UBC CERC Chair Proposal: Building Compelling Worlds

Criterion 1 – The institution's research strengths in the proposed field, assessed against global standards of excellence.

Institutional commitments and investments: The two main foci of the proposal are animation and games, supported by the areas of rendering, human computer interaction (HCI) and intelligent user interfaces. In the past eight years, UBC Computer Science has invested heavily in these areas, as shown in the following table listing current faculty members who are highly relevant to the proposed research.

Name	Research Focus	Year of Hire
Kelly Booth	HCI, collaboration technologies	1990
Robert Bridson	Animation, graphics	2003
Giuseppe Carenini	Intelligent user interfaces	2004
Cristina Conati	Intelligent user interfaces	2000
Wolfgang Heidrich	Rendering, digital media	2000
Karon MacLean	HCI, haptics	2000
Joanna McGrenere	HCI, collaboration technologies	2002
Tamara Munzner	Visualization, graphics	2002
Dinesh Pai	Animation, simulation	1991; 2006
Ron Rensink	Visualization, HCI	2001
Alla Sheffer	Geometric modelling, graphics	2003
Michiel van de Panne	Animation, graphics	2002

Since 2000, UBC Computer Science has hired 25 research faculty members. A significant proportion of the funding came from the Double The Opportunity program established by the provincial government and UBC. As listed above, 11 of the 25 (44%) are core to the proposed research, confirming the strong departmental commitments to the related areas. Three of the faculty hold research chairs relevant to animation and games:

- Professor Dinesh Pai is a Tier 1 Canada Research Chair. Pai has contributed in many areas within the field of animation, including the simulation of deformable objects, the dynamics of collision and contact, and multisensory interaction with sound and haptics. His current research aims to create more realistic simulations of human movement for computer animation and other applications. Pai started his CRC in 2006 when he returned to UBC and Canada from an unpaid leave of absence.
- Professor Michiel van de Panne is a Tier 2 Canada Research Chair. Van de Panne has made significant contributions to many topics in animation including physics-based methods for character animation, novel animation interfaces, and data-driven character animation. His Tier 2 chair position was renewed in 2007.
- Professor Wolfgang Heidrich is recently appointed in the fall of 2008 as the Dolby Computer Science Research Chair at UBC. He has made significant contributions in rendering and imaging, with a strong recent focus on high dynamic range imaging, a rendering and display technology for games and film which is seeing widespread adoption.

UBC Computer Science has also made significant investments in space and infrastructure on related areas. There are five related laboratories in the ICICS Building, amounting to a total of 450 square metres of research space. The ICICS Building was a $14M project, with funding from CFI, the provincial government and around $3M from UBC.

Last but not least, UBC Computer Science helps to recruit graduate students by providing guaranteed financial support. MSc students are guaranteed 20 months of financial support at a rate of $18.5K per year, and PhD students are guaranteed 36 months of support at $20K per year. The funding comes from supervisors' research grants, departmental and university scholarships, fellowships, and departmental positions such as teaching assistants.

Existing institutional excellence: UBC is home to one of the top animation and computer graphics groups, second-to-none in Canada, among the top 5 in North America, and easily in the top 10 worldwide. The faculty members cover a broad spectrum of research in animation, games, and digital media, including character and fluid animation, geometric modeling, imaging, and image synthesis. In the following, we highlight some of the accomplishments of selected faculty members.

- Canada Research Chair van de Panne is an international expert on character animation and sketch-based modeling and animation systems. He co-founded and co-chaired the ACM Eurographics Symposium on Computer Animation, which has since become the leading conference worldwide specific to computer animation research. He founded Motion Playground, a company whose online game has been played over 300 million times. Van de Panne also co-developed the hair animation technique used by Rhythm & Hues for their movie special effects (e.g., in the Chronicles of Narnia).His paper on "composable controllers for physics-based character animation" has received over 150 citations according to Google Scholar.
- Canada Research Chair Pai is well-known internationally for his contributions to physics-based animation and simulation, as well as sensori-motor computation. His achievements include fast, scalable algorithms for contact between rigid and deformable objects, one of the first physically based sound synthesis algorithms, the UBC Active Measurement facility for acquiring reality based models, and realistic biomechanical models of muscles and tendons for human animation. Pai's paper on "ArtDefo: accurate real time deformable objects" has received over 300 citations.
- Bridson conducts research on physics-based animation that has led to the development of software in collaboration with many major film studios, starting with Industrial Light and Magic for cloth simulation and most recently Double Negative Visual Effects and Weta Digital for fluids. He is co-founding a spin-off company. His code was used to generate special effects involving fluids (smoke, water, fire, etc.) in recent top movies such as Batman: The Dark Knight and Quantum of Solace, and is proving crucial to in upcoming releases such as the sixth Harry Potter film. His paper on "robust treatment of collisions, contact and friction for cloth animation" has received over 250 citations.
- Dolby Research Chair Heidrich is a key member and contributor in the UBC team that has developed novel high dynamic range display technology and associated image processing algorithms. This technology redefines the image quality potentially available on monitors and televisions and has been commercialized by UBC spinoff company Brightside Technologies. The acquisition of Brightside Technologies by Dolby Labs in 2007 has led to the founding of Dolby Canada. Heidrich has also made significant contributions to real-time image synthesis used in games, and to video-based geometry and motion capture. His paper on "realistic, hardware-accelerated shading and lighting" has received over 200 citations.
- Sheffer's research focuses on geometric modeling using triangle meshes, as well as sketch-based and image-based techniques for digital content creation. Her algorithms for the parameterization of triangle meshes have been integrated into both commercial and open source software packages that

