Akshay Rajhans | Curriculum Vitae

MathWorks – 1 Lakeside Campus Drive, Natick, MA 01760
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Professional Experience

MathWorks, Natick, MA **Jul 2013–present**
Principal Research Scientist, Advanced Research & Technology Office (May 2018–present)
Senior Research Scientist, Advanced Research & Technology Office (Jun 2016–Apr 2018)

- **Founding member**: Along with a senior colleague who now directs the office, helped define the vision, mission, and operating principles for the new Advanced Research & Technology Office. Key contributor to strategy and annual executive briefs. Helped recruit and mentor two research scientists and three research interns.
- Multi-faceted role that includes three key personas:
  - **Research Scientist**: Organize and co-chair MathWorks research conferences; serve on academic conference Program Committees, Thesis Committees, Industry Advisory Boards, Technical Committees, and Editorial Boards; provide thought leadership via invited talks and panels; author technical publications; represent MathWorks in the research community; carry out research and advanced technology development for technical computing and model-based design intelligent *cyber-physical systems* (CPS)
  - **Research Alliance Manager**: Manage the worldwide research collaboration program including annual planning, budgeting, and debriefs; represent MathWorks research in front of visiting deans and department heads from top research universities; identify and foster research collaboration for facilitating bidirectional technology transfer; contribute to long-term research engagement strategy; scope out the collaborative research project deliverables; help negotiate software license and project legal agreements with external institutions
  - **Innovation Officer**: Member of the Patent Review Board, perform idea pre-screening and review, participate in invention disclosure meetings with external patent attorneys; help inventors articulate and strengthen their inventions and work with patent attorneys to craft patent applications; technical review of draft patent applications for suitability and coverage
- Other roles include: • software design involvement with cross-organizational and cross-product software development teams • creating exemplar computational content • working with lead users for exploring advanced modeling, simulation, and analysis workflows

Senior Software Engineer (Jul 2013–Jun 2016)
• C++ software development pertaining to the core semantics of Simulink, particularly, *initialization* semantics, *conditional subsystems* semantics, and *Simulink in Stateflow* semantics for graphical modeling of hybrid dynamics. • CPS Research community engagement

Bosch, Research and Technology Center, Pittsburgh, PA **Aug 2009–Dec 2009**
Intern
• Developed a new approach to non-intrusive load monitoring using hybrid system state estimation. • *Co-inventor on a U.S. and international patent*. See the **Patents** section for the citation.

University of Pennsylvania, Philadelphia, PA **Jan 2008–Jun 2008**
Research Staff at the General Robotics, Automation, Sensing, and Perception (GRASP) Laboratory (May 2007–Jun 2008)
Teaching Assistant, Mathematics and Electrical and Systems Engineering Departments (Aug 2006–May 2008)
Operations Staff, Wharton Management Department and Chemistry Library (Jan 2006–Jul 2007)

Cummins, Pune, India **Aug 2003–Dec 2005**
Manager, IBU Application Engineering (Aug 2005–Dec 2005)
• Application engineering for electronic control software and hardware for diesel engine applications in mining, marine, defense, rail, compressors, oil rigs, fire pumps, automotive and off-highway construction equipment. ***One of only two*** engineers in charge of electronic controls of all of Industrial Business Unit (IBU) Applications in India.
Operations Management Program Participant (Aug 2003–Aug 2005)
• Research, development and application engineering of electronic control software and hardware for diesel engines and their applications.

Education

Degrees

- **Ph.D.**, Electrical and Computer Engineering **May 2013**
  Carnegie Mellon University, Pittsburgh, PA, U.S.A.
  Advisor: Prof. Bruce H. Krogh.
- **M.S.**, Electrical Engineering **December 2007**
  University of Pennsylvania, Philadelphia, PA, U.S.A.
  Advisor: Prof. George J. Pappas.
- **B.E.**, Electronics and Telecommunication **May 2003**
  University of Pune, Pune, India.

