brought together within GRAND. Particular research projects of interest include the *CAPSIM* 3D modeling capture and simulation project, the procedural modeling project *PROMO*, the shared displays project *SHRDSP* and the sketch-based interfaces project *SKETCH*. Pixar hopes to be in a position to commit resources to their partnership once the Vancouver office is actually established.

BARDEL ENTERTAINMENT INC.

Bardel has been collaborating with Professor Seif El-Nasr on the precursor to the *EOVW* project on *developing methods to evaluate virtual worlds,* specifically, an integrated model for co-operative multi-player games and virtual worlds for children and a study on user groups which concentrated on understanding what the target market engages in doing. The benefits of GRAND for Bardel include an outside perspective on product development; research and design expertise that complements and enhances Bardel's internal teams; broader perspectives and access to academic and other industry knowledge bases for related disciplines; and visibility to impact public policy on the importance of convergent media and industry-academic collaborations. Bardel will contribute: approximately $100,000 per year in in-kind funding with use of space and equipment at Bardel; access to their beta community and focus groups; human resources such as designers, artists, software engineers and project management as well as expertise in storytelling and entertainment-related areas; and co-operative employment for 2-4 students.

CMLABS SIMULATIONS INC.

CMLabs is a world leader in real-time interactive simulation of vehicles (such as heavy equipment) for operator training, usability and safety analysis. Research in GRAND will help CMLabs improve its human simulation to create more realistic complex environments and to develop better models of operator performance from the data captured in simulation. In particular, CMLabs will interact initially with the researchers on the *MOTION* project led by Profs. Van de Panne (UBC) and Kry (McGill).

GSMPROJECT

Montreal-based gsmproject designs and produces interactive exhibits in museums and pavilions worldwide. Interaction with the Canadian new media research community broadly through GRAND, and with the *PLAYPR* project in particular, will provide ideas, technologies and possibly prototypes to help gsmproject create new participant interactions with exhibits. For example,

game-like interaction could entice participants to progress through the levels of an exhibit's story. gsmproject will provide a minimum of $10,000 cash support each year and at least $30,000 per year of in-kind for the supervision of student internships to experimentally apply research ideas to problems at gsmproject.

CANADIAN FILM CENTRE MEDIA LAB

The Toronto-based Canadian Film Centre Media Lab is a world leader in interactive narrative research and education, and is interested in collaborating with GRAND to be on the cutting edge of new media. The mobile biometric technologies research undertaken by Prof. Gardner at OCAD in the *PLAYPR* project has the potential to produce innovative opportunities for residents at CFC. CFC will provide $8,000 per year in-kind in the form of space, staff support for workshops, equipment use and promotional activities.

INTEL

Intel is developing a new multi-core Graphics Processor Unit, with both CPU and GPU cores, offering opportunities to exploit more flexible rendering models to provide new real-time capabilities for games creators. This architecture has the potential for disruption in other domains such as scientific computing and supercomputer applications.

Intel Senior Graphics Architect Paul Lalonde will continue his collaboration with the GRAND *PLATFORM* project, led by Prof. Bruce Gooch in the Department of Computer Science at the UVic and Prof. Alexandra Fedorova in the School of Computing Science at SFU, as they create abstractions, constructs and tools to support programmers in creating task parallel code to exploit the parallel performance of emerging multi-core hardware platforms, such as Intels, without manually parallelizing the code. By building parallelism in from the start, and automatically distributing tasks to the most appropriate kind of core in a multi-core heterogeneous CPU, improvements in the efficiency of the code should result. The benefit to Intel of seeing how programmers use the distributed programming environment, including the adoption of OpenCL, is magnified for Intel by the involvement of Electronic Arts experts in this project.

Intel is committing a cash research grant estimated at $30,000, hardware resources including access to the new GPU, and three days per month of Paul Lalonde's time, valued at $75,000 per year, for interaction, collaboration and co-supervision of students.

METRANOME

Metranome's mobile video application platform for the iPhone, iPod Touch and BlackBerry supports major content creators, publishers and advertisors to engage mobile users through short form entertaining or informative video. Quality is kept high and costs low by leveraging WiFi, but still Metranome must preselect and preload videos, based on explicit user preferences, implicit behaviour and social networking cues. Research in this NCE, such as the *NEWS* project on news media production, search, retrieval and distribution will help Metranome refine these aspects of the system, interact with relevant experts and link to graduates. Metranome values the ability to connect with other industry partners through GRAND to explore opportunities to provide their mobile video distribution as part of another solution. Metranome is providing $20,000 per year of in-kind support in the form of 25 days of interaction with Metranome's CEO, CTO, Director of Systems Architecture and other key members of the engineering team.

RAMIUS CORPORATION

Ramius Corporation is a Canadian software development and services company in online communications and social networking. Their senior consultant will spend two days per year, valued at $2,000 per year, with the Usable Privacy and Security for New Media Environments project (PRIVNM) led by Prof. Robert Biddle, to improve the design of Ramius software in terms of privacy, human-computer interaction and usability.

BIOWARE

BioWare, a studio within Electronic Arts, is a world leader in story based games that has had a very successful collaboration with University of Alberta for ten years. GRAND will strengthen this relationship by connecting BioWare to other Canadian researchers active in search and pathfinding, and scripting for games. The *MCSIG* project led by Profs. Schaeffer and Hoos will help BioWare achieve more sophisticated intelligent behaviour of characters by adopting Monte Carlo tree search techniques.

In the game development process, scripting dictates game agent behaviour. The *BELIEVE* project led by Profs. Szafron and Seif El-Nasr, will improve the ways that game designers (who often aren't programmers) can easily create predictable character behaviour and enable player actions to influence the plot.

BioWare will provide its codebase for one or more story-based games to the researchers to enhance their efforts.

COOLE IMMERSIVE

Coole Immersive is an Edmonton-based company that creates games to promote healthier lifestyles, training and education. It is working with the GRAND project on gaming for fitness, *GAMFIT*, led by Profs. Graham and Mandryk, to help Coole Immersive understand how games can be created to better create behavioural change and ways to assess and communicate, to prospective users, the effectiveness of the game. *GAMFIT* is investigating the design of exercise (and mental fitness) games, building tools to evaluate the effectiveness of games for fitness, and addressing the problems of connecting fitness games to an array of special input devices. Coole Immersion will provide access to technical experts, internships for HQP and access to its game software.