are used worldwide for geometric modeling and animation. Her paper on “fundamentals of spherical parameterization for 3 D meshes” has received over 150 citations.

Given their reputations, these faculty members routinely chair some of the most important computer graphics and animation conferences and symposia, including the Symposium on Rendering, the Symposium on Computer Animation, and the Symposium on Geometry Processing. They hold international leadership positions, such as elected members of the executive board for the Eurographics Association. They also regularly serve on the most important program committees as well as the editorial boards of major journals. For example, in 2008 UBC was the only institution world-wide with 3 representatives on the program committee of ACM SIGGRAPH, the top computer graphics conference and journal. The recent decision by SIGGRAPH to hold its 2011 conference in Vancouver, the first ever outside the US for SIGGRAPH, highlights UBC CS’s prominence in North America and Vancouver’s position as a hub for animation and games research and development.

The animation and rendering expertise is complemented by one of Canada’s leading groups in intelligent user interfaces and HCI that also provides specific expertise in collaborative technologies. Both are central to games and digital media. While space precludes a more detailed presentation of accomplishments of all the faculty members involved, the following are several selected highlights:

UBC CS established an international reputation in HCI games research, specifically in educational games, more than 10 years ago. The EGEMS project, led by Klawe, focused on collaborative learning through games. Conati was an active participant. For the past few years, Conati has taken her research in a new strategic direction and has become an international leader in adaptive user interfaces, intelligent tutoring systems and user modeling. A key research contribution impacting upon the design of next-generation games is the development of computational models that combine information on both the causes and effects of users’ emotional reactions, as captured via physiological sensors. Her joint paper with McGrenere and Bunt on this topic won the Best Paper award at the ACM International Conference on Intelligent User Interfaces in 2007, the premier conference on this topic. Conati will be a program co-chair of this conference in 2009.

MacLean has made internationally recognized contributions in the fields of HCI, haptic device design and human perception and attention. She has received numerous Best Paper awards, including those at the most prestigious conferences in HCI (Best of CHI, 2006) and haptics (IEEE Haptics Symposium 2008). She co-led the creation of the IEEE Transactions on Haptics, co-chaired the search for its Editor-in-Chief, and in 2007 joined its inaugural editorial board. In 2008, she received UBC’s highest honor for young researchers, the Charles A. McDowell Award.

McGrenere is well known for her research on collaboration and assistive technologies, in addition to highly-cited contributions in personalization of graphical user interfaces. She was the first awardee for the Anita Borg Early Career Scholar Award in 2004.

Given the prominence of the UBC team, it has a stellar record of HQP training. The UBC animation and graphics faculty currently supervise 10 M.Sc, 20 Ph.D students, as well as 4 postdoctoral fellows. For the past 5 years, our alumni include over 50 M.Sc. and 14 Ph.D. students, as well as 7 postdoctoral fellows. On the HCI and intelligent user interfaces side, over the past 5 years, the group has supervised 7 postdoctoral fellows, graduated 34 M.Sc. and 9 Ph.D. students, with another 14 graduates currently in training. Our former trainees now hold faculty positions at Cornell University, the University of Illinois, UBC, the University of Victoria, McGill University, and the University of Ottawa. Others hold permanent research staff positions at the University of Southern California’s Institute of Creative Technologies, INRIA, and Microsoft Research Asia. Other alumni are working for companies such as Autodesk (formerly Alias|Wavefront), Bioware, Dolby Canada, Dreamworks Animation, Electronic

