Exhibit 3

Karan Sher Singh

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Bio and Career Highlights

Karan Singh is an expert in Interactive Computer Graphics. Born and raised in India (1969), he holds a BTech. (1991) from IIT Madras and MS (1992), PhD (1995) from the Ohio State University. He has been an Associate Professor at the Univ. of Toronto since 2002. His research interests lie in artist driven interactive graphics, spanning geometric and anatomic modeling, character animation and sketch based interfaces. He has been a technical lead on two commercial projects that won technical Oscars (Maya, Paraform). These software systems are the current industry standards for animation and reverse engineering respectively. He is a co-founder of Arcestra, a sketch based software solution for architecture and industrial design. He lead the design of two research systems based on sketch and sculpt metaphors (www.ilovesketch.com , www.meshmixer.com), that have been featured on leading design forums. He co-directs a reputed graphics and HCI lab, DGP, has supervised over 20 MS/PhD theses and is currently supervising 6 MS/PhD students. He was the R&D Director for the 2005 Oscar winning animated short *Ryan* and had his first exhibition of electronic art titled *Labyrinths*, in 2010 www.karanshersingh.com. His current research focus is on 3D shape perception and understanding and sketch/touch based interfaces.

Degrees

- Ph.D., *Computer and Information Science*. Ohio State University. 12/92-10/95
  Thesis: Realistic Human figure Synthesis and Animation for VR applications.
  Advisor: Richard Parent
- M.S., *Computer and Information Science*. Ohio State University. 9/91-11/92
- B.Tech., *Computer Science and Engineering*. 8/87-7/91
  Indian Institute of Technology, Madras, India.

Employment

- June 2006- present: *co-founder*, Arcestra Inc., Canada.
- Jan.2002- present: *Associate Professor*, Computer Science, University of Toronto, Canada.
- Jan.2002- present: C*hief Scientist*, Geometry Systems Inc. http://www.geometrysystems.com.
- Jun.1999- Jun.2001: *Technical Lead*, Paraform Inc., Santa Clara, CA.
- Feb.1999- May 1999: *Visiting Professor*, Computer Science, University of Otago, New Zealand.
- Dec.1995- Jan.1999: *Graphics Researcher*, Alias Inc., Toronto, Canada.
- Jan.1994- Dec.1994: *Invited researcher*, Communication Systems Research Labs, Advanced Telecommunications Research (ATR), Kyoto, Japan.
- Summer 1989-1993: *Instructor*, Ross Program (Num. Theory & Combinatorics), http://www.math.ohio-state.edu/ross/

Industrial Consulting and Research Collaborations

- *Software*: Autodesk, NVidia, ATI, Adobe, Microsoft Research.
- *Film and Games*: Disney, Core, Starz Animation, Sony Imageworks, Electronic Arts.
- *Industrial Design*: Bruce Mau Design.
- *Medical*: Bodyworlds, Clynch Technologies.
- *Robotics and manufacturing*: Hanson Robotics.

Research Interests

Sketch and touch interfaces, Character animation, Geometric modeling and design, Hand anatomy, Artistic rendering.

Honours and awards

- **MITACS** 2008-2009 Mentorship Award of Excellence.
- **Indo-Canada Chamber of Commerce** (Technology Award), 2008.
- **International Distinguished Scholar** (University of Pennsylvania), 2007.
- **Centennial Foundation of Canada award** 2006.
- **ICES Visiting Professor award** (University of Texas, Austin) 2005.
- **Ryan.** (Software R&D Director) **Oscar** (Best Animated Short) 2005, *Cannes* 2004, Kodak Discovery, Young Critic's Prize, Canal+ Best Film, *SIGGRAPH* 2004, Los Angeles, CA, Electronic Theater, Jury Prize, *Annecey* International Film Festival 2004, Jury Award, *Prix Arts Electronica* 2004, Golden Nica, *Ottawa* animation festival, Grand Prize, *Genie* (Best Canadian Animation) 2005.
- **Paraform 1.0, 2000.** (**Technical achievement Academy Award/Oscar 2001**) for R&D work on first commercial reverse engineering technology.
- **Maya 1.0, 1998. (Technical Oscar 2003,** only 38 such awards since 1930**)** for R&D work on character and facial animation tools that is now the de facto commercial standard in modeling and animation. The papers [SF98], [SK00] chronicled some of this work and developed a new class of surface-oriented deformation techniques.
- **Bingo.** (Technical Director) *SIGGRAPH* 1998, Orlando, FL, Electronic Theater, Grand Prize, *Genie* 1998, Best Canadian Animated Short Film.

