Jacob W. Crandall, Ph.D.

Assistant Professor
Masdar Institute of Science and Technology
jcrandall@masdar.ac.ae
http://www.mit.edu/~jcrandal

Research Interests

Human-machine interaction, multi-agent systems, machine learning (reinforcement learning and interactive artificial learning), game theory, supervisory control, robotics

Appointments

Jul 2008 – present	**Masdar Institute of Science and Technology**†, Abu Dhabi, UAE *Assistant Professor*, Computing and Information Science Program *CIS Program Coordinator* (Aug 2010 – Aug 2011)
Nov 2009 – Nov 2011	**Massachusetts Institute of Technology**, Cambridge, MA *Research Affiliate*, Technology and Development Program
Jul 2008 – Jun 2009	**Massachusetts Institute of Technology**, Cambridge, MA *Visiting Scholar*, Technology and Development Program
Jan 2006 – Jun 2008	**Massachusetts Institute of Technology**, Cambridge, MA *Postdoctoral Associate*, Department of Aeronautics and Astronautics/CSAIL Supervisor: Prof. Mary L. Cummings, Humans and Automation Lab
Jun 2000 – Dec 2005	**Brigham Young University**, Provo, UT *Research Assistant*, Computer Science Department Advisor: Prof. Michael A. Goodrich, HCMI–MAGICC Lab

Education

Apr 2006	**Brigham Young University**, Provo, UT Ph.D. in Computer Science Dissertation: *Learning Successful Strategies in Repeated General-Sum Games* Defense date: December 2005
Apr 2004	**Brigham Young University**, Provo, UT M.S. in Computer Science Thesis: *Towards Developing Effective Human-Robot Systems* Defense date: December 2003
Aug 2001	**Brigham Young University**, Provo, UT B.S. in Computer Science (minor in Mathematics)

† Masdar Institute is a graduate research university being established in collaboration with MIT. The university's first semester of classes in Sept 2009, and awarded its first Master's degrees in Summer 2011. The university currently has about 60 faculty members spread across eight programs. Its graduate students come from all parts of the globe, including Asia, Africa, Europe, and North and South America. I have had the wonderful opportunity of being a part of this unique start-up venture, which I consider to be a great success up to this point in time.

Teaching

Full Courses Taught

Note: Student evaluations and comparisons to university or department averages are given where available.

- **CIS 503 – Multi-agent Systems**
  Masdar Institute, Fall 2011
  Mid-term instructor rating: **3.8** out of 4
  Mid-term course rating: **3.8** out of 4
  16 Master and Ph.D. students are enrolled.

- **FDN 453 – Mathematics for Computers Science**
  Masdar Institute, Fall 2011
  Mid-term instructor rating: **3.25** out of 4
  Mid-term course rating: **3.0** out of 4
  4 "foundation students" are enrolled.

- **CIS 503 – Multi-agent Systems**
  Masdar Institute, Fall 2010
  Instructor rating: **3.54** out of 4
  Course rating: **3.31** out of 4
  Notes: I created the curriculum for this course. 20 Master and Ph.D. students were enrolled.

- **FDN 453 – Mathematics for Computers Science**
  Masdar Institute, Fall 2010
  Instructor rating: **3.25** out of 4
  Course rating: **3.5** out of 4
  Notes: I created the curriculum for this course by combining MIT course OCW 6.042J with content from the Rosen textbook. 5 "foundation students" were enrolled.

- **ITE 502 – Principles of Computer Systems Engineering**
  Masdar Institute, Fall 2009
  Instructor rating: **3.41** out of 4 (university average that semester was 3.0)
  Course rating: **3.18** out of 4 (university average that semester was 2.91)
  Notes: 17 Master students were enrolled.

- **16.499 – Learning in Games**
  Massachusetts Institute of Technology, Spring 2008
  Notes: I never received student evaluations from MIT for this course. I created the curriculum for this course. 18 graduate and undergraduate students were enrolled.

- **CS 235 – Data Structures**
  Brigham Young University, Summer 2004
  Instructor rating: **6.8** out of 8 (department average that semester was 6.2)
  Course rating: **6.1** out of 8 (department average that semester was 5.7)
  Notes: 39 undergraduate students were enrolled.

