Material for the Nomination of the Dynamic Graphics Project and Alias/Autodesk Research for an NSERC Synergy Award for Innovation

1. History and Background

From its inception, the remarkable success of computer graphics in Canada has been due to synergies among many institutions. In 1966, Nestor Burtnyk and Marceli Wein of the National Research Council of Canada began a collaboration to develop the field of computer graphics in Canada. In 1969, they were inspired by traditional Disney animators to look at the problem of computer assistance for the painstaking process of hand-drawn animation. This led to the development of a key-frame animation system in the early 1970s that attracted the interest of the National Film Board of Canada. In particular, Peter Foldes, a classical animator, worked with Burtnyk and Wein to create the remarkable film “Le Faim (Hunger)”, which received the Jury Prize in the short film category at Cannes Film Festival as well as the first ever Academy Award nomination for a computer animated film. Foldes, Burtnyk and Wein have since served as role models for countless Canadian artists, scientists and engineers, both to demonstrate that the disproportionate impact that Canadians can have, as well as the importance of synergistic collaboration among institutions. For indeed many partnerships have historically been formed among universities such as UBC, Waterloo, Calgary, McGill, Montreal and Toronto, together with Canadian media companies such as Side Effects, SoftImage, Vertigo, Alias, Radical Entertainment, Nelvana, and so on.

Over the past four decades, however, there has been no more successful partnership than that between the University of Toronto (particularly the “Dynamics Graphics Project” or dgp—see www.dgp.toronto.edu) and researchers at Alias|Wavefront, now called “Autodesk Research”. This partnership was based on the goal of improving the ability of artists and designers to develop visual models in the areas of design and entertainment. Visual modelling requires both deep mathematical modelling of specific phenomena, as well as considerable insights into workflow, usability and interaction. An unusable technology is an unsuccessful technology. An understanding of the need to make progress on both the human and scientific aspects of visual modelling is a unique aspect of the dgp-Alias relationship. This relationship has prospered both due to technology transfer and to the bilateral movement of highly talented and skilled personnel between both groups: professors became employees of Alias/Autodesk, employees at Alias/Autodesk became professors, graduate students went to work at the company, and workers at the company became graduate students. This reciprocity has become a mutually advantageous key to the success of both groups. As we shall see, the numbers are staggering.

The interactive graphics lab at the University of Toronto was founded in 1967 by Professor Leslie Mezei. He was joined by Professor Ron Baecker in 1972, who coined the name Dynamic Graphics Project or dgp in 1974. The name of the group was intended to convey the idea the dynamism of
human computer interaction together with animated computer graphics. The group developed innovative and influential hardware and software techniques for interactive media. Through the 70s and 80s, Bill Buxton, Alain Fournier and Eugene Fiume joined dgp as faculty, steadily becoming a world academic leader in both computer graphics and human-computer interaction.

The life of Alias Research began in Toronto in 1983, which combined with Wavefront Technologies and became known as Alias|Wavefront. Through the eighties, it became a leader in developing software to aid creative professionals in geometric design, architecture and animation. The story of the evolution of both Alias and dgp will continue in the next section.

2. Partnership

The dgp-Alias partnership began in 1992. Alias was recovering from a financial downturn with renewed investments in R&D for computational tools for design and entertainment. Computational power had by then reached the stage where high-quality interactive graphics was within reach, but a great deal of basic research was still needed. Alias collaborated with various universities on mathematical techniques for modelling surfaces, and on animating and rendering geometric models. However, the modelling of natural phenomena such as smoke, fire, clouds and water was embryonic research. By 1994, Eugene Fiume and his then student Jos Stam demonstrated a new way to model “gaseous and fluid phenomena” that was then licensed by Alias. Stam and Fiume worked with engineers from Alias to integrate these techniques into the Alias design product with astonishing success: the enhanced product drew considerable attention from film animators, and the (now) world-renowned animator, Chris Landreth, while working at Alias, used this technology often in completely unexpected ways to create an Academy Award nominated film called “the end”. Dozens of film productions used this work in short order, routinely including Landreth himself, who ten years later won an Academy Award in 2005 for his beautiful film “Ryan”. This film incidentally also involved members of dgp. Jos Stam joined Alias and continued a string of innovations that make him among the most highly cited researchers in computer graphics. His efforts were recognised in a “Computer Graphics Achievement Award” presented by the premier organisation in the field, ACM SIGGRAPH. After more years of enhancement, Stam and his colleagues at Alias won a Technical Academy Award for their fluid simulation software. The story has come around full circle, as Stam is now an Adjunct Professor in the Department of Computer Science at the University of Toronto, working with several students in dgp.

Likewise, in the early 1990s, Gord Kurtenbach developed an innovative user interface dialogue technique called “Marking Menus” as part of his Ph.D. work in dgp under the supervision of Bill Buxton. This technology was also transferred to Alias and became central to distinguishing the workflow and user interface of Alias from its competitors. Both Buxton and Kurtenbach then joined Alias, forming the core of a new research group at Alias. This was among the first groups in industry to focus on fundamental research on human-computer interfaces and on usability engineering. The group,
strengthened by more dgp graduates such as George Fitzmaurice and Russell Owen, quickly established an international reputation in HCI, publishing a series of highly cited papers. Bill Buxton went on to become a Chief Scientist of the company.