Network Agreements

Our partners will sign a network partner agreement outlining the basis for their participation in the network, to ensure that there are no misconceptions about confidential information, availability of results, evolution of research, potential technology transfer or other commercialization, principles for jointly created intellectual property, and liability for the use of results. Partners who are investing cash in GRAND research will also sign an agreement specific to that investment, involving the host university(ies), because such investments may sometimes involve specifics that are not the norm in GRAND projects. For example, a company might need to ensure that any changes made to its source code are wholly owned by the company, which is different than the clause we contemplate for our network partner agreement. Interestingly, we're finding that smaller companies have more need for specific clauses of this type and that larger companies appear to be envisaging a more precompetitive engagement, where all results would be published and transferred to the company, if they wish to adopt them, in the public domain.

GRAND Partner Events

The NCE will sponsor a variety of networking activities designed to encourage multidisciplinary collaboration. An Annual General Meeting will be held in conjunction with the yearly Graphics Interface conference, the world's oldest regularly-scheduled computer graphics and human-computer interaction conference, which is an internationally-recognized venue for reporting advances in many of the research areas within GRAND's mandate. The conference is sponsored by the Canadian Human-Computer Communications Society, which will co-host the combined AGM and conference, ensuring a wider audience for dissemination of the results of the research as well as greater exposure to related research in artificial intelligence and computer and robotic vision, the topics of two other conferences that are held jointly each year with Graphics Interface.

Other events will include topic-specific workshops, open house events and other forms of informal knowledge exchange.

Networking within the NCE is a powerful way to bring the breadth of expertise together, for academic researchers, industry partners and other new media companies. Our researchers will include producers of content, experts in media studies, human computer interaction specialists, researchers in experience design, computer scientists, engineers, and experts in new media business and policy. To accelerate innovation, in addition to our annual research meeting, we will hold two theme workshops on specific topics each year at which research results, scholarship and creative output will be the basis for dialogue amongst network researchers, industry partners, and public sector and other stakeholders.

6.6 Knowledge and Technology Exchange and Exploitation

Digital new media, graphics, animation, and game design have become key international economic sectors. According to the 2006 Government of Canada report "Invest in Canada," there are over 2,300 firms involved in multimedia R&D in Canada. They employ about 18,000 people and have annual revenue of about $3 billion, with an impressive annual growth rate of 20%. If multimedia is already a powerful industrial force, mobile and ubiquitous applications promise to surpass that industry by the scope of applications they will encompass. For Canada to become competitive in this arena, investment must be made in creating and maintaining leading-edge talent in experiential media design. Leading-edge talent and intellectual capital, which exists in Canada, is made possible through the research expertise provided by universities, and anchored by the support and investment made by industrial partners.

Knowledge transfer in this model is not uni-directional. All of the partners must be engaged in sharing their expertise with their counterparts across the network. Practitioners in cultural industries – the animators, artists, and musicians who use new media technology – must be able to gain early access to new tools and techniques, and provide early and critical feedback to researchers and developers. This will reduce the time to market and reduce the risks of "fast fail" endeavors for novel designs. GRAND will play an important role in creating research that combines different experiential, design, and technical backgrounds to bring more opportunities and solutions to Canada in many dimensions. Through GRAND, partners will participate in exploring and studying emerging digital urban cultures and establish new fields of expertise in the creation and delivery of new media and gaming designs. It will enable research that will influence multiple industrial sectors and spawn

patents, commercializable products, and other intellectual property including, but not limited to:

Accessibility

The goal of research in this area is to explore, develop, and evaluate innovative sensory substitution technologies and alternative techniques to improve access to new media systems for people with disabilities, seniors, and vulnerable individuals. For example, providing access to non-speech audio for television requires new approaches that involve visual and/or tactile stimulation. The ICT standard for the Accessibility for Ontarians with Disabilities Act (AODA) has been generated and is undergoing public review. It is expected to be made into law in 2010 and compliance will be required by all public and private sector organizations with more than 20 employees within five years. Some of the results of this project will generate innovative media access solutions and procedures that can be used to satisfy compliance requirements.

Other provinces are just now proceeding through a legislative process regarding accessibility. The research from this project can help to inform their work. Network Investigators in this area have experience with commercialization in this sector, and anticipate their research in the next five years under GRAND will result in patentable and commercializable products.

Emergent Interaction Modalities

Current technology tends to rely on a graphical display as the primary mechanism for communicating information to the user. This can result in overwhelming the user's visual channel, and further does not adequately leverage the other sensory channels that humans use to communicate in the "real world." Research in this broad area includes the design and development of haptic (touch), auditory, and 3-D devices for interacting with information, data, and devices. In addition, the development of platforms integrating sensing devices to perceive the real world, virtual reality tools to simulate environments and phenomena, and novel interfaces through which to change the state of the real and virtual worlds for training and simulation. These multi-model, multi-sensory interfaces offer commercial promise for the development of training scenarios and platforms in a wide range of educational, artistic, medical, technical, and educational environments.

Design of Game Technologies

Game design consists of multiple components: game objectives, narrative and storytelling elements, graphics and animation, and programming of the game. New knowledge, algorithms, and a greater understanding of players' behaviors are expected to be generated throughout GRAND. At this stage, many virtual worlds are limited in the amount of participants they can accommodate simultaneously. New media simulation and game designs will grow in use and require enhanced novel wide-area distributed game server technology. There are numerous companies in the entertainment and gaming industries in Canada that can benefit from optimization of game engines and game design for personal as well as massive multiplayer use. Emerging social, and political impacts of the new media economy.

Social and Political Impacts

Games, animation, and new media are necessarily interdisciplinary, multidisciplinary and multi-sectoral. Research requires multiple perspectives. Potential applications and requirements cross industry sectors. What is more, innovation in these fields does not follow a linear cycle (Bloom, 2008; Crossick, 2009) where commercialization, social innovation, or policy implications of research are only realized at the end of the research cycle. The

product-to-market cycle can be extremely fast paced and deeply interdisciplinary. Current best practice is to engage all relevant partners and consultants early and throughout the cycle. This requires broad dialogue with investors, business analysts, producers, designers, artists, and technologists. For these reasons, research and technology sharing requires effective links between private sector participants, academic institutions, federal and provincial agencies and not-for-profit stakeholders. This industrial climate puts a premium on research assessment that is both rapid and thorough.

The NCE will use the following five "channels of innovation" as key elements of its strategy for exploiting the results of the research program: *People* directly transfer knowledge through student research projects, co-op placements, internships, workshops and seminars; *Knowledge Transfer* takes place through on-line and print publications, conference presentation, faculty consulting, continuing professional education, and availability of research tools, data, and repositories; *Collaborative Research* occurs in joint projects, field trials, affiliate programs and consortia, and community-based outreach efforts that engage end users; *Intellectual Property* coordinated across the partner organizations creates value through licensing and leads to implicit and explicit standards that benefit all players; and *Entrepreneurship* promotes economic development through formation of spin-off companies, venture capital formation, and university-led research park and incubator activity.