Arts, Epic Games, IMAX, Mainframe, Radical Entertainment, and Ubisoft. Many of these students held graduate fellowships from NSERC, UBC, and other sources.
Another strength of the UBC team is the existence of first-class facilities for research in animation, games and digital media. Special equipment available includes three large multi-projector projection screens for research in virtual reality, a Vicon motion capture system and a multi-camera array for 3D animation capture and novel user interfaces, a Cyberware 3D scanner for detailed geometry capture, a rapid prototyping machine as well as several leading-edge display technologies (high-dynamic range displays, SMART-boards, etc). These specialized facilities are complemented by a broad range of general infrastructure, including observation rooms for human factors studies, a professional sound recording studio, a video editing room, and ample space for special setups and experiments. This combination of facilities is truly unique world-wide. All of this will be available for use by the Chair.

Key competitors worldwide: With respect to animation and computer graphics, UBC's main competitors include the computer graphics groups at MIT, Stanford University, the University of Washington and the University of Toronto. The key competing academic institutions in Europe are the Max-Planck-Institute (MPI) for Computer Science in Germany, INRIA in France, and ETH Zurich in Switzerland. UBC is competitive with these institutions with respect to key metrics, such as publication count in top conferences and journals, successful commercialization efforts, and leadership positions (e.g., conference chairing, involvement in professional societies). Regarding HCI and intelligent user interfaces, UBC's competitors include University of Toronto, Georgia Institute of Technology, Stanford University, Carnegie Mellon University, University of California at Berkeley, University of Washington, Microsoft Research, and Germany's DFKI-Institute for Artificial Intelligence.

The primary area in which UBC is currently behind some of these institutions is group size and number of trainees. This can be directly attributed to discrepancies in funding available to the UBC group compared to some of the other institutions. For example, the computer graphics group at the MPI has an annual base funding of several million Euros, and access to vast project-specific funding sources including both state and federal funding, as well as EU funding such as the FP7 framework. Similar funding structures exist for INRIA and other graphics laboratories above. While such opportunities are currently not available to UBC, the addition of the Chair would level the playing field significantly.

Criteria 2 and 3 – The promise of the proposed field of research for the Chair, measured in the context of leading global research in this field and the likelihood that the work associated with the proposed Chair will be recognized as relevant and will advance the frontiers of research in the field globally.

Future research directions: This proposal focuses on one of the biggest challenges in animation and games: content creation. This encompasses geometric models of objects or scenes, motion for virtual humans and other characters, character behaviour, and appearance. These are commonly designed by expert artists and programmers essentially "by hand" in an ad hoc process with tools which provide little more than raw capabilities. This is time and labour intensive, setting up barriers to scalability for companies and also to the possibility of amateurs engaging in creation. To illustrate the former, the development time and budget of a major game now is in the same range as the biggest films, and in both games and film the economics of this process frustrates the demand to go further. In the latter, one can point to the emergence of a Web 2.0 culture of consumer-as-creator, with new media such as video blogs and creative/participatory games such as Spore becoming a major cultural force, demonstrating the desire of non-experts to engage in content creation. In response, the field of computer graphics research has begun to shift from investigating raw capabilities towards more scalable methods to create content and to build worlds. Our proposed Chair will take part in leading this transformation of the discipline.

The proposed Chair's research will not only tackle the question of how to build, but also understanding what to build: how to 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. The Chair would form a natural new bridge linking science and engineering to humanities and arts. The proposed program would also study the human part of the experience from psychological and artistic standpoints. How can one quantify "compelling"? What is perceptually and emotionally important to humans? How can a media interaction engender "flow"? Answers to these questions will fundamentally define the next-generation of animation tools, games and new media, and will increase their impact on the society as a whole.

At a high level, we can divide the proposed research in four main directions:

- **Scalable content generation:** algorithms that leverage computational power to extend the ability of a user to create compelling animation, character behaviours, geometric models, and so forth. This includes prominent subfields such as physics-based animation (simulating the laws of physics to generate realistic results ab initio) and procedural modeling.
- **Data-driven content generation:** methods for effectively acquiring or measuring real-world data (such as motion, geometry, appearance, user behaviour) and then analyzing and resynthesizing it into usable content. This 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 motion-capture data.
- **Effective and intelligent user interfaces**: for manipulating or creating content, featuring new ideas in sketch-based modeling, interfaces using the sense of touch (haptics), and intelligent editing tools (e.g., 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).
- **Human perception**: deals with understanding the parts of a digital experience that are perceived by humans. This understanding is crucial in developing visualization systems and user interfaces that can communicate content to the user more effectively. It is also critical to the inference of human-meaningful semantics in geometry and motion.