Selected Coursework, Certificates, and Continuing Education

At MathWorks

• Leadership is Everyone's Business • Model-Based Design Labs

Independent

• Introduction to Marketing (Offered on Coursera by Wharton School of Management, University of Pennsylvania)

At Carnegie Mellon University

• Numerical Methods for Engineering Design and Optimization • Formal Languages Automata, Computability and Complexity • Real Analysis • Linear Systems • Architectures for Software Systems • Hybrid Systems Analysis and Theorem Proving • Introduction to Model Checking

At University of Pennsylvania

• Systems Biology • Advanced Robotics: Motion Planning and Control • Advanced Artificial Intelligence and Machine Learning • Digital Signal Processing • Introduction to Optimization • Artificial Intelligence and Machine Learning • Engineering Entrepreneurship • Hybrid Systems • Control of Systems

At Cummins India Limited

• Operations Management Program • Young Leadership Development Program • Common Approach to Continuous Improvement • Six Sigma • Seven Habits of Highly Effective People • Cummins Production System

Keynotes, Invited Talks, and Panels

Keynote Talks

- "*Challenges and opportunities in design and operation of intelligent cyber-physical systems,*"19th International Runtime Verification Conference (RV), Part of 3rd World Congress on Formal Methods, Porto, Portugal, October 2019. **Chairs:** Leonardo Mariani and Bernd Finkbeiner.
- "*Multi-Paradigm Modeling for Design and Operation of Intelligent Cyber-Physical Systems,*" First International Workshop on Multi-Paradigm Modeling for Cyber-Physical Systems (MPM4CPS), co-located with the MODELS Conference, Munich, Germany. September 2019. **Chairs:** Simon Van Mierlo and Hans Vangheluwe.

Invited Talks

- "*A Model-Based Design Perspective on Challenges and Opportunities in Automated Software Certification,*" 20th Software Certification Consortium (SCC) Steering Committee Meeting, Annapolis, MD, USA. May 2019. **Hosts:** Alan Wassyng and Mark Lawford, Organizers.
- "*Specification Formalisms for Cyber-Physical Systems: A Tools Perspective,*" Dagstuhl Workshop on Specification Formalisms for Modern Cyber-Physical Systems, Dagstuhl, Germany. February 2019. **Hosts:** Jyotirmoy Deshmukh, Oded Maler, Dejan Nickovic, Workshop Organizers.
- "*Graphical Modeling of Hybrid Systems with Simulink and Stateflow,*" Workshop honoring the retirement of Prof. Bruce Krogh, Carnegie Mellon University, Pittsburgh, PA, May 2018. **Host:** Bruno Sinopoli, Workshop Chair.
- "*A Vision for Application-Focused International Collaboration Networks in Cyber-Physical Systems,*" an NSF

Visioning Workshop on International Networks for Advancing CPS Research, Development, and Education Worldwide, part of CPS Week 2018, Porto, Portugal, April 2018. **Hosts**: Seta Bogosyan, Frankie King, Ralph Wachter, Workshop Organizers.

- "*Heterogeneous Model-Based Design of Tomorrow's Cyber-Physical Systems,*" ECE Department Colloquia, Tufts University, Medford, MA, November 2017. **Host**: Prof. Usman Khan.
- "*Model-Based Design of Next Generation Cyber-Physical Systems,*" MIT LIDS, IDSS, MITei, Lincoln Labs, NSF and IWR Workshop on Rethinking Modeling, Simulations and Control for the Changing Electric Energy Industry, Massachusetts Institute of Technology, Camridge, MA, September 2017. **Hosts**: Prof. Marija Ilić and Prof. Ekaterina Kostina.
- "*Challenges and Opportunities for Intelligent Transportation Systems,*" Robotica 2017, Newton, MA, June 2017. **Host**: Dr. Waseem Naqvi, AUVSI New England Chapter President (Chair).
- "*Model-Based Design of Connected Autonomous Vehicles,*" 2nd IEEE Summer School on Connected and Autonomous Vehicles, Worcester Polytechnic Institute, Worcester, MA, May 2017. **Hosts**: Prof. Alexander Wyglinski and Prof. Raghvendra Cowlagi (Program Chairs).
- "*Model-Based Design Challenges for Cyber-Physical Systems,*" Expeditions in Computer Augmented Program Engineering (ExCAPE) Principal Investigators' (PI) Meeting, University of Pennsylvania, Philadelphia, PA, May 2017. **Host**: Prof. Rajeev Alur (Principal Investigator).
- "*Safety in Freely-Composed Cyber-Physical Systems—Challenges and Opportunities,*" with Pieter Mosterman, Exploring the Dimensions of Trustworthiness: Challenges and Opportunities Workshop, National Institute of Standards and Technology (NIST), Gaithersburg, MD, August, 2016. **Host**: Dr. Edward Griffor (Program Chair).
- "*Recent Advancements in MathWorks Verification and Validation Tools and Techniques*", CPS V&V I&F Workshop 2016, May 2016, Carnegie Mellon University. **Host**: Prof. André Platzer.
- "*Verification of Systems Using Robust Temporal Logic Testing*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, September 2008. **Host**: Prof. Ed Clarke.
- "*Robustness of Temporal Logic Specifications for Testing of Signals*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Host**: Prof. Ed Clarke.