Partners will benefit from early knowledge transfer via network events and tailored briefings, as well as submission of publications before disclosure on work they have funded (to provide opportunities for IP protection), and the ability to receive non-exclusive licenses to exploit the IP developed within the research program. The NCE will especially seek out research collaborations with smaller companies that typically do not have the resources of larger companies, but which often can adapt new approaches more quickly. Two of our primary partners are small- and medium-size companies, reflecting this philosophy. A key element of this strategy is the pre-competitive nature of many of the research projects. In most cases technological advances have application in many different aspects of the new media, animation and games industries. Often these advances lead to larger markets, where all of the stakeholders benefit from having a slice of the proverbial "larger pie" rather than competing against each other in a zero-sum game. Advance knowledge of new technologies provides a competitive advantage that Canadian companies and practitioners participating in the network can use to gain a larger penetration of global markets. This philosophy will be a central focus of the policies developed by GRAND's Technology and Commercialization Committee and a hallmark of the GRAND Keystone Series.

Access to Results of the Research

Intellectual property arising from GRAND projects that is potentially protectable will be disclosed to the host university(ies) and GRAND according to the IP policy at the specific school. If there is an agreement with a GRAND private sector partner for company investment in the research, then the IP provisions of that agreement will dictate how the IP is handled. For example, the company might have an option to arrange a commercial license. GRAND's Director of Technology Transfer and Commercialization will work with the relevant researchers and their university technology transfer and licensing office to create a plan to communicate the results within and outside GRAND's partners, and to drive the exploitation of the intellectual property. Two of our partners, the British Columbia Innovation Council and the Canadian Digital Media Network, have missions to connect research results

and innovation to companies or entrepreneurs who can exploit them. GRAND will rely heavily on these two partners to help create wealth in Canada from our results.

GRAND will work with the university technology transfer and licensing office to assess the value of protecting the intellectual property and determine who will pay the costs. Normally, the protection would be a relatively inexpensive provisional patent pending a full patent application made by one of the partner companies, who wants to exploit the results or add them to their patent portfolio, in the names of the creators. Often companies are motivated to decide to patent IP arising from university collaborations by the timing of an upcoming publication, so GRAND's Director of Technology Transfer, Director of Partnerships, other executive members and researchers will be careful to communicate these opportunities to the partners.

The Network Agreement and the Network Affiliate Agreement will include provisions to ensure that access to the results of the research is made available to all partners entitled to pursue commercial exploitation of the intellectual property that arises from the research under terms that recognize the nature and level of their respective contributions. Dissemination of results through the peer-reviewed literature will be a normal expectation for all research conducted under the auspices of the Network. We will employ a variety of vehicles to maximize communication amongst the various projects, universities, disciplines, partners, and other stakeholders. Because of our core competencies in New Media, we expect to make extensive use of Web-based technologies that will streamline many of the reporting and administrative functions of the Network.

External Communication

This will be accomplished primarily through three venues: SIGGRAPH Chapters, the Annual General Meeting, and Keystone Series Events.

SIGGRAPH Professional Chapters form a global network within the ACM SIGGRAPH community, each providing a geographically localized focus of activities and exchanges, and all contributing to the enthusiasm, creative energy, and high standards of SIGGRAPH. Vancouver ACM SIGGRAPH will be partnering with GRAND in a number of ways as part of GRAND's Knowledge and Technology Exchange and Exploitation strategy:

Vancouver ACM SIGGRAPH will host speakers arranged by GRAND at local chapter meetings. This will provide GRAND researchers and industry partners from across Canada an easy way to connect to the local community of developers, artists, and aficionados.

GRAND will stage various events including its "keystone" series of targeted workshops and other networking activities that will provide opportunities for Vancouver ACM SIGGRAPH members to see early-stage presentations of work-in-progress within the research program, and to participate in two-way conversations about the needs of the user community. These events will include keynote presentations and focused case studies.

With sister chapters in Montreal, Toronto and other cities, they will expand existing mechanisms and develop new channels for reaching out to the wider new media, animation, and games community, and will work to keep GRAND researchers aware of local chapter activities.

The *Annual General Meeting* (*AGM*) attended by all Network Investigators and their students will serve as a focal point, augmenting the everyday, "always connected" communication mechanisms that will be in place. The AGM will often be held in

conjunction with other research conferences.

The first AGM will take place in Ottawa on June 3-4, 2010, immediately after the annual AI/GI/CRV 2010 conference.

The second AGM may be held in Vancouver, in conjunction with either the ACM CHI 2011 conference May 7-12, or the ACM SIGGRAPH 2011 conference August 8-12. These are the pre-eminent conferences, respectively, in human-computer interaction and computer graphics.

The *GRAND Keystone Series* will bring together the five "channels of innovation" to enhance connections across disciplines and sectors, inject application ideas into its focused research projects, and build relationships with current and potential GRAND partners, to amplify research impacts. Each Keystone event will have a declared topic area and will be located and structured to best enable GRAND researchers, partners and assessors to advance work in that area.

The Keystone series provides a means for aggregating dialogue with private and public partners, applied researchers in art and design, and business innovators and practitioners. Keystone events will use pedagogical approaches from the successful Banff Method (Diamond, 2005), that accelerate cross-disciplinary dialogue, networking, and fast-track outcomes. Social media (Donath, 2004) facilitating online and simultaneous dialogue will play a key role as will the effective use of Canada's high-speed knowledge infrastructure. Experts from GRAND partner institutions will design and study the process, and ensure that there is analysis of the effectiveness of collaboration with the private and public sectors in technology, market development, and public policy development through these events. Hence the Keystone Events will contribute to knowledge about innovation processes.

GRAND Knowledge Keystone Goals

GRAND Keystone events enable: networking and partnerships, HQP, and Knowledge and Technology Exchange and Exploitation at different levels of research and application. Keystone Events will contribute to knowledge about innovation processes. Partners gain previews of GRAND research and prototypes. HQP trainees have opportunities for network building and external feedback on their work. For technology researchers, Keystones provide a venue to demonstrate and evaluate prototypes that arise within projects in collaboration with design, art, and business analysts. Social science and evaluation researchers will have opportunities to study technology use with and by actual users. By providing overview, wide perspective, and new ideas, Keystones help GRAND align with and adjust to rapidly changing context

The leadership role of the Ontario College of Art and Design (OCAD) enhances GRAND's ability to link research to real world applications. Links to applied research and practice will produce technology outcomes more apt to produce technologies crucial to Canadian productivity, economic growth, public policy, and quality of life. This is patterned after methods that have been highly successful in Northern Europe.