These categories are certainly not independent; we expect the most significant breakthroughs will involve a synthesis of all four. Indeed, it is this synthesis that most demands a program of the scope and level of a CERC Chair.

The global trend towards the proposed research is already underway. As a benchmark, consider ACM SIGGRAPH, the top venue for research publication in computer graphics. In 2008, of the 90 journal papers accepted, at least 29 deal with scalable content generation, 24 with data-driven content generation, 13 with intelligent user interfaces, and 12 with human perception, with some spanning more than one category. There is every indication this trend will continue. Content dominates the frontier of research as more traditional computer graphics topics have matured. This reflects both academic research and the concerns of over 20,000+ industrial attendees at SIGGRAPH each year. The gaming community finds itself similarly concerned with issues of content creation.

The current UBC team is already at the forefront of much of this research. However, relative to top institutions worldwide, we face barriers in research on scalability, barriers that the proposed Chair could remove. This is one prime example of why recruiting the CERC Chair will prove critical for advancing the UBC team to be a global leader. For example, faculty member Robert Bridson is one of a handful of experts worldwide to whom visual effects studios turn when faced with physics-based animation challenges beyond their R&D abilities. His engagement with these companies provides a valuable conduit to test and shape speculative research in highly demanding real-world settings, at the scale of the biggest budget films in the world. However, there remain serious impediments in the way of the research

meeting the real world, such as limits on time spent at a company or IP restrictions (e.g., the impossibility of working with film assets such as detailed geometric models outside of the film studio). The CERC Chair will command the resources to hire in-house professionals to generate industry-scale animation scenarios (such as those involving highly detailed geometric models) for research at the university, similar to that available in some of the best laboratories worldwide. The Chair will dramatically expand the scope of problems that can be efficiently tackled by researchers at UBC.

Specific institutional expectations of impact and ongoing commitments: The current research group is already strong and diverse; the proposed Chair will complement and supplement existing excellence, and will fill a critical role in founding a centre with significantly increased impact. The centre will help existing faculty to also be able to easily address real-world-scale challenges as mentioned above, and provide a natural hub for researchers and industry to connect more effectively. As director of the centre, the Chair should play a highly visible role nationally and internationally both in leading the shift towards content concerns in computer graphics and in bringing together industry and university research. Not only will the Chair be expected to continue in the present research group's mould of developing relationships with industry (i.e., users of the research outputs and outcomes) but will develop, in the centre, infrastructure and visibility to attract and facilitate better linkage with industry.

The Chair will also continue the UBC group's track record of training graduate students who go on to succeed in the field. Despite the current economic downturn, the prospects for the game and animation industries remains surprisingly bright, and the focus of this program is one of the most critical in-demand aspects to their future success. The enhanced visibility and expanded scope of research problems the CERC program will afford will also increase the group's ability as a whole to attract the best prospective graduate students from around the world. This will of course form part of the measurement of success of the Chair: numbers of graduate students and postdoctoral fellows, numbers of scholarships, and the success of the alumni.

By the end of the seven years, we expect the Chair to have succeeded in commanding international leadership in the field, not just measured in pure research impact (reported in terms of publications at the top-tier computer graphics venues: ACM SIGGRAPH, Symposium on Computer Animation, Eurographics, etc.) but also in terms of visibility in and impact on industry (reported in terms of significant companies and products such as games, films, or software tools relying on technology transferred from this research), and peer evaluation (reports including successes in grant applications particularly for sustainability beyond seven years, and leadership on program committees, etc.).

Criterion 4 – The extent to which the proposal fits in one or more of the priority and sub-priorities areas identified, or will address issues that will be of benefit to Canada.

Alignment with the sub-priority area of animation, games and new media: Content creation is one of the key challenges in games and animation. Here when we refer to games we also include "serious" games, e.g., the use of games in training, health, education, and public policy. Content creation includes interactive methods such as sketch-based interfaces for generating geometric models and animations from scratch; robust, efficient, and affordable methods for capturing real-world geometry and motions; and methods of authoring or simulating complex, environment-aware motions or behaviours at interactive rates. A key component of building compelling worlds revolves around new research on animation. Specifically, in order to animate millions of open-ended narratives in cinematic detail and in a compelling fashion, it is imperative to develop rich and scalable models of motion for humans, animals, cloth, fluids, and indeed for everything we can see in worlds, real and imaginary.