Patents

- Interactive labyrinth curve generation and applications (US patent no. 7928983).
- System method and computer program for 3D sketching with dynamic partial image recognition and comparable image retrieval. (U.S. patent no. 062108-0007).
- A system for creating and modifying curves and surfaces (U.S. patent no. 7289121).
- Method and apparatus for geometric model deformation using wires U.S. patent no. 6,204,860.
- Motion synthesis equipment using 3D models. Tokuganhei 7-42120 (Jap. Patent# 1995 - 42120).
- 3D image synthesis equipment for enabling wrinkle formation. Tokuganhei 7-105012 (Jap. Patent# 1995 - 105012).

Keynotes, Invited Lectures and Colloquia (2000-present)

- *Sketching: perception, interaction and modeling.* Eurographics Symposium of Geometry Processing SGP July 2010.
- Interactive Sketch & Sculpt systems: August 2010, Dreamworks, Adobe, Disney research, Oct. 2010.
- *Sketching and sculpt: perception, interaction and modeling* . Colloquium, March 18, School of Technology & Design, NYC College of Technology, GRAND Lecture, UBC, Computer Science keynote Lecture *APICS*, Oct. 2010, RWTH Aachen, Dec. 2010, TCS Delhi April 2009, INRIA Grenoble Sept. 2009.
- *Psychorealism, anatomy and animation*, Chinese International film festival, Hangzhou April 2007.
- *Art and science of computational anatomic modeling*, Ontario Science Center, Nov. 2005, Microsoft research Jan. 2005.
- *Computer modeling of the human hand*, Great Lakes Hand Society Oct. 2005
- *Labyrinths and Mazes*, INRIA Grenoble June 2005, Ross Program 2005.
- *Artist driven interactive graphics*, UT Austin March 2004, Microsoft Research Asia April 2004, Beijing Film Academy April 2004, INRIA Grenoble May 2004, Gobelins Animation School Paris June 2004, McGill University Sept. 2004, Washington Univ. at St. Louis Nov. 2004, Rutgers Dec. 2004, UBC, Electronic Arts Vancouver Dec. 2004, Microsoft Research Seattle Jan. 2005, University of Calgary Feb. 2005, Northwestern Univeristy Jan. 2006.
- *Mathematical surface representations for conceptual design*, MITACS, Banff 2003.
- *Cameras and psychorealism.* Electronic Arts Vancouver 2002, CMU (Carnegie Melon University) 2003, IIT (Indian Institute of Technology) Bombay 2003.
- *Conceptual Automotive Design*, Porsche Design Center, Weissach, Germany, 2000.

Animations and Exhibitions

- Labyrinths www.karanshersingh.com, Nov. 2010, Galerie Romain Roland, New Delhi.
- The Spine (R+D *programming and NPR),* 2009.
- Amazing: Computer Animation Festival, Eurographics 2005.
- Ryan *(Software R&D Director)* Oscar for Best animated short film, 2005.
- Bingo *(Technical Director)* Canadian Genie for Best animated short film, 1999.