Keystone Structure

For the senior component we will use The Banff Method (Diamond, In: Goodman & Milton; 2005), in which expert moderators draw out the crux of research problems and facilitate debate and insights regarding development, related research, or product development. Some parts of the event will be open to the larger application community, through keynote presentations and focused case studies, ensuring a focus on GRAND's results and their effective dissemination. Within the Keystone, research and industrial cases will be presented in

multiple forms, through short papers, thematic debates, creative presentations, experiences, hands-on workshops (with presentations at the end of the session), exhibitions and "jams" in which participants engage around an issue or problem (Spangler, et al., 2006). Research in digital media moves through related, often tangible forms such as the design sketch (Laurel, 2003; Greenberg & Buxton, 2008). Moderators are skilled at engaging remote participants in the dialogue, as well as drawing in on-site discourse from social media (Donath, 2004). Workshops that accompany the formal summit environment provide a means to engage researchers, students, private sector partners and others in advancing technology development.

Keystones will generally be two days in duration, and may include high-level briefings for executives (1/2 or 1/4 day) and lunch-time and evening talks that reach a general audience. As well we will organize two- to five-day technology workshops on GRAND-related topics for knowledge and technology exchange.

Keystone Topics

Keystones address topics that lie both above and below GRAND projects. Above projects are questions and issues for all of GRAND. Below projects are insights gained when teams and partners from different projects connect on specific research issues and ideas. Keystones address the spectrum of roles within GRAND and its industry and public sector partners, from junior researchers and developers whose focus is specific, to practice-based researchers and practitioners seeking new product development, to leaders seeking new direction and vision. Each Keystone will have a declared topic and its activities will be specifically designed for the appropriate level(s) with the spectrum of roles. The most suitable topics will and must evolve as GRAND moves forward. Following is a short list of key topics and our choices for the first four GRAND Keystones.

DESIGN

Design can be understood as the critical factor in translating and exploiting research from the laboratory into actual products, services and processes. It is increasingly clear that products and services can be greatly enhanced when design has an early, integral and strategic role. Furthermore, there is a shift towards understanding products as experiences that must be designed for consumers; success or failure rests on the human interface. What were once considered 'human factors' has become a complex of aesthetics, cognitive science, HCI, and user-engagement in product development. Design research and practice encompasses industrial processes, considering the efficiency of the production process as important as the end product. Design is a critical factor for taking product to market: branding, positioning and the social relationship of a product to its consumer base must be considered early on in the development phase, especially in the volatile and fast-changing world of new and digital media.

Many organizations have used design and design research to enhance their products and place in the market. Apple (iPod and iPhone), RIM (Blackberry Pearl), SAP (Design Services Group), Bombardier and Umbra are all key examples. Within research, design can be a powerful enabler of new ideas for systems and products, but current research practices and methods have not fully incorporated design expertise. Designers play the role of enabling collaboration within complex teams. A Keystone event on the Role of Design will provide both strategic insight onto design and specific techniques for enabling design within research and development. This first Keystone will be held in Toronto and organized by OCAD, with the Design Exchange, Interactive Ontario, design associations representing various disciplines and the Mobile

Experience Innovation Centre and its associated partners.

SIMULATION

Simulation is an enabling technology across games, animation and new media. Every subfield in GRAND has developed its own approaches to and uses of simulation, with little interaction with others. A Keystone event on Simulation in Games, Animation and New Media will provide partners and researchers with perspectives from other areas and potential new applications of their work. GRAND partner Autodesk is taking a leadership role in simulation research and development and would be heavily involved in this Keystone.

PLAY

Play is serious business in recent years, there has been growing interest in using digital games to enhance performance, learning and training for business and education. To date, most of the design and development in this area has been on an "ad hoc" basis, at best, with few, if any "lessons learned" shared among developers. Further, proponents of play as an enabler typically know only the examples that pertain to their area. A Keystone event on Serious Play will enable managers to better harness play-based strategies. Developers and researchers will gain understanding of how play is actually used in partner organizations.

MOBILITY

In many ways, the current state of mobile and wireless industries resembles that of the early years of any new, disruptive media. Just as the Internet transformed human behavior, communications, and business in a ubiquitous manner, mobile and wireless technologies are leading the next revolution. We are rapidly moving towards an era where everyone is connected, wherever they are, through a robust, interconnected network and communication infrastructure. Mobile capacity is a key factor for growth across industries, being the technical, organizational, and human thread that will link all activities in coming years. Changing times require new ideas. A Keystone event on Mobility would seek to elicit and facilitate the widest range of new thought possible and would showcase examples of innovation from around the world.

PARALLEL PLATFORMS

The GRAND project on Platform Performance aims at a new language for expressing parallelism in game programming. Its success depends upon the technological sophistication of the language, its elegance, and especially its usability. A Keystone on Parallel Platforms would combine the impacts of new parallel technologies on project workflows with a junior event in which participants would use parallel programming techniques for games in an intense workshop setting. The event would have both knowledge and technology exchange and exploitation aspects as well as being a unique opportunity to collect research data on programming styles with parallel languages.

LOCATION

Keystone events will be located in cities where they can draw industry focus and partnerships. They may also be positioned adjacent to larger conferences. Partnerships with new media and related industry associations will facilitate sector engagement. Outreach will attract and include the researchers, partners, users, and applications experts best suited to addressing its topic and most enabled by participation. For example, the Design event will occur in Toronto due to the size of Toronto's design industry, its concentration of universities with design programs, and its central location. It will be hosted by the Ontario College of Art & Design in partnership with other GRAND

institutions, partners, government design policy experts from the City of Toronto, and design industry associations. Participants for this event will be drawn from partners, researchers, and especially universities with strong design disciplines. A workshop on Play will occur in Vancouver, a strong centre for Canada's gaming industries.

VENUE AND TIMING

There will be two Keystones per year over the duration of GRAND. The location for Keystones is largely partner driven. Much of the Canadian games, animation and new media industries are within short distances of three cities: Montreal, Vancouver, and Toronto. In addition, the Banff Centre has many years experience in conducting similar events, particularly those where strategic direction plays a major role. At the city locations, Keystones will be planned in consultation with key industry associations such as New Media BC and other regional industry groups.

MANAGEMENT

The Keystone Team will be led by the Ontario College of Art and Design, with participation from other GRAND academic and industry partners. It will work with the GRAND management to plan workshops and summits, drawing from successful models of past practice, taking care to integrate emerging research within GRAND and to engage users, partners and government. An overview of the Keystones' engagement process will also be presented to the GRAND Board of Directors as these individuals have extensive ties to industry and academia.

Results will be documented, communicated to partners, analyzed for effectiveness, and reported to the GRAND Board. The Keystone Team will use this data in developing and refining this ongoing series.

6.7 Network Management

The organizational chart is on page 27 in Figure 1.