Apart from advances in animation, new-generation games require research to be done on rendering, HCI and intelligent interfaces. Rendering gives the cinematic detail that contributes towards a compelling experience. The importance of massively-multiplayer online role-playing games is demonstrated by the popularity of World of Warcraft, a game with over 11 million subscribers. 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 HCI highlights the importance of careful game design when there is a goal of encouraging active collaboration and competition. As part of the motivation of data driven content generation, understanding how game players interact in virtual worlds, which is critical for game developers to refine and enrich the game playing experience, is one benefit that HCI brings to gaming. Another is the design of sound evaluation methods, including the development of heuristics useful for evaluating the usability of games.

Intelligent and adaptive user interfaces are also critical to new generation games. An example is that of intelligent interfaces that model and adapt to the game players' complex cognitive processes and emotional states. This is an exciting area of overlap between HCI and artificial intelligence. Advances in adaptive user interfaces will greatly enhance the gaming experience.

Current state-of-the-art research in animation and games often entails a remarkable degree of sophistication in its use of mathematical and perceptual modeling, building on state-of-the-art techniques. Thus while the focus of this CERC proposal is on animation and games, there is also tremendous potential to benefit other applications. A straightforward example is that of using advances in state-of-the-art physics-based models of human motion to help better understand the biomechanics and kinesiology of human motion and for developing improved sensing-and-control strategies for robotics. Similarly, an improved understanding of human visual perception in the context of level-of-detail issues in games and high dynamic range imaging also has direct applications to the design of novel visualization and visual analytics tools which allow users to make better sense of an increasingly data-rich society. Current and past research from the group has been used to create state-of-the-art models for human musculoskeletal structure, dynamic human walking, future high dynamic range radiography displays, information visualization of intra-cellular processes, haptic design issues relevant for surgical simulations, automotive cockpit design, and even the numerical simulation of airborne wind power prototypes. Stated in another way, many of the fundamental modeling issues underlying animation and games are equally fundamental to other medical and engineering applications, and the current research group has a strong expectation that the CERC program should exploit such synergies.

Alignment with provincial priorities and interaction with Canadian groups: For over two decades, British Columbia has cultivated a strong software industry, with animation, games and new media playing a growing role. The four-university Great Northern Way program in digital media and the establishment of the School for Interactive Art and Technology at SFU are recent B.C. initiatives to provide academic training in this area. The proposed chair will complement those efforts with training at the graduate and undergraduate levels targeted specifically to science and engineering students (by comparison, the other two programs have a stronger focus on the arts). This strong integrative approach has the potential to strengthen the other two programs by increasing the prospects for multi-disciplinary teams trained in B.C.

Within UBC, the Media and Graphics Interdisciplinary Centre (MAGIC) was created to foster research covering the entire spectrum of new computer-based and computer-associated media. The Centre highlights the commitment of UBC to the use of advanced media technology. There are also groups in psychology and music within UBC that are synergistic with the proposed research. Computer Science and Psychology already have strong ties in research, graduate and undergraduate education. Outside of

UBC, there are many existing collaborations with researchers from SFU, McGill University and the University of Toronto. The Chair would naturally strengthen research interactions within Canada, leading in such efforts as the creation of a new National Centre of Excellence.

Benefits to the automotive industry: The UBC team already has a track record of working with the automotive industry. Rensink, who has a joint appointment between Computer Science and Psychology, received $2M in research funding from Nissan Motor Inc. from 2002 to 2006. The goal was to help guide the design of next-generation intelligent automobile interfaces. This included operation of basic dashboard indicators, navigation displays, and semi-automated controls and camera systems. A core research related to the effective integration of the driver with the automobile, tackling issues such as the visualization of information for quick pickup and understanding by drivers and situational awareness. Results impacted the design of several systems currently in use. Since 2006, relationship with Nissan still continues, on the basis of intermittent contracts. The proposed program of building compelling worlds includes the development of tools allowing users to interact with data-rich worlds, of which the Nissan project is a great exemplary application.

The design of geometric surfaces such as a car body is a major geometry processing challenge. Many of such surfaces are manufactured from metal sheets and therefore the minimal stretch unfolding of such surfaces is a critical design step. The amount of stretch during unfolding reflects the stretching or shrinkage the metal needs to undergo when forming the desired surfaces. An increase in stretch/shrinkage increases the amount of energy needed to generate the shape, and is reflected in the cost of manufacturing. It also negatively affects the structural stability of the manufactured surfaces, causing local thinning or thickening. Thus, methods for low stretch unfolding both reduce manufacturing costs and increase the quality of the manufactured surfaces. Sheffer's research on mesh parameterization is widely used for surface unfolding in automotives and in other industries. She continues to investigate and develop tools to model a wider variety of surfaces. Developing a wide range of modeling tools is a key component of the proposed program of building compelling worlds.

Criterion 5 – The ability of the university to sustain the research advantage created by the proposed Chair after the seven-year term of the Chair expires.