Research Awards and Grants

- NSERC collaborative R+D grant. PHuman: parametric, multiscale modeling and simulation of human anatomy. 2012-2014, 160,000$ per year, Co-Investigator.
- DDD (Data Driven Design) 2011. 3D sketch canvases 15K$. Collaborative grant with Prof. Laura Millard, Ontario College of Art and Design, OCADU.
- Google University Relations: 2 Google Android phones for use in course projects for CSC2521, CSC490, 2011.
- NSERC Discovery Accelerator Supplement 2011-2014, 40,000$ per year.
- Sketch based modeling and perception. NSERC Discovery Grant 2011-2015, 33,000$ per year.
- GRAND NCE (2010-). Network Investigator and Project Leader SKETCH. 55,000$ per year.
- Autodesk Research (Industrial Grant) 20,000$, 2010.
- Interactive interfaces for the visualization and exploration of anatomic structures. 2007-2011, 100,000$, Early Research Award, Ontario Research Foundation.
- Autodesk Research (Industrial Grant) 30,000$, 2007.
- Character Animation. NSERC Discovery Grant 2007-2011, 30,000$ per year.
- Intuitive interfaces for Modeling and Animation of Graphical Environments 2005, 21,200 Euros + 8,880 Euros (France-Canada research Foundation). (Co-Investigator Lionel Reveret, INRIA Grenoble, France) (Direction des Relation Européennes et Internationales).
- 3D Sketch Graphics Software Development Project, 2005, 125,000$, NSERC (National Science and Engineering Research Council of Canada), I2I (Ideas to Innovation).
- 3D Sketching with a suggestion database, 2005, 25,000$, CITO, Technical readiness.
- 3D Sketching Software, 2005, 50,000$, NSERC (National Science and Engg. Research Council of Canada), IPM.
- Mathematical Surface Representations for Conceptual Design, 2003-2007, $120,000 per year for two years, MITACS (Mathematics of Information Technology and Complex Systems). (Co-investigators: Michiel van de Panne, Eugene Fiume, Richard Zhang, Ravin Balakrishnan, Pierre Poulin).
- Laboratory for human computer interaction and graphics, 2003, $994,066, CFI (Canadian Foundation for Innovation) New Ops (Co-investigator: Ravin Balakrishnan)
- Laboratory for large scale high resolution interaction graphics, 2002, $96,792, (National Science and Engineering Research Council of Canada) NSERC #: EQPEQ 252430. (Co-investigators: R. Balakrishnan, E. Fiume, K. Kutulakos).
- Intelligent character setup and animation, 2002-2006, 25000$ per year for four years, NSERC (National Science and Engineering Research Council of Canada) Discovery Grant #: 250321.
- Next generation user interfaces for data visualization, 2004-2007, $82,900, $89,400, $91,500, NSERC (National Science and Engineering Research Council of Canada). (Co-investigator: Ravin Balakrishnan).
- Startup Grant, 2002, 90,000$, BUL (Bell University Labs, Connaught Foundation).

Publications (last 5 years 2007-present)

- [TSB 11] Elasticurves: Exploiting Stroke Dynamics and Inertia for the Real-time Neatening of Sketched 2D Curves Y. Thiel**, K. Singh**, R. Balakrishnan**.** ACM UIST 2011.
- [MSM 11] Slices: A Shape-proxy Based on Planar Sections. J. McCrae, **K. Singh**, N. Mitra. SIGGRAPH Asia, 2011 (to appear).
- [LS 11] Biomechanically-Inspired Motion Path Editing. N. Lockwood, **K. Singh**. SCA '11.
- [MS 11] Neatening sketched strokes using piecewise French Curves. J. McCrae, **K. Singh**. Sketch-Based Interfaces and Modeling, SBIM 2011.
- [K+11] Dots, line, contour & surface edge trigger centre-surround pickup mechanism. J. Kennedy, M. Wnuczko, M. Santos, P. Coppin & **K. Singh**. International Conference of perception and action ICPA 2011.
- [B+11] High-Precision Surface Reconstruction of Human Bones from Point-Sampled Data. J. Bibliowicz, A. Khan, A. Agur, **K. Singh**. International Summit on Human Simulation (ISHS) 2011.
- [K+10] GeoBrush: Interactive Mesh Geometry Cloning (2010). K. Takayama, R. Schmidt, K. Singh, T. Igarashi, T. Boubekeur, O. Sorkine. Eurographics 2011 / Computer Graphics Forum.
- [SK10] meshmixer: an interface for rapid mesh composition (2010). R. Schmidt, **K. Singh**. SIGGRAPH 2010 Talks.
- [R+10] K. Ravichandiran, M. Ravichandiran, M. Oliver, **K. Singh**, A. Agur, N. McKee. *Fiber bundle element method of determining physiological cross sectional area from three-dimensional computer muscle models created from digitized fiber bundle data.* Computer Methods in Biomechanics and Biomedical Engineering 2010.
- [M+10] J. McCrae, M. Glueck, T. Grossman, A. Khan, K. Singh. *Exploring the Design Space of Multiscale 3D Orientation.* Advanced Visual Interafaces 2010.