The following organizational chart will be referred to throughout this section as the relationships between the components of the network are described, and as the management plan and key business objectives are articulated.

In general, scanning left to right in Figure 1 (especially in the upper half) moves from a research focus to an administrative focus. Scanning from top to bottom moves from a management focus to an operational focus.

Business Objectives

The GRAND NCE has a number of key business objects for its first five years.

- Build an integrated, multi-disciplinary understanding of the Technical and Methodological aspects of New Media as well as the Social, Legal, Economic, and Cultural aspects.
- Foster an appreciation for the role of Design in the research, development, and deployment of technology.
- Develop strong end-to-end Networking and Partnerships among the Academic, Public, and Private sector stakeholders that enhance Canada's competitive advantage.
- Conduct world-class research in New Media, Animation, and Games.
- Deliver the results of the research program through trained HQP and Knowledge and Technology Exchange and Exploitation activities that lead to commercialization and innovation, and that inform public policy decisions.

The Network will be managed to maximize success in meeting these objectives.

Management Structure

The GRAND NCE will have a BOARD OF DIRECTORS, a NETWORK MANAGER, and staff. The SCIENTIFIC

DIRECTOR and the NETWORK MANAGER will work closely together, reporting directly to the BOARD OF DIRECTORS, to ensure that all policies and guidelines of the NCE Program and of GRAND are carried out and that the Network fulfills its mandate. GRAND will be incorporated under a Network Agreement after approval by the NCE Program, after which permanent personnel will be hired. We describe the role of each committee and identify key personnel, their required expertise, and their roles and responsibilities.

The Board of Directors has overall responsibility for the management, direction, and financial accountability of the Network. The Board appoints the Network Manager and the Scientific Director, who are non-voting ex officio members. The Board approves all funding allocations for the research program and for the operational budget of the Network, and it approves all reports submitted to the NCE Program. Members include a representative from the Host Institution (UBC), a member of the NCE staff who has observer status, one Network Investigator who is not a Theme Leader or Co-Leader or Director, the two ex officio members, and six to ten additional members, half of whom are not directly affiliated with the network. Among these will be members representing perspectives and interests of academic, industry, and public sector stakeholders. The board will elect its own chair.

DR. IAN KYER is interim CHAIR OF THE BOARD OF DIRECTORS pending the formal establishment of the Board. He is a Partner at Fasken Martineau. Founder and first president of the Canadian IT Law Association, former president of the Computer Law Association, editorial board member for *Oxford International Journal of Law* and *Information Technology*, and former editor in chief of *University of Toronto Faculty of Law Review*, he specializes in legal issues for the IT, online gaming, and outsourcing sectors. Twice rated in the top 25 IT lawyers by *Euromoney*, he advises ePresence, an open source multimedia company, and was past chair of the board for NECTAR, an NSERC strategic research network.

The INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE (ISAC) will have seven members from the international research community who span the range of disciplines represented within the GRAND NCE research program. They will be international experts from industry and academia who will annually assess the research program and make recommendations to the Board of Directors.

DR. JOE MARKS is CHAIR OF THE INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE. He is Vice President of R&D for Walt Disney Imagineering Research. Formerly Director of Research for Mitsubishi Electric Research Laboratories, he led basic research and advanced development in computer and communication technologies before assuming his current position at Disney. He has a wealth of experience organizing and directing collaborative research partnerships between industry and academia. An active member of the research community, he has chaired numerous conference and program committees.

DR. GERRI SINCLAIR is NETWORK MANAGER AND COO. She is currently the Executive Director of the Masters of Digital Media Program, and former President of UBC's Great Northern Way Campus. Her 20-year cross-domain career spans Internet and new media technology, entrepreneurship, academic research, and government policy. As Chair of The Telecom Policy Review, she advised the Government of Canada on policy and regulatory environments for advanced telecommunications. She has been General Manager of MSN Canada, founder/CEO of NCompass Labs, member of Canada's Information Highway Advisory Council and National Broadband Taskforce, CFI, Canadian Communications Research Council, and Genome BC, a director of Ballard Power, SSHRC, the TSX,

and the Vancouver Film Festival. She founded ExCITE, the first new media R&D lab and production studio in Canada, in 1987.

The Network Manager's role includes all aspects of managing the Network's day-to-day operations, insuring accountability, and providing leadership and guidance to the Network staff and to the researchers. A broad knowledge of the state of the art both in industry and in academia is essential, as is a thorough understanding of the art and design practices that exist within the wide spectrum of the New Media, Animation, and Game sectors of the economy.

The role and responsibilities of the RESEARCH MANAGEMENT COMMITTEE was described earlier in Section 6.3.

VIC DICICCIO is DIRECTOR FOR RESEARCH PARTNERSHIPS. He is responsible for developing relationships with the user sector and potential partners in the private and public sector, and for establishing an effective Network Affiliates program to provide opportunities for linkages between researchers and receptors. He is Director of the Institute for Computer Research and Research Professor of Computer Science at the University of Waterloo, where he fosters collaborative research partnerships across a broad range of information and communication technology topics. He has helped start several spin-off companies. He was chair of the board for NECTAR, an NSERC strategic research network on collaboration technology.

The COMMERCIALIZATION AND TECHNOLOGY TRANSFER COMMITTEE is responsible for identifying opportunities to exploit the results of the research program in ways that provide direct benefits to Canada. Preference will be given to exploitation within Canada, and through Network partners. The committee will review intellectual property that arises from the research and will recommend licensing and other arrangements for approval by the Board. It will also encourage the development of new Canadian receptor companies when appropriate, either as spin-offs from the research program or as licensees of Network-created IP. The committee will be chaired by a representative from an industry partner.

ANGUS LIVINGSTONE is INTERIM TECHNOLOGY TRANSFER AND COMMERCIALIZATION OFFICER. He is Managing Director of the University-Industry Liaison Office at UBC. Co-founder and Chair of the Alliance for the Commercialization of Canadian Technology, he serves on numerous corporate boards and international advisory committees. He played critical roles in many Canadian technology transfer and commercialization initiatives: Westlink Technology Commercialization Internship Program, West Coast Licensing Partnership and the Canada California Strategic Innovation Partnership IP Framework. He is a member of the Association of University Technology Managers and the Licensing Executive Society. When the Network is incorporated, Livingstone will step down and be replaced by a staff member to be hired, but he will remain a member of the Technology Transfer and Commercialization Committee.

The GRADUATE STUDENT ADVISORY COMMITTEE will have graduate students representing the various disciplines and universities involved in the research. Elected members of the committee will serve one-year terms (for a maximum of two consecutive terms) to provide a conduit for direct communication between graduate students engaged in the research program and the Executive and Research Management Committees.