Panels

- **Panelist**, *Future Challenges for Autonomous & Intelligent Transportation*, IEEE Situational Awareness for Emerging Transportation Systems (SAFENETS) Workshop, Lowell, MA, October 2019.
- **Panelist**, *Hybrid simulation for cyber-physical systems—where are we, and where do we want to go?*, Symposium on Modeling and Simulation of Complex, Intelligent, Adaptive and Autonomous Systems (MSCIAAS), Spring Simulation Multi-Conference (SpringSim), Baltimore, MD, April 2018.
- **Panelist**, *What are the challenges posed to CPS theory by modern applications?*, Joint Panel between the Hybrid Systems: Computation and Control Conference and the International Conference on Cyber-Physical Systems, part of CPS Week, Porto, Portugal, April 2018.
- **Panelist**, *Why do we need holistic concern-driven engineering?*, CPS Framework Open Source Workshop, National Institute for Standards and Technology (NIST), Rockville, MD, September 2017.
- **Panelist**, *Safety of connected autonomous vehicles*, First International Workshop on the Safety of Connected Autonomous Vehicles (SCAV), part of CPS Week, Pittsburgh, PA, May 2017.

Technical Community Service

Technical Committees

- IEEE Technical Committee on Homeland Security

Industry Advisory Committees and Boards

- **Autonomous Vehicles Industrial Advisory Committee**, Worcester Polytechnic Institute
- **Industry Vice Chair**, 2018 IFAC Conference on Analysis and Design of Hybrid Systems (ADHS)
- **Industry Advisory Board**, 2018 International Symposium on Circuits and Systems (ISCAS)
- **Global Professional Advisory Community**, Association for Computing Machinery

Conference Program Committee (PC) Leadership

- **PC Chair**: • MathWorks Research Summits, Boston edition: 2017–, Tokyo edition: 2016– • Fourth International Workshop on Monitoring and Testing of CPS (MT-CPS), part of CPS-IoT Week, Montreal, 2019 • Spring Simulation Conference (SpringSim) 2020 and 2019: CPS Track • Winter Simulation Conference (WSC) 2017: CPS Track

- **Awards Chair**: • Hybrid Systems: Computation and Control (HSCC) 2018

- **Demo and Poster Chair**: • Hybrid Systems: Computation and Control (HSCC) 2017

- **PC Member**: • International Conference on Cyber-Physical Systems (ICCPS) 2020 • Hybrid Systems: Computation and Control (HSCC) 2019, 2018, 2017, 2016 • International Conference on Informatics in Control, Automation and Robotics (ICINCO) 2018, 2017 • Winter Simulation Conference (WSC) 2018: Cyber-Physical Systems (CPS) Track and Complex, Intelligent, Adaptive, and Autonomous Systems (CIAAS) Track • Numerical Software Verification Workshop (NSV) 2018 • International Workshop on Formal Co-Simulation of Cyber-Physical Systems (CoSim-CPS) 2018, 2017 • Summer Simulation Multi-Conference (SummerSim) 2017, 2016, 2015, 2014 • International Conference on Cyber-Physical Systems (ICCPS) 2015 • Conference on Analysis and Design of Hybrid Systems (ADHS), 2015