UBC and the UBC Faculty of Science are conducting a capital campaign. The proposed field of research will be highlighted as one of the highest priority areas. The goal is to establish a $10M endowment fund within seven years. Assuming a 5% annual return on the endowment, this would provide a revenue of $500K per year to the proposed program starting from the eighth year and onwards. As the endowment begins to build up from the first to the seventh year, all the interest proceeds will be banked for use after the seventh year. In addition, UBC is negotiating with the provincial government to guarantee a funding stream of $200K per year to the proposed program after the seventh year.

Regarding the first seven years of the proposed program, UBC is contributing $800K for a junior faculty member in the proposed research areas. At the end of the seventh year term, both the Chair and the junior faculty member would retain their positions at UBC. Given their prominence, we expect that they be able to obtain at least $100K per year combined in NSERC individual discovery grants. More importantly, they are expected to apply for bigger grants (e.g., NSERC strategic grants, NSERC strategic network grants, NSF grants), and to lead the creation of a National Centre of Excellence in animation and games. As noted earlier in the section on alignment with Canadian groups, the proposed program is synergistic with various groups within UBC, including psychology, music and MAGIC. UBC will facilitate these groups to work together with the objective of creating a prominent national profile on

animation and games, making the team even more likely to be awarded the bigger grants. These efforts are expected to bring in an additional $300K per year.

Apart from UBC central, the department of Computer Science itself is also contributing to fund students and postdoctoral fellows. Graduate students are guaranteed funding with teaching assistantships, and stipends for postdoctoral fellows are partly provided if they teach courses for the department. Partial funding for equipment maintenance and administrative costs will also be provided. All these items add up to about $100K per year.

One of the key strengths of the proposed research program is its immense commercialization potential. We have solicited input from several potential industrial collaborators in animation, film and games for the CERC process. All expressed strong support and interest in further collaboration. Below we include several extracts from these letters, and we note that the full letters are available upon request.

- **Dr. Joe Marks (Vice President, R & D, Walt Disney Imagineering & Animation Studios):** "*…My first reaction when I read this proposal was a chuckle, because it so closely resembles my current hiring plan for Disney Research! I'd like to think that the commonality reflects shared wisdom. The fundamental problem that the proposal addresses is the cost of creating digital content for movies and games on a large scale. This is a very real problem. For example, major animated movies now cost US $150M+. Major game titles can be as expensive. These costs threaten the vitality of the media & entertainment industry in North America. Moreover, they also constrain artistic expression: it's hard to take creative risks when the financial stakes are so great. The four specific topics described in the proposal (scalable content generation, data-driven content generation, effective user interfaces and human perception) address this problem head-on…The existing faculty at UBC has many of the skills necessary to do world-class research on these topics. An additional senior professor would build on these strengths and help move the UBC group into the very top echelon of computer-graphics research groups, perhaps from top 10 to top 3 in the world…*"
- **Dr. Tony DeRose (Senior Scientist and Lead of the Research Group, Pixar Animation Studios):** "*…Pixar is a pioneer in computer graphics and animation, with significant technical accomplishments dating back to the inception of the discipline. Our films have tremendous appeal, each typically garnering nearly half a billion dollars in worldwide box office… Areas where our needs for new technology are the greatest include many of those being investigated by faculty at UBC. We are particularly interested in, and are keeping a close eye on, Robert Bridson's physical simulation work, and Alla Sheffer's work on garment modeling and mesh parametrization. Advances in these areas have the potential to dramatically improve the quality of our work while substantially reducing our costs. The proposed chair position and research program, if funded, would make the UBC Computer Science team a world leader. Many of the research results would have high commercialization potential, not just at Pixar, but also within our parent company Disney, and in the broader entertainment industry…*"

- **Mr. Don Mattrick (Senior Vice President, Interactive Entertainment Business, Microsoft Corp.):** "*… The division I lead accounts for the bulk of Microsoft's Entertainment and Devices business, which did more than $8 billion in revenue and $426 million in operating profit last fiscal year. We have sold nearly 25 million Xbox 360 consoles to consumers worldwide, have 14 million members in our Xbox LIVE online service, and are home to best-selling video games such as Halo 3 and Fable 2. The UBC proposal focuses on scalable content generation tools, an area of high interest in our business. Creating content is a significant cost component, and we value any tools that can help us to reduce the time and money we and our partners spend developing games. Such tools have very high potential for commercialization. Another important aspect of the proposal*

concerns the overlap of human computer interaction, artificial intelligence and user modeling in games. This research would help to create video-game characters that behave more like humans, thereby making games a much more entertaining, immersive, and powerful medium. Microsoft's games business is growing fast and exploring ways to expand in Canada. However, finding highly trained personnel continues to be a challenge. This proposed training program will go a long way towards meeting this need. The existing UBC team is already very strong in many related aspects, but a $10 million investment by the Canadian Government would transform UBC into a world-class institution for games research and education. This would benefit not only Microsoft but all game companies in Vancouver and throughout Canada. The return on this investment would be highly beneficial to all concerned. I sit on the President's Strategic Advisory Council at UBC and have advised their Computer Science department on several joint research-related activities. Given the strategic importance of this proposal, I would be keen to provide additional advice to UBC on issues related to this program…"