The EXECUTIVE COMMITTEE comprises the Director for Science and Engineering Research, the Director for Social Sciences and Humanities Research, and the Network Manager. The EXTENDED EXECUTIVE COMMITTEE includes the Director for Art and Design Practice, the Director for Research Partnerships, and the Technology Transfer

and Commercialization Officer. The expertise of each has already been described (see Section 6.3 for more information on the research members). The Executive Committee oversees day-to-day operation of the Network, assisted by the other members of the Extended Executive Committee and Network staff.

Operational Structure

Key staff members to be hired include a FINANCE OFFICER to oversee management of NCE funds and allocations to partner institutions, a FINANCE CLERK for accounting, a COMMUNICATIONS OFFICER to manage internal and external communications and public relations, a TECHNOLOGY TRANSFER AND COMMERCIALIZATION OFFICER, an OFFICE ADMINISTRATOR to support the Network Manager and the Scientific Director, a SECRETARY, and TECHNICAL SUPPORT staff to look after local IT and to interface with UBC networking staff for Network-wide IT. In many cases staff will be shared with the Masters of Digital Media program at the Great Northern Way Campus. Some functions will be handled by contract personnel, or outsourced if that is more cost-effective. The eight staff functions at the Network Headquarters will require an estimated 5 FTEs.

Each academic node (19 universities) has one Network Investigator identified as its BLOCK CAPTAIN to coordinate the Network Investigators and Collaborating Researchers at the node and to liaise with the research administration and financial units of the respective university to ensure accurate and timely reporting. A modest allowance ($5K-$10K per year per node) will be available to defray the costs of administrative support for the larger nodes (those with more than two Network Investigators).

The Network will adhere to the policies and rules of NSERC for all matters not specified by the regulations and administrative policies of the NCE Program.

Administration of Funds

The Network Host (the University of British Columbia) will provide financial and accounting services for all funds received from the NCE Program, and for all funds received from partner organizations.

Funds will be administered consistent with the NCE Terms and Conditions and other requirements set forth by the NCE Program, and with the financial policies of the respective Network Members. In situations where these policies differ, the more restrictive policy will apply.

A Network Agreement to be signed by all Network Members, and a Network Affiliate Agreement to be signed by all non-academic partners, will be established by the Board of Directors and administered under the direction of the Network Manager.

Proper financial reports will be required from all Network Members on an annual basis

Access to Results of the Research

The Network Agreement and the Network Affiliate Agreement will include provisions to ensure that access to the results of the research is made available to all partners entitled to pursue commercial exploitation of the intellectual property that arises from the research under terms that recognize the nature and level of their respective contributions.

Dissemination of results through the peer-reviewed literature will be a normal expectation for all research conducted under the auspices of the Network.

Compliance Issues

All projects will be required to obtain appropriate certification or approval under the Tri-Council Policy Statement *Requirements for Certain Types of Research*.

Many projects will involve human subjects. All students engaged in the Network, regardless of discipline, will be required to complete the *Introductory Tutorial for the Tri-Council Policy Statement: Ethical Conduct for Research Involving Human Subjects*. In addition to ensuring that ethical guidelines are followed, this will be a form of cross-disciplinary training, and thus a component of our HQP strategy. Special workshops will be offered on an annual basis to familiarize students with these and other issues related to the conduct of research, emphasizing the importance of understanding the different methodological approaches necessary in multidisciplinary research and raising awareness of the diversity of concerns that can arise during the course of a research project.

Requirements for other types of certification are not anticipated, but every project will be screened as part of the approval process to ensure that all necessary certifications and approvals have been obtained in advance of the research activity.

Included in the screening will be steps to insure that all necessary environmental review requirements are met and that no potential adverse environmental effects are present. To insure objectivity, a contract agency will conduct environmental assessments when initial screening indicates this is necessary.

The Conflict of Interest Policy Framework will be implemented. The Board will determine the appropriate management strategy and will establish a Conflict of Interest Subcommittee to carry out the strategy.

Continuous Quality Assessment

A unique aspect of GRAND's management strategy is the inclusion of two research projects that monitor the success of the Network in achieving its business objectives. The NAVEL project (Section 6.3) will assess the degree to which the Network functions as a Network, rather than as a disparate collection of projects. This will provide valuable feedback to the management team. In a similar way the MEOW project (Section 6.3) will assess the degree to which the Network fully and effectively utilizes New Media technology as a tool to achieve its objectives. Continuous self-assessment is a novel approach for an NCE, and we believe it is an investment that will pay back handsome dividends.

User Sector and Network Partners

Partner and other user sector representatives on the Board, the Research Management Committee, the Technology Transfer and Commercialization Committee, and on individual project teams will provide on-going input into the directions set for the research program. Section 6.3 describes User Sector and Network Partner involvement in developing the initial set of projects.

Workshops and other networking events (see Sections 6.5 and 6.6) will include opportunities for current and potential receptor organizations to engage with the researchers in the Network.

Internal Communication

The Network will employ a variety of vehicles to maximize communication amongst the various projects, universities, disciplines, partners, and other stakeholders. Because of our core competencies in New Media, we expect to make extensive use of Web-based technologies that will streamline many of the reporting and administrative functions of the Network. Specific examples are provided in Section 6.3. An ANNUAL

GENERAL MEETING (AGM) attended by all NIs and their students will serve as a focal point, augmenting the everyday "always connected" communication mechanisms that will be in place.

Descriptions of all research activities, and copies or references to publications arising from the research will be available on the Network website. Whenever appropriate, confidential information will be password-protected. Workshops and other regional activities will raise awareness of opportunities for increasing collaboration within the Network.

External Communication

An "industrial-strength" Communications Plan will be developed and administered by the Communications Officer in collaboration with the Executive Committee and other key stakeholders. This will include a public Web presence that again reflects core competencies within the Network. The many activities described in Sections 6.4-6.6 (HQP, Networking and Partnerships, and Knowledge and Technology Exchange and Exploitation) will be key elements of the external communication strategy, with the AGM a highlight that all partners will be encouraged to attend.

The AGM will often be held in conjunction with other research conferences. The first AGM will take place in Ottawa on June 3-4, 2010, immediately after the annual AI/GI/CRV conference, a federation of the Canadian Artificial Intelligence Conference, the Graphics Interface Conference, and the Computer and Robot Vision Conference. The three conference hosts are the Canadian Artificial Intelligence Association (CAIAC), the Canadian Human-Computer Communications Society (CHCCS), and the Canadian Image Processing and Pattern Recognition Society (CIPPRS). Many of the researchers participating in GRAND attend the conference. A joint poster session will be organized to allow conference attendees to learn more about the GRAND NCE and its research program.