Other Teaching Responsibilities

- I was a *guest lecturer* for 16.400/16.453 *Human Factors Engineering* at MIT in Fall 2007. I taught two courses on statistics.

- I organized and taught a two-day IAP workshop at MIT on distributed learning in Jan 2007.

- I was a *guest lecturer* for 16.422 *Human Supervisory Control* at MIT in Spring 2008.
- I was a *guest lecturer* for CS 670 *Multi-agent Systems* at BYU in Fall 2005.
- I was a *graduate mentor* for an inter-disciplinary course on *cooperation* at BYU, a two-semester course taught Fall 2003 through Winter 2004.
- I was a *teaching assistant* for CS 670 *Multi-agent Systems* at BYU in Fall 2002.
- I was a *teaching assistant* for CS 601R *Learning in Games* at BYU in Spring 2002.

Student Advisement

Supervision of PhD Students (Main Advisor):

1. Vimitha Manohar, Masdar Institute, PhD (June 2011 – present)
   Topic: TBD
2. Waleed Najy, Masdar Institute, PhD (Oct 2011 – present)
   Topic: TBD

Supervision of Master Students (Main Advisor):

1. Vimitha Manohar, Masdar Institute, Master of Science (Oct 2009 – May 2011)
   Thesis title: *Assistive Robotics for Autism Therapy: Programming Robots to Express Emotions*
2. Salman Ahmed, Masdar Institute, Master of Science (Oct 2009 – Jun 2011)
   Thesis title: *Combining Learning from Demonstration and Distance Metric Learning for Online Learning Problems*
3. Mehmet Ergun, Masdar Institute, Master of Science (Oct 2009 – Jul 2011)
   Thesis title: *An Adaptive Dynamic Pricing Mechanism to Balance Supply and Demand In Electricity Markets Powered by Renewable Energy Sources*
4. Asad Ahmed, Masdar Institute, Master of Science (Oct 2009 – Aug 2011)
   Thesis title: *Multi-agent Learning in Smart Power Grids for Efficiently Acquiring and Distributing Electricity*
5. Edmond Awad, Masdar Institute, Master of Science (Oct 2009 – Aug 2011)
   Thesis title: *Learning to Share: A Study of Multi-agent Learning in Transportation Systems*
6. Yomna Mahmoud, Masdar Institute, Master of Science (Oct 2009 – Aug 2011)
   Thesis title: *Applicability of Interactive Genetic Algorithms to Multi-agent Systems: Experiments on Games Used in Smart Grid Simulations*
7. Malik Altakrori, Masdar Institute, Master of Science (Nov 2008 – Dec 2011)
   Thesis title: *Learning from demonstrations in multi-agent systems*
8. Shamma Al Marzooqi, Masdar Institute, Master of Science (May 2010 – present)
   Area: Supervisory control of a semi-autonomous humanoid robot
9. Vahagn Harutyunyan, Masdar Institute, Master of Science (Oct 2010 – present)
   Area: Supervisory control of a semi-autonomous humanoid robot

10. Wen Shen, Masdar Institute, Master of Science (Oct 2011 – present)
11. Rafael Harutyunyan, Masdar Institute, Master of Science (Oct 2011 – present)
12. Alanoud Al Khemiri, Masdar Institute, Master of Science (Oct 2011 – present)
13. Issak Gezehei, Masdar Institute, Master of Science (Oct 2011 – present)

Master Thesis Committees:

1. Abdullah Sawas, Masdar Institute, Master of Science, Aug 2011
2. Hanan Shemaili, Masdar Institute, Master of Science, Aug 2011
3. Hamzah Alzubi, Masdar Institute, Master of Science, Jun 2011
4. Nauman Zafar, Masdar Institute, Master of Science, Jun 2011
5. Fatimah Ishowo-Oloko, Masdar Institute, Master of Science, Jun 2011
6. Andrew Culhane, Virginia Tech, Master of Science, Dec 2007

Supervision of Postdocs:

1. Ravikumar Pandi, Masdar Institute (Feb 2010 – Dec 2010)

"Ghost-supervision" at MIT:

Note: As a postdoctoral associate at MIT, I assisted in advising the following students on work toward achieving their degrees. Dates reflect times of my involvement.