- [KHS10] E. Kalogerakis, A. Hertzmann, **K. Singh**. *Learning 3D Mesh Segmentation and Labeling.* accepted in the ACM Transactions on Graphics, Vol. 29, No. 3, July 2010 (SIGGRAPH 2010).
- [S+09i] R. Schmidt, A. Khan, **K. Singh**, G. Kurtenbach. *Analytic drawing of 3D scaffolds* (ACM SIGGRAPH Asia 2009).
- [K+09i] E. Kalogerakis, P. Simari, D. Nowrouzezahrai, **K. Singh**. *Extracting lines of curvature from noisy point clouds*. Computer-Aided Design journal 2009, Volume 41, Number 4 (April 2009), pp. 282-292 (10 pages).
- [MS 09] J. McCrae, **K. Singh**. *Sketching path layouts.* (8 pages) Graphics Interface 2009.
- [S+09ii] P. Simari, E. Kalogerakis, D. Nowrouzezahrai, **K. Singh**. *Multi-objective shape segmentation and labeling.* (SGP Symp. Of Geometry Processing 2009).
- [S+09iii] R. Schmidt, A. Khan, G. Kurtenbach, **K. Singh**. *On Expert Performance in 3D Curve-Drawing Tasks* (ACM/Eurographics SBIM Sketch based interfaces and modeling 2009). (**best paper**).
- [BBS09] S. Bae, R. Balakrishnan, **K. Singh**. *Everybody LovesSketch:3D sketching for a broader audience* (ACM UIST 2009).
- [R+09] K. Ravichandiran, M. Ravichandiran, M. Oliver, **K. Singh**, A. Agur, N. McKee. *Determining physiological cross-sectional area of extensor carpi radialis longus and brevis as a whole and by regions using 3D computer muscle models created from digitized fiber bundle data.* Computer Methods and Programs in Biomedicine, 2009.
- [K+09ii] E. Kalogerakis, P. Simari, D. Nowrouzezahrai, J. McCrae, A. Hertzmann, **K. Singh**. *Real time line drawing for animated surfaces.* (14 pages) ACM SIGGRAPH Transactions on Graphics Volume 28, Issue 1, January 2009.
- [MS 09] J. McCrae, **K. Singh**. *Sketching path layouts.* (8 pages) Graphics Interface 2009.
- [GSS 09] C. Grimm, N. Sudarsanam, and K. Singh *CubeCam: A Screen-Space Camera Manipulation Tool*, Computational Aesthetics 2009**.**
- [BBS08] S. Bae, **R. Balakrishnan**, **K. Singh**. ILoveSketch: *As natural as possible curve sketching for creation of 3D models.* (ACM UIST 2008).
- [C+08] P. Coleman, J. Bibliowicz, **K. Singh**, M. Gleicher. *Staggered Poses: A Character Motion Representation for Detail-Preserving Editing of Pose and Coordinated Timing.* Symposium on Computer Animation 2008.
- [MS08] J. McCrae, **K. Singh**. *Sketching piecewise clothoid splines.* (8 pages) Eurographics, Sketch based interfaces and modeling SBIM 2008 (**Best Paper Award**).
- [SGS08] N. Sudarsanam, C. Grimm, **K. Singh**. *Non-linear perspective widgets for creating multiple-view images* (8 pages) (ACM NPAR 2008).
- [D+08] P. Dragicevic, G. Ramos, J. Bibliowicz, D. Nowrouzezahrai, R. Balakrishnan, **K. Singh**. *Video browsing by direct manipulation*, ACM SIGCHI CHI 2008 (10 pages).
- [SSB08] R. Schmidt, **K. Singh**, R. Balakrishnan. *Sketching and Composing Widgets for 3D Manipulation***.** Proceedings of Eurographics 2008 / Computer Graphics Forum (10 pages).
- [SS08] R. Schmidt, **K. Singh**. *Sketch-Based Procedural Surface Modeling and Compositing with Surface Trees.* Proceedings of Eurographics 2008 / Computer Graphics Forum (10 pages).
- [AS07] A. Angelidis, **K. Singh**. *Kinodynamic skinning using volume-preserving deformations.* (ACM SIGGRAPH SCA Symposium of computer animation 2007, (12 pages).
  Best Paper Award.
- [S+07] R. Schmidt, T. Isenberg, P. Jepp, **K. Singh**, B. Wyvill. *Sketching, scaffolding and inking:a visual history for interactive 3d modeling*.(10 pages) (ACM NPAR 2007).
- [K+07] E. Kalogerakis, P. Simari, D. Nowrouzezahrai, **K. Singh**. *Robust statistical estimation of curvature on discretized surfaces***.** Eurographics/ACM Siggraph Symposium on Geometry Processing (SGP '07), pp. 13-22.
- [N+07] D. Nowrouzezahrai, P. Simari, E. Kalogerakis, **K. Singh**, E. Fiume. *Compact and Efficient Generation of Radiance Transfer for Dynamically Articulated Characters*, Proceedings of the ACM Graphite 2007**.** (8 pages).
- [W+07] F. Wu, V. Ng-Thow-Hing, **K. Singh**, A. Agur, N. McKee. *Computational representation of the aponeuroses as NURBS surfaces in 3D musculoskeletal models.* Computer Methods and Programs in Biomedicine 88(2): 112-122 (2007) (10 pages).