Press releases and other information about the research program will be made available on a regular basis through the GRAND website and other outlets. Researchers will be encouraged to describe their work in popular publications using terms that are accessible to the general public, as well as through technical reports and peer-reviewed conferences and journals.

Funding to subsidize travel to major international conferences to present invited talks or significant new results related to research conducted in the Network will be available in limited amounts to Network Investigators. Allocation of the funds will be subject to annual limits and will be determined by the importance of the research being reported and the expected impact of the particular venue. Priority will be given to keynote and plenary talks. A matching formula will be used to ensure that Network funds are leveraging external funding.

6.8 Budget Rationale

The five-year budget for GRAND is based on seven principles that are designed to maintain the proper balance necessary to achieve the objectives of the Network. We first summarize the principles and then make specific comments on the budget, with explanations for particular income or expense items when required.

Guiding Principles

Our seven principles are derived from the NCE Program's guidelines. They are intended to complement the principles inherent in GRAND's Strategic Plan, which is an innovative approach to managing a diverse, multidisciplinary team.

PRINCIPLE 1: MANAGEMENT IS IMPORTANT

Up to 20% of the total expenditures of NCE funds are in the Administration (7) or Management and Networking (8) categories (see B2). The NCE

Program recommends a minimum of 15% be used for these purposes. The Network Manager will spend roughly equal time overseeing the administrative functions of the NCE and assisting the Scientific Director in managing the network's research and knowledge exchange activities. The Administrative Officer, Finance Officer, and Communication Officer are in the Administration category; salaries for the Administrative Assistant, Finance Clerk, Clerical Assistant, and Technical Assistant positions are split across the two categories.

PRINCIPLE 2: HQP IS PARAMOUNT

Stipends for students and postdoctoral fellows comprise more than 60% of the expenditures from NCE funds and 100% of the expenditures from industry funds. This decision was made to ensure that funds from partners are focused as much as possible on direct costs of research and HQP training. Over time, we anticipate that partner funding will increase. This will allow us to increase the amount of funding for HQP.

PRINCIPLE 3: NETWORKING IS NECESSARY

Travel necessary for Administration and for Management and Networking – including the costs for the Annual General Meeting, Keystone events, Workshops, and exchange visits for students among research labs and other network partners – is included in those budget categories. Travel that is a direct cost of research for external dissemination of results (conferences) or field trips for data collection are in the traditional Tri-Council category of B2 Travel (8).

PRINCIPLE 4: EQUIPMENT IS EASY

Expenditures for Equipment (3) are not expected to be high. Much of the equipment needs that are not commodity items will be met through existing or new facilities obtained through CFI and other programs, including NSERC RTI awards held by, or to be applied for by, the researchers or made available by our industry partners on companies' premises. In Section 6.4 of this application, more detail is provided about some of the infrastructure. A small amount of specialized equipment, to be determined in the context of specific projects, will be located at nodes within the network and made available to GRAND researchers under the Operation of Core Facilities (2) budget category. Computing costs (4) will include media servers and digitization of media when appropriate, and access to compute servers for projects with high computational needs.

PRINCIPLE 5: INVEST STRATEGICALLY

Allocation of resources within the Network requires careful coordination. The Strategic Plan has a number of provisions that ensure this happens. Among these are the requirements for a Project Champion (a non-academic partner) for each project, and the 5x30x50 theme-project-investigator matrix on which the research program is built.

Project Champions, and partner contributions to projects, are evidence of relevance to projects and "grease the skids" of bi-directional flow of ideas and the experimental application of results. For these reasons, contributions from partners should not diminish access to NCE funding for a successful project.

The diverse balance of research endeavors encapsulated in the matrix of Projects overlapping Themes conducted by a dynamic web of Network Investigators will need to be monitored to ensure that balance is maintained. Hence, the hybrid nature of GRAND's process of resource allocation: both top-down and bottom-up.

PRINCIPLE 6: NCE FUNDING IS FLAT

The amount requested from the NCE program is constant over the five years. The budget does not explicitly account for inflation, but this will be accommodated for by increases in partner contributions over the lifetime of the NCE.

PRINCIPLE 7: CONTRIBUTIONS WILL GROW

The long-term goal is that 20% of the expenditures for direct costs of research will be paid from non-NCE funds. The budget for the first five years does not reflect this yet, in large part because of the high degree of uncertainty within the business community as the result of the temporary global financial situation. Because many companies are severely cutting their discretionary expenditures, it is not realistic to expect significant cash investments to be committed at this early stage of the NCE formation. While we expect to attract new partners in the coming months leading to more funds from industry partners in subsequent years, the budget being submitted reflects only current commitments for cash and in-kind contributions. We believe this conservative approach is the most realistic and safest in setting expectations among researchers about their project budgets.

In many cases we are still discussing contributions with our partners. We have a full range of private and public sector partners, and we feel extremely fortunate to have so much partner enthusiasm for our research translate into support in the current economic climate. When we achieve our goal of 20% of the direct costs of research coming from partners in our fifth year, the budget for direct costs of research will have grown by 25% over the amount requested from the NCE. The relatively fixed Administrative and Management and Networking budgets will then be closer to 17% of the total. This is an ambitious challenge, but nevertheless we have set this goal for ourselves.

Details on Specific Budget Items

In addition to the general comments above, the following explanations are provided for individual budget items.

SALARIES

In B2 Salaries (1), only salaries and stipends related to direct costs of research are included: students, postdoctoral fellows, and research technicians. Salaries for Administration and Management are in their own sections.

TRAVEL

Costs for travel are included in four parts of the budget.

Research-related travel for field trips to gather data or interact with partners, and for relevant conference attendance is included in B2 Travel (6a and b). In most cases, conference travel will be by graduate students presenting their research results.

Travel for Administrative purposes includes staff travel, and travel by the Board of Directors and by other committees. This is in B7 Travel (4), except for the Research Management Committee, which is in B3 Management and Networking (8) because non-NCE funds provided by the Host Institution will be used.

Workshops, including the Keystone events described in Section 6.6, will include some travel. Because participants often pay these costs themselves, only travel for organizers will be paid by GRAND. In Year 1, expenses will be less, in part because some of the Workshop activity will take place at the AGM.

The Annual General Meeting will be a significant networking event that incurs significant travel costs. This investment is a key element of our strategy for Networking, Knowledge and Technology Exchange and Exploitation, and HQP

Training. The first year has a larger-than-normal budget because we will pay full travel costs for faculty and graduate students who attend, and because we will subsidize partner travel. In subsequent years, registration fees and cost sharing will reduce the budget expenses in B2 Management and Networking (8c). The savings will pay for additional Workshop activity.

The costs of travel to Keystone and AGM events incurred by our industry partners are unrecognized in-kind contributions.