1. Carl Nehme, Ph.D. candidate, MIT (Jan 2006 – June 2008)
2. Amy Brezezinski, Master student, MIT (Sep 2007 – Dec 2007)
3. Angela Ho, Master student, MIT (Jan 2006 – Aug 2006)
4. Paul de Jong, Master student visiting from TU Delft (Jan 2008 – May 2008)
5. Mauro Della Penna, Master student visiting from TU Delft (Aug 2007 – Dec 2007)
6. Vanessa Esch, Undergraduate student (UROP), MIT (Jan 2007 – Aug 2007)
7. Justin Wong, Undergraduate student (UROP), MIT (Sep 2006 – Dec 2006)

Invited Talks

- *Learning in Multi-agent Systems: What is Your Learning Bias?*, Massachusetts Institute of Technology, Cambridge, MA, Jul 2011.
- *Online Artificial Learning in Distributed Systems: Moving from Theory to Practice*, Computer Science Department, Carnegie Mellon – Qatar, Doha, Qatar, Jan 2010.
- *The Hack that Happens: Putting Intelligence into AI*, Computer Science Department, Brown University, Providence, RI, Apr 2009.
- *Computational Models to Support Human-Machine Interaction*, Institute for Human-Machine Collaboration (IHMC), Pensacola, FL, Aug 2008.

- *From Policies to Aspirations – Learning to Collaborate and Compete in Repeated Games*, Intel Research, Pittsburgh, PA, May 2008.
- *Multi-UAV Research at MIT's Humans and Automation Laboratory*, MIT Lincoln Laboratory, Lexington, MA, Oct 2007 (given with Sylvain Bruni).
- *Decision Support for Supervisory Control of Multiple Unmanned Vehicles*, BAE Systems, Burlington, MA, Jul 2007.
- *Predictive Metrics for Human-Robot Teams*, Computer Science Department, University of Massachusetts Lowell, Nov 2006.
- *Measurement Technologies for Unmanned Vehicles*, Charles River Analytics Inc., Cambridge, MA, Jul 2006.
- *Research in human-robot teams*, Department of Aeronautics & Astronautics, Massachusetts Institute of Technology, Cambridge, MA, Nov 2005.
- *Learning to Compete, Compromise, and Cooperate in Repeated General-sum Games*, Department of Computing Science, University of Alberta, Feb 2005.

Grants

1. Siemens, $261,745 (direct costs). Managing Real-time Interventions in Smart Buildings: Learning to Influence People's Behavior. PIs: Jacob W. Crandall and Iyad Rahwan. Scheduled to begin Dec. 2011.
2. Masdar Institute Research Grant (internal), $100,000. Supervisory Control of a Humanoid Robot for Sustainable Development. PI: Jacob W. Crandall. Co-PIs: Wei Lee Woon and Hosni Ghedira. Dec 2010 – Dec 2011.
3. Monash-Masdar Seed Fund (internal). $9,888. A Game Theoretic Approach to Agent-based Modeling for Carbon Markets. PIs: Madhu Chetti and Jacob W. Crandall. 2010
4. MIT–Masdar Institute Collaborative Project (internal). Intelligent Devices for Smart Power Grids. $400,000 (to Masdar Institute). PIs: Jacob W. Crandall and Munther Dahleh. July 2009 – June 2011.

Academic Service

Journal Reviewer	Systems, Man, and Cybernetics – Part A, Systems, Man, and Cybernetics – Part B; Journal of Economic Dynamics and Control; Machine Learning; IEEE Intelligent Systems; Human Factors; Artificial Intelligence; IEEE Transactions on Robotics; Journal of Aerospace Computing, Information, and Communication; Intelligent Service Robots; Journal of Artificial Intelligence Research; Autonomous Agents and Multi-agent Systems
Program Committee/ Reviewer	LAMAS 2005, AAMAS 2006, AAMAS 2007, IJCAI 2007, AAAI 2007, AAAI 2007 Student Abstract Program Committee, ICRA 2007, ALAg 2007, RSS 2007, 2007 IS Best Paper Award, HRI 2008,

	AAMAS 2008, RSS 2008, RO-MAN 2008, IROS 2008, AAAI 2008 Student Abstract Program Committee, NIPS 2008, AAMAS 2009, HRI 2009, IJCAI 2009, HRI 2010, ICAART 2010, SMC 2010, SSRR 2010, ICRA 2011, HRI 2011, AAMAS 2011, IJCAI 2011, RSS 2011, HRI 2012
Conference Organization	Session Chair for AIAA@Infotech 2008 Video Session Co-Chair (video session organizer) for HRI 2010 Video Session Co-Chair (video session organizer) for HRI 2011 Session Chair for ALA 2011 Associate Editor for IROS 2011 Publications Co-Chair for HRI 2012 Publicity Chair for PRIMA 2012

University Service

- CIS Faculty Search Committee (Fall 2009 – present)
- CIS Student Admissions Committee (July 2008 – present)
- EE/EP Faculty Search Committee (Fall 2009 – Spring 2010)
- CIS Curriculum Committee (ad hoc) – Worked with other CIS faculty to upgraded/overhaul the CIS course curriculum in Spring 2010
- CIS/IT Accreditation Committee (ad hoc, Fall 2008 – Spring 2010)
- PhD Admissions Committee (Spring 2011 – present)
- Organized the Masdar Institute Seminar Series (Fall 2010 and Spring 2011)
- Human Subjects Research Ethics Committee (August 2011 – present)

Publications

Total citations: 754 H-index: 14 G-index: 27 (Google Scholar, 1 Jan 2012)

$*$ denotes a student I supervised at Masdar Institute

† denotes a student I "ghost-supervised" at MIT

Journal Articles

1. **J. W. Crandall**, M. L. Cummings, M. Della Penna†, and P. M. A. de Jong†. Computing the Effects of Operator Attention Allocation in Human Control of Multiple Robots. *IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans*, Vol. 41, No. 3, pp. 385-397, May 2011.
   Citations: 2

2. **J. W. Crandall** and M. A. Goodrich. Learning to Compete, Coordinate, and Cooperate in Repeated Games Using Reinforcement Learning. *Machine Learning*, Vol. 82, No. 3, pp. 281-314, Mar 2011.
   Citations: 2

3. **J. W. Crandall**, M. L. Cummings, and C. E. Nehme†. A Predictive Model for Human–Unmanned Vehicle Systems. *AIAA Journal of Aerospace Computing, Information, and Communication*, Vol. 6, No. 11, pp. 585-603, Nov 2009.
   Citations: 5

4. C. E. Nehme†, B. Mekdeci, **J. W. Crandall**, and M. L. Cummings. The Impact of Heterogeneity on Operator Performance in Futuristic Unmanned Vehicle Systems. *International C2 Journal, Special Issue: Representing Human Decision Making in Constructive Simulations for Analysis*, Vol. 2, No. 2, Dec 2008.
   Citations: 12

5. **J. W. Crandall** and M. L. Cummings. Identifying Predictive Metrics for Supervisory Control of Multiple Robots. *IEEE Transactions on Robotics*, Vol. 23, No. 5, pp. 942-951, Oct 2007.
   Citations: 30

6. **J. W. Crandall**, M. A. Goodrich, D. R. Olsen, and C. W. Nielsen. Validating Human-Robot Interaction Schemes in Multi-Tasking Environments. *IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans*, Vol. 35, No. 4, pp. 438-449, July 2005.
   Citations: 125

Conference Papers, Workshop Papers, and Book Chapters

1. **J. W. Crandall**. Just Add Pepper: Extending Learning Algorithms for Repeated Matrix Games to Repeated Markov Games. In *Proceedings of the Eleventh International Conference on Autonomous Agents and Multi-agent Systems (AAMAS)*, Valencia, Spain, June 2012. To appear.
   Acceptance rate: 20%

2. **J. W. Crandall**, A. Ahmed*, and M. A. Goodrich. Learning in Repeated Games with Minimal Information: The Effects of Learning Bias. In *Proceedings of the Twenty-Fifth Conference on Artificial Intelligence (AAAI)*, San Francisco, CA, Aug 2011.
   Citations: 1 Acceptance rate: 25%

3. **J. W. Crandall**, M. A. Altakrori*, and Y. M. Hassan*. Learning by Demonstration in Repeated Stochastic Games. In *Proceedings of the AAMAS Workshop on Adaptive Learning Agents (ALA)*, Taipei, Taiwan, May 2011.

4. **J. W. Crandall**, M. A. Altakrori*, and Y. M. Hassan*. Learning by Demonstration in Repeated Stochastic Games. In *Proceedings of the Tenth International Conference on Autonomous Agents and Multi-agent Systems (AAMAS)*, Taipei, Taiwan, May 2011. (short paper)
   Acceptance rate: 22% (full papers) plus an additional 23% (short papers)

5. M. A. Goodrich, P. B. Sujit, B. Pendleton, **J. W. Crandall**, and J. Pinto. Toward Multi-Operator, Multi-Robot Teams: Human Interaction with Bio-Inspired Teams. In *Proceedings of the Tenth International Conference on Autonomous Agents and Multi-agent Systems (AAMAS)*, Taipei, Taiwan, May 2011. (short paper)
   Acceptance rate: 22% (full papers) plus an additional 23% (short papers)

6. **J. W. Crandall**, M. A. Goodrich, and L. Lin. Encoding Intelligent Agents for Uncertain, Unknown, and Dynamic Tasks: From Programming to Interactive Artificial Learning. In

Proceedings of the AAAI Spring Symposium on Agents that Learn from Human Teachers, Palo Alto, CA, Mar 2009.

7. M. L. Cummings, P. Pina, **J. W. Crandall**. A Metric Taxonomy for Supervisory Control of Unmanned Vehicles. In *Proceedings of AUVSI's Unmanned Systems North America*, San Diego, CA, Jun 2008.

8. C. E. Nehme[†], **J. W. Crandall**, and M. L. Cummings. Using Discrete-Event Simulation to Model Situational Awareness of Unmanned-Vehicle Operators. In *Proceedings of the ODU/VMASC Modeling, Simulation, and Gaming Student Capstone Conference*, Suffolk, VA, Apr 2008.
Citations: 14

9. P. Pina, M. L. Cummings, **J. W. Crandall**, and M. Della Pena[†]. Identifying Generalizable Metric Classes to Evaluate Human-Robot Teams. In *Proceedings of the HRI Workshop on Metrics for Human-Robot Interaction*, Amsterdam, The Netherlands, Mar 2008.
Citations: 14

10. **J. W. Crandall** and M. L. Cummings. Attention Allocation Efficiency in Human-UV Teams. In *Proceedings of the AIAA Infotech@Aerospace Conference and Exhibit*, Rohnert Park, May 2007.
Citations: 8

11. C. E. Nehme[†], **J. W. Crandall**, and M. L. Cummings. An Operator Function Taxonomy for Unmanned Aerial Vehicle Missions. In *Proceedings of the 12th International Command and Control Research and Technology Symposium*, Newport, RI, Jun 2007.
Citations: 16

12. **J. W. Crandall** and M. L. Cummings. Developing Performance Metrics for the Supervisory Control of Multiple Robots. In *Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Washington, DC, Mar 2007.
Citations: 41 Acceptance rate: 22%

13. M. A. Goodrich, T. W. McLain, **J. W. Crandall**, J. Anderson, J. Sun. Managing Autonomy in Robot Teams: Observations from Four Experiments. In *Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Washington, DC, Mar 2007.
Citations: 63 Acceptance rate: 22%

14. M. L. Cummings, C. E. Nehme[†], and **J. W. Crandall**. Predicting Operator Capacity for Supervisory Control of Multiple UAVs. In *Innovations Intelligent Machines*, Volume 70, *Studies in Computational Intelligence*, J. S. Chahl, L. C. Jain, A. Mizutani, and M. Sato-Ilic, Eds., pp. 11-36, 2007.
Citations: 35

15. **J. W. Crandall** and M. A. Goodrich. Learning to Compete, Compromise, and Cooperate in Repeated General-Sum Games. In *Proceedings of the Twenty-second International Conference on Machine Learning (ICML)*, Bonn, Germany, Aug 2005.
Citations: 35 Acceptance rate: 27%

16. **J. W. Crandall** and M. A. Goodrich. Learning to Teach and Follow in Repeated Games. In *Proceedings of the AAAI Workshop on Multiagent Learning*, Pittsburgh, PA, Jul 2005.
Citations: 7