- **Repeatability Evaluation Committee Member**: • Hybrid Systems: Computation and Control (HSCC) 2014

Editorial Duties

- **Editorial Advisory Board** Member, "Resilience in Cyber-Physical Systems: From Risk Modelling to Threat Counteraction," F. Flammini (Ed.), Springer Book in the Series Advanced Sciences and Technologies for Security Applications, A. J. Masys (Series Ed.)
- **Editor**, "*EGO Insider's Guide*", ECE Graduate Organization (EGO), Carnegie Mellon University, 2012. Available at `http://www.ece.cmu.edu/~ego/files/insiders/guide2012.pdf`.
- **Reviewer**
  - Journals
    - Nonlinear Analysis: Hybrid Systems
    - Simulation: Transactions of the Society for Modeling and Simulation International
    - IEEE Journal on Miniaturization for Air and Space Systems
    - Technological Forecasting & Social Change
  - Conferences (reviewing while not formally a PC Member)
    - (2017) Tools and Algorithms for the Construction and Analysis of Systems (TACAS)
    - (2013, 2009) American Control Conference (ACC)
    - (2011) Conference on Decision and Control (CDC)
    - (2011) Intelligent Transportation Systems Conference (ITSC)
    - (2010) Hybrid Systems: Computation and Control (HSCC)

Publications and Patents

Theses

T2. **Akshay Rajhans**, "Multi-Model Heterogeneous Verification of Cyber-Physical Systems", Ph.D. Thesis, Department of Electrical and Computer Engineering, Carnegie Mellon University, 2013. **Advisor:** Prof. Bruce H. Krogh.

T1. **Akshay Rajhans**, "Development of a Robust Testing Toolbox for Hybrid Systems", M.S. Thesis, Department of Electrical and Systems Engineering, University of Pennsylvania, 2007. **Advisor:** Prof. George J. Pappas.

Patents

PP1. Burton Andrews, Diego Benitez, Badri Raghunathan and **Akshay Rajhans**, "*Method for Non-Intrusive Load Monitoring using a Hybrid System State Estimation Approach*", U.S. Patent # 8209062, granted on June 26,

2012. Also filed as European and International Patents # EP 2514068 A1 and # WO 2011084390 A1.

Journal Papers

J4. Frank Allgöwer, João Borges de Sousa, James Kapinski, Pieter Mosterman, Jens Oehlerking, Patrick Panciatici, Maria Prandini, **Akshay Rajhans**, Paulo Tabuada, Philipp. Wenzelburger, "*Position paper on the challenges posed by modern applications to cyber-physical systems theory*", Nonlinear Analysis: Hybrid Systems, Volume 34, Pages 147-165, November 2019.

J3. **Akshay Rajhans**, Ajinkya Bhave, Ivan Ruchkin, Bruce H. Krogh, David Garlan, André Platzer and Bradley Schmerl, "*Supporting Heterogeneity in Cyber-Physical System Architectures*", IEEE Transactions on Automatic Control, Special issue on Cyber-Physical Systems, Volume 59, Issue 12, Pages 3178-3193.

J2. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li and Larry Pileggi, "*Formal Verification of Phase-Locked Loops Using Reachability Analysis and Continuization*", Communications of the ACM, Volume 56, Issue 10, Pages 97-104. ***Research Highlight for the October 2013 issue***.

J1. **Akshay Rajhans**, Shang-Wen Cheng, Bradley Schmerl, David Garlan, Bruce H. Krogh, Clarence Agbi, and Ajinkya Bhave, "*An Architectural Approach to the Design and Analysis of Cyber-Physical Systems*", Electronic Communications of the EASST, Volume 21, 2009.

Book Chapters

B3. S. Castro, P. J. Mosterman, **Akshay Rajhans**, R. G. Valenti, "*Challenges in the Operation and Design of Intelligent Cyber-Physical Systems*", Book Chapter, To Appear.