TECHNOLOGY TRANSFER

A strong, proactive technology transfer program will encourage effective exploitation of the results of the research. Because of the diversity of the research, consultants with specialized expertise will be hired under contract (B7 6a).

The Network Manager will play an active role in this effort and will select an appropriate mix of consultants for the portfolio of assets.

The Year 1 technology transfer budget is less than in subsequent years. The funds will be used to defray expenses related to incorporation (B7 8a) and other start-up costs.

Funds from the NCE to assist with prototype development and IP protection (B7 6b) will be augmented by income obtained from successful technology transfer and matching funds from industry and university partners interested in exploiting the results of the research.

Distribution of Cash and In-kind Contributions from Partners

As previously noted, cash contributions from industry partners will normally be used to support students working on research. Each partner will be working with specific projects of their choice, to which the funds will be targeted. The annual reviewing cycle for projects will include a review of the partner funds contributed to each project to ensure that these are appropriate and consistent with the guidelines of the NCE Program and the goals of GRAND.

In-kind contributions are similar in nature. Usually these will be for specific projects or clusters of projects, although in some cases (such a the software provided by Precision Conference Systems) the resources will provide part of the infrastructure for the Network.

Each of the B6 spreadsheets for contributing partners has a list of the projects in which the partner initially expects to be involved. An important reason most partners are involved in GRAND is to broaden their interactions with Canadian researchers, so we expect to see these lists grow significantly as partners network with more researchers and as the research projects evolve. These are initial indications of how the cash and in-kind contributions from partners will be distributed.

Theme Budgets

The non-hierarchical nature of the themes-projects-investigators matrix means that budgets are allocated both bottom-up and top-down, under the watchful eye of the Research Management Committee.

For this application, we have estimated the distribution of funds across the five themes, based on an initial assessment of the overlap of each project with the five themes, and on the anticipated funding for each project. This is an informal invocation of the process that will be undertaken during each annual review cycle, when the Research Management Committee computes the "roll up" calculations to determine how resources will be allocated to each project and to each theme.

As a matter of policy, the distribution of funds across the five themes will be expected to

maintain balance. Between 15-25% of the funds being allocated to activities should support each of the theme's goals and objectives. The recommendations of the Research Management Committee will be expected to conform to this policy. Exceptions will require approval by the Board of Directors and consultation with the NCE Program.

The initial distribution has been estimated at 22% each for Themes 1-3, and 17% each for Themes 4 and 5. These are estimates only. A full "roll up" calculation has not been performed. Prior to funding distribution for Year 1, the calculation and adjustments will be made to ensure that theme allocations are within the proscribed limits.

The On-going Budgeting Process

The budget submitted reflects the current state of our planning. As we continue to confirm agreements with more partners, and as we further develop detailed research plans for each project and how projects overlap with and support the theme structure, we will make adjustments to the budget to reflect a better understanding of the financial needs of the research program. This process has been underway since December 2008. It will continue throughout the lifetime of the Network, following the principles described earlier.

The Executive Committee's primary responsibility is to put into place mechanisms for training HQP, nourishing Networking and Partnerships, and encouraging Knowledge and Technology Exchange and Exploitation, while leading a world-class research program. The annual budget will be a crucially important and significant tool for guiding the Network and for achieving a significant increase in new media research in Canada by leveraging existing resources wherever possible. The Executive Committee will be supported in its efforts by the staff and the various committees. The process described earlier in this section is designed to ensure that the seven principles on which the budget is based are observed.

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8. Acronyms

A

AESTHVIS — Aesthetics and Visualization; research project.
AFEVAL — Evaluating Affective User Experience; research project.
AMBAID — Ambient Information Display; research project.
AnImage — Animation, Graphics, and Imaging; research theme 3.

B

BELIEVE — Believable Character Behaviors and Stories in Story-Based Games, research project.

C

CAPSIM — From Capture to Simulation; research project.
CBC — Canadian Broadcasting Corporation.
CPRM — Confronting Pain Redefining Mobility; research project.

D

DIGILAB — Digital Labor: Authors, Institutions and the New Media; research project.
DIGLT — Digital Games for Learning and Training; research project.
DINS — Digital Infrastructures: Access and Use in the Network Society; research project.
DR — Director.

E

ENCAD — Enabling Technologies for CAD Systems; research project.
EOVW — Developing Methods for Evaluation of Virtual Worlds and Understanding User Experiences; research project.

G

GAMFIT — Gaming for Fitness; research project.
GamSim —Games and Interactive Simulation, research theme 2.
GRAND — (English) Graphics, Animation and New Media, (French) Graphisme, Animation et Nouveaux Médias; Abbreviation for proposed NCE network.

H

HCTSL — Technologies for Sustainable Living; research project.
HDVID — New Interactions Around HD Video; research project.
HLTHSIM — Virtual Reality Simulation and Collaborative Games for Healthcare Training; research project.
HSCEG — High Speed Coordination in Electronic Games; research project.

I

INCLUDE — Accessibility of New Media for Disabled, Elderly, and Vulnerable Individuals; research project.
ISAC — International Scientific Advisory Committee.

M

MCSIG — Monte-Carlo Search in Games, research project.
MEOW — Media Enabled Organizational Workflow; research project.
MOTION — Modeling Human Motion; research project.

N

NAVEL — Network Assessment and Validation for Effective Leadership; research project.
NCE — Networks of Centres of Excellence.
nMEDIA —New Media Challenges and Opportunities; research theme 1.

NEWS — Access to News Media; research project.
NFB — National Film Board (see also, ONF).
NGAIA — Next Generation Information Appliances; research project.
NI — Network Investigator.
NSERC — Natural Sciences and Engineering Research Council, Canada.

O

ONF — Office national du film (see also, NFB).

P

PCL — Project Co-Leader.
PERUI — Personalized User Interfaces in Real World Contexts; research project.
PL — Project Leader.
PLATFORM — Platform Performance; research project.
PLAYPR — Play and Performance Interfaces for Culture and Games; research project.
PRIVNM — Usable Privacy and Security for New Media Environments; research project.
PROMO — Procedural Modeling; research project.

S

SD — Scientific Director.
SHRDSP — Shared Displays; research project.
SIMUL — Enhanced Communication in Simulation and Training; research project.
SKETCH — Sketch Interfaces; research project.
SocLeg — Social, Legal, Economic, and Cultural Perspectives; research theme 4.
SSHRC — Social Sciences and Humanities Research Council, Canada.

T

TCL — Theme Co-Leader.
TechMeth —Enabling Technologies and Methodologies; research theme 5.
TL — Theme Leader.

V

VIRTPRES — Enhanced Virtual Presence and Performance; research project.