- **Ms. Pauline Moller (Vice President, Studio General Manager, Electronic Arts Canada):** "*…The topic of this proposal is of direct interest to EA. The creation of digital content is central to our business. For example, creating lifelike, compelling and realistic motion is essential to the success of most of our products, from our sports titles such as NHL09 and FIFA09, to The Sims and Spore. We are interested in the proposed research program outlined, and all four core topics mentioned impact the development of interactive entertainment software: scalable content generation, data-driven content generation, effective user interfaces and human perception. The development of a better understanding of these topics will be of direct relevance to our business…The program would also help to expose many graduate and undergraduate students to world-class research and education in this field. The game development industry in Canada, expected to continue to grow, would benefit from having a Canadian university with significant expertise in this area…*"

In the context of the above feedback from key industrial players and given seven years to cultivate the relationships, the Chair is expected to raise significant industrial funding from within and outside of Canada. We expect at least $300K per year from this source.

Criterion 6 – The ability of the institution to leverage additional resources that, together with the CERC program, will enable the university to adequately support the direct and indirect costs associated with a world-class program.

Past Leverage: The funding received by researchers whose work focuses on animation, games and new media research through competitive grant applications totalled $2M in the last five years. The primary funding sources are NSERC and NCE programs, including Discovery, RTI, CFI, I2I, SRO, and CRD grants. The NCE programs our researchers actively participated in include MITACS, GEOIDE, and IRIS. Other competitive funding sources have included NSF, British Columbia Knowledge Development Fund, and Human Frontier Science Program. The total doubles to $4M when competitive funding received by researchers in HCI and intelligent user interfaces is included. This does not include funds for the construction of the ICICS Building and the associated equipment.

The animation and graphics faculty members have in the last few years forged numerous industry ties, many of which have resulted in significant financial support, including funding from Adobe Systems, Agilent Technologies, AT&T, Brightside Technology (currently Dolby), Dolby Canada, Google, IBM, Nvidia, Point Grey Research, Terrapoint and Stratasys, totalling over $650K. When including researchers from HCI and intelligent user interfaces, who have ties with Boeing, Immersion Corp., Microsoft, Nissan and Nokia, the total industry funding figure goes up to around $1M.

Potential Leverage: The next round of NCE applications is likely to receive a proposal that will have a theme involving animation, games and new media as part of a larger research program that can be described as "information intensive industries". Key technologies of artificial intelligence, computer graphics, databases, networking and security complemented by HCI and visualization will support specific economically important application domains of entertainment, business intelligence, and e-commerce. The proposed CERC chair would be an obvious candidate to serve as the theme leader for this area, or be a senior applicant playing a major role in the scientific leadership of the NCE.

Apart from the NCE, we expect that the CERC chair will lead a new CFI effort to improve the infrastructure necessary for maintaining a world-class research centre. Equipment such as humanoid robots for developing robotics-based gaming, advanced motion capture systems and range scaners for large-scale outdoor acquisition of geometric modes costs millions of dollars. Furthermore, in the past there have been Precarn, NSERC, SSHRC, BC ASI, and BC Science Council grants to support collaborations between UBC researchers in the various aspects of research related to the proposed program. This can be expected to increase with the additional resources provided by a CERC award.

As documented by the four support letters shown earlier, animation studios and games companies in Vancouver, Canada, and the US are likely to closely monitor the research program being conducted by the proposed CERC Chair. We expect that the Chair would be able to foster strong ties with many of these companies. In the sustainability plan outlined earlier, we expect the Chair to be able to raise $300K from industrial partners per year after seven years. We are optimistic that the Chair would bring in significant industrial funds much earlier.

Criterion 7 – The potential to apply the research results from the Chair to advance public policy and/or to commercialize research discoveries from the Chair.