Fiume joined Alias for several years starting in 1995, going on to establish broadly based Research and Usability Engineering department. This set the stage for a similar growth in computer graphics research as Buxton spearheaded in HCI: Karan Singh and Jos Stam joined the research group, developing new techniques in geometric modelling, deformations, and the modelling of natural phenomena. When Fiume returned to the University of Toronto to chair the Department of Computer Science in 1998, Kurtenbach took over as Director of Research, and both Kurtenbach and Fitzmaurice became Adjunct Professors in the department. By then the Alias Research group was a world leader in both HCI and computer graphics.

The 2000s saw a period of rapid change for dgp and Alias/Autodesk Research. In his role of department chair, Fiume was able to recruit both Karan Singh and Ravin Balakrishnan, two outstanding people who had been at Alias, to the faculty. This further strengthened the connection between the two groups. In 2003, Alias was awarded an Academy Award in Technical Achievement for the software system called *Maya*, which was shared by many scientists and engineers, including several at dgp. In the meantime, forces within the digital media industry moved inexorably toward amalgamation. The company Alias found a home within Autodesk, and its research group was re-created as *Autodesk Research* (see [www.autodeskresearch.com/](http://www.autodeskresearch.com/)). It is notable that not only did Kurtenbach assume the role of Director of Autodesk Research: the entire research team remained in Toronto, together with many former Alias employees. The opportunities for further collaboration in recent years have considerably increased. For example, with the leadership of Azam Khan of Autodesk Research, researchers at dgp and elsewhere at the University of Toronto have combined with Autodesk Research to create a long-term research programme in computational anatomy with a focus on parametric, physically based models of humans (see [www.parametrichuman.org/](http://www.parametrichuman.org/)).

In retrospect, the growth and success of this partnership is astonishing. The industry over the past twenty years went from an addressable market of about $100M in 1992 to about $2B in 2011. Over this period, more than 100 papers were co-authored by dgp alumni at Alias/Autodesk Research, of which more than 50 were co-authored by current members of dgp (see [www.autodeskresearch.com/publications](http://www.autodeskresearch.com/publications)). Numerous co-authored patents have also ensued.

Alias/Autodesk has employed about 100 graduates of the University of Toronto: 45 from dgp, most with PhDs from the Department of Computer Science, 20 other graduates of Computer Science, and 35 graduates of other disciplines at the University of Toronto. The number of internships is beyond our ability to count them, but many employees began their work with Alias/Autodesk as interns. More than one-half of these people are still with the company, and virtually all of these 100 people have remained in Canada (including several who have returned to the university and others who started up their own companies), providing a huge net return to the economy.
3. Effective Use of Resources

The relationship between dgp and Alias/Autodesk Research has always been based on a clear recognition of their different mandates: the former does basic science that has largely been funded by NSERC Discovery Grants while the latter performs applied (and some basic) research, engineering and product development. This complementarity has afforded extremely productive opportunities for members of both groups: students have learnt about production software and customer requirements, while employees have seen the difference between basic and applied research. The relationship has also allowed considerable access to matching-funds opportunities afforded by National Centres of Excellence such as MITACS and GRAND. Kurtenbach in fact chairs the Research Management Committee of GRAND, which is further evidence that the influence of Autodesk Research has now propagated throughout Canada.

As indicated earlier, Alias/Autodesk Research has provided many diverse opportunities for internships across many disciplines, including computer graphics, human computer interaction, physical simulation, green initiatives, and computer aided geometric design, with a large proportion of interns ultimately being employed at Autodesk in Toronto.

See the last two paragraphs in Section 2 for quantitative employment and research data.

4. Tangible Benefits

If by synergy we mean “a mutually advantageous conjunction of distinct elements”, the successful twenty year collaboration between dgp and Alias/Autodesk Research clearly demonstrates it. The unusually powerful reinforcement that one group has had on another also demonstrates the “ability of a group to outperform even its best individual member”. The connection between dgp and Alias/Autodesk Research certainly is one that has celebrated individuals but has even more powerful groups. It is worth summarising the benefits of this relationship:

- Individuals have had an opportunity to do technology transfer.
- Professors assumed leadership roles in the company.
- Thought leaders in the company became professors.
- 100 graduates of the university became employees of the company.
- Many employees of the company have become students.
- Most of the students, employees and activities of both groups have remained in Canada.
- The work performed has involved collaborative research in science, technology, engineering, and the arts. It has resulted in numerous recognised technical achievements, including technical Academy Awards.
- The results of the collaboration have also resulted in numerous artistic achievements.
A relationship that began with the modest technology transfer of some basic scientific results has flourished into a collaboration of huge economic, scientific, artistic and social benefit. This relationship promises to continue long into the future and is worthy of celebration.