B2. Yi Deng, **Akshay Rajhans**, and A. Agung Julius, "*STRONG: A Trajectory-Based Verification Toolbox for Hybrid Systems*", in Kaustubh Joshi, Markus Siegle, Mariëlle Stoelinga and Pedro R. D'Argenio, editors, Lecture Notes in Computer Science, *10th International Conference, QEST 2013, Buenos Aires, Argentina, August 27-30, 2013. Proceedings*, Volume 8054, Pages 165-168, Springer, 2013.

B1. Alexandre Donzé, Bruce H. Krogh, and **Akshay Rajhans**, "*Parameter Synthesis for Hybrid Systems with an Application to Simulink Models*", in Rupak Majumdar and Paulo Tabuada, editors, Lecture Notes in Computer Science, *Hybrid Systems: Computation and Control, 12th International Conference, HSCC 2009, San Francisco, CA, USA, April 13-15,2009. Proceedings*, Volume 5469, Pages 165-179, Springer, 2009.

Peer Reviewed Conference and Workshop Papers

C13. Jean-Francois Kempf, Khoo Yit Phang, and **Akshay Rajhans**, "*Specification and Assessment of Temporal Requirements using Simulink Test,*" Fourth International Workshop on Monitoring and Testing of Cyber-Physical Systems (MT-CPS 2019), part of CPS-IoT Week 2019.

C12. Akshay Rajhans and Dan Lluch, "A Digital Twin Approach to Online Monitoring in Industrial Internet of Things Applications," Fourth International Workshop on Monitoring and Testing of Cyber-Physical Systems (MT-CPS 2019), part of CPS-IoT Week 2019.

C11. Andreas Tolk, Fernando Barros, Andrea D'Ambrogio, **Akshay Rajhans**, Pieter J. Mosterman, Sachin S. Shetty, Mamadou K. Traoré, Hans Vangheluwe, and Levent Yilmaz, "*Hybrid Simulation for Cyber-Physical Systems—A Panel on Where we are Going Regarding Complexity, Intelligence, and Adaptability of CPS Using Simulation*", in Proceedings of the Spring Simulation Multi-Conference, 2018.

C10. **Akshay Rajhans**, Srinath Avadhanula, Alongkrit Chutinan, Pieter J. Mosterman, and Fu Zhang, "*Graphical Hybrid Automata with Simulink and Stateflow,*", in Proceedings of the 21st ACM International Conferenec on Hybrid Systems: Computation and Control (HSCC), 2018.

C9. **Akshay Rajhans**, Srinath Avadhanula, Alongkrit Chutinan, Pieter J. Mosterman, and Fu Zhang, "*Graphical Modeling of Hybrid Dynamics with Simulink and Stateflow*", in Proceedings of the 21st ACM International Conferenec on Hybrid Systems: Computation and Control (HSCC), 2018. ***Best Repeatability Evaluation Award Finalist.***

C8. **Akshay Rajhans** and Pieter J. Mosterman, "*A Vision for Application-Focused International Collaboration Networks in Cyber-Physical Systems*", NSF Visioning Workshop for International Collaborations for Advancing CPS Research, Development, and Education Worldwide, part of CPS Week 2018.

C7. **Akshay Rajhans** and Bruce H. Krogh, "*Compositional Heterogeneous Abstraction*", in Proceedings of the 16th ACM International Conference on Hybrid Systems: Computation and Control (HSCC), 2013.

C6. **Akshay Rajhans** and Bruce H. Krogh, "*Heterogeneous verification of cyber-physical systems using behavior relations*", in Proceedings of the 15th ACM International Conference on Hybrid Systems: Computation and Control (HSCC), 2012.

C5. **Akshay Rajhans**, Ajinkya Bhave, Sarah Loos, Bruce H. Krogh, André Platzer, and David Garlan, "*Using Parameters in Architectural Views to Support Heterogeneous Design and Verification*", in Proceedings of the 50th IEEE Conference on Decision and Control (CDC), 2011.

C4. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, and Larry Pileggi, "*Formal Verification of Phase-Locked Loops Using Reachability Analysis and Continuization*", in Proceedings of the IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2011. ***William J. McCalla Best Paper Award.***

C3. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, Larry Pileggi, "*Using Continuization in Rechability Analysis for the