17. **J. W. Crandall** and M. A. Goodrich. Learning Near-Pareto Efficient Solutions With Minimal Knowledge Requirements Using Satisficing. In *Proceedings of the AAAI Fall Symposium on Artificial Multiagent Learning*, Washington, D.C., Oct 2004.
Citations: 6

18. M. A. Goodrich, E. R. Boer, **J. W. Crandall**, R. W. Ricks, and M. L. Quigley. Behavioral Entropy in Human-Robot Interaction. In *Proceedings of the Performance Metrics for Intelligent Systems Workshop (PERMIS)*, Gaithersburg, MD, Aug 2004.
Citations: 10

19. **J. W. Crandall** and M. A. Goodrich. Establishing Reputation Using Social Commitment in Repeated Games. In *Proceedings of the AAMAS Workshop on Learning and Evolution in Agent Based Systems*, New York City, NY, Jul 2004.
Citations: 8

20. **J. W. Crandall** and M. A. Goodrich. Multiagent Learning During On-Going Human-Machine Interactions: The Role of Reputation. In *Proceedings of the AAAI Spring Symposium on Interaction between Humans and Autonomous Systems over Extended Operation*, Palo Alto, CA, Mar 2004.
Citations: 8

21. **J. W. Crandall** and M. A. Goodrich. Measuring the Intelligence of a Robot and its Interface. In *Proceedings of the Performance Metrics for Intelligent Systems Workshop (PERMIS)*, Gaithersburg, MD, Sep 2003.
Citations: 23

22. **J. W. Crandall**, C. W. Nielsen, and M. A. Goodrich. Towards Predicting Robot Team Performance. In *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics*, Washington, D.C., Sep 2003.
Citations: 24

23. M. A. Goodrich, **J. W. Crandall**, and J. R. Stimpson. Neglect Tolerant Teaming: Issues and Dilemmas. In *Proceedings of the AAAI Spring Symposium on Human Interaction with Autonomous Systems in Complex Environments*, Palo Alto, CA, Mar 2003.
Citations: 20

24. C. W. Nielsen, M. A. Goodrich, and **J. W. Crandall**. Experiments in Human-Robot Teams. *Multi-Robot Systems: From Swarms to Intelligent Automata*, Volume II, Editors Alan C. Shultz, Lynne E. Parker, Frank E. Schneider, Kluwer Academic Publishers. Washington, D.C., Mar 2003.
Citations: 20

25. **J. W. Crandall** and M. A. Goodrich. Principles of Adjustable Interactions. In *Proceedings of the AAAI Fall Symposium on Human-Robot Interactions*, Cape Cod, MA, Nov 2002.
Citations: 12

26. **J. W. Crandall** and M. A. Goodrich. Characterizing Efficiency of Human-Robot Interaction: A Case Study of Shared-Control Teleoperation. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, Lausanne, Switzerland, Oct 2002.
Citations: 45

27. **J. W. Crandall** and M. A. Goodrich. Experiments in Adjustable Autonomy. In *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics*, Tuscan, AZ, Oct 2001.
    Citations: 31

28. M. A. Goodrich, D. R. Olsen, **J. W. Crandall**, and T. J. Palmer. Experiments in Adjustable Autonomy. In *Proceedings of the IJCAI Workshop on Autonomy, Delegation, and Control: Interaction with Autonomous Agents*, Aug 2001.
    Citations: 131

Theses and Reports

1. **J. W. Crandall** and M. A. Goodrich. Satisficing Multi-Agent Learning: A Simple but Powerful Algorithm. Technical Report BYU-HCMI 2008-1, Oct 2008.

2. **J. W. Crandall** and M. L. Cummings. A Predictive Model for Human-Unmanned Vehicle Systems. Technical Report HAL2008-05, Jun 2008.

3. **J. W. Crandall** and M. L. Cummings. A Predictive Model for Human-Unmanned Vehicle Teams. Technical Report HAL2007-07, Jul 2007.

4. **J. W. Crandall**. Learning Successful Strategies in Repeated General-Sum Games. Ph.D. Dissertation, Brigham Young University, Dec 2005.

5. **J. W. Crandall**. Towards Developing Effective Human-Robot Systems. M.S. Thesis, Brigham Young University, Dec 2003.
    Citations: 6