Commercialization Potential: The extracts of the support letters all comment explicitly on the commercialization potential of the proposed research. For example, for animation, DeRose's letter says: "*…many of the research results would have high commercialization potential, not just at Pixar, but also within our parent company Disney, and in the broader entertainment industry…*". Marks' letter says: "*The fundamental problem that the proposal addresses is the cost of creating digital content for movies and games on a large scale. This is a very real problem.*" For games, Mattrick's letter says: "*…creating content is a significant cost component, and we value any tools that can help us to reduce the time and money we and our partners spend developing games. Such tools have very high potential for commercialization…*" Thus, commercialization potential is one of the key strengths of the proposed Chair.

Vancouver is internationally known as a center for game development, having an estimated 150 game-related companies in the greater Vancouver area, including Electronic Arts, THQ, Activision Blizzard, Backbone Entertainment, Radical Entertainment, Rockstar Games and United Front Games. Maya and SoftImage, two of the principal software packages used worldwide for computer animation and modeling are developed in Canada. Vancouver animation production companies include Rainmaker Animation, Image Engine, Bardel Entertainment, and a number of others. Apart from commercialization potential, another key benefit of the CERC chair is to serve as a seed point for the innovations and HQP that are the key drivers for these knowledge-based industries. The letter from Mattrick highlights: "*Microsoft's games business is growing fast and exploring ways to expand in Canada. However, finding highly trained personnel continues to be a challenge. This proposed training program will go a long way towards meeting this need.*" The letter from Moller expresses the same opinion. While we can

expect that animation and games (and new media) will continue to evolve in rapid and sometimes unpredictable directions, the underlying themes, undertaken by the proposed program, of being able to model, animate, and efficiently interact with data-rich worlds will remain constant.

The public good: As described in the future research direction section, we anticipate significant benefits to society and public policy from new digital media experiences. Effective new techniques for acquiring and uniting disparate data sources and allowing anyone to intuitively interact with the resulting virtual world will enhance public planning, navigation, security and connecting Canadians to their communities in new ways. Imagine, for example, the benefits to democracy if any citizen could easily visualize the impact of a proposed new development (e.g., a power plant, a shopping centre), and make informed and realistic suggestions to improve it with the digital tools this CERC project could produce. Importantly, as described earlier, the fundamental modeling issues underlying this proposal overlap in significant ways with core problems in medicine, engineering, and other applications. Indeed, this kind of symbiosis is a unique aspect of university environments and the current research group sees this as a responsibility as well as an opportunity.

Track record of knowledge translation: Heidrich has played a key role in the Brightside (now Dolby Canada) UBC spinoff company that is commercializing high-dynamic range imaging technology. Bridson is co-founding a company specializing in physics-based animation. Sheffer's work on parameterization is used worldwide as part of CAD packages, including CATIA, and she has ongoing collaborations with Adobe. Van de Panne founded Motion Playground to commercialize ideas related to interactive physics-based animation. Booth has worked with a long list of industry collaborators through a number of NSERC strategic grants and as former director of MAGIC at UBC. MacLean has collaborated with Nokia and Immersion technologies on research projects. McGrenere has ongoing collaborations with the IBM Center for Advanced Studies in Toronto. Rensink has established multi-million dollar collaborations with Nissan and Boeing. Munzner has collaborated with Google, ATT, and Agilent laboratories. All these examples show that the existing faculty members are keen to see their research results adopted by companies and the user communities.

Current barriers and opportunities: While UBC has considerable expertise in the scientific and algorithmic aspects of creating animation and games, there are other aspects that UBC needs to link with other units. The proposed Chair will help provide the resources necessary to help develop courses that also cover aspects of authoring, storytelling, design, creativity, and evaluation that are not typically covered in the more mathematical and algorithmic courses on computer animation and gaming. Successful models here include the Carnegie Mellon Entertainment Technology Centre, and the University of Washington Animation Laboratories. The expertise can be further pooled with those of the Masters of Digital Media program and the Great Northern Way Campus in Vancouver. New game industry/academia conference venues such as the Vancouver International Games Summit 2008 and Future Play 2008 (Toronto) also provide potentially fruitful venues for enhancing the impact and use of research findings.

University Industry Liaison: The UIL Office at UBC is the recognized leader in this field in Canada and UBC was ranked 8th in North America for its commercialization activities in a recent study conducted by the Milken Institute. Since its inception in 1984, the UILO has fostered the creation of over 130 spin-off companies, secured over $115M in licensing revenue, and annually manages in excess of $40M in industry sponsored research. When researchers at UBC wish to commercialize patentable, or otherwise functional (e.g. software), intellectual property (IP) that is developed at UBC, the IP is owned by the University and its commercialization managed by the UILO; with net proceeds shared among the participating institutions and the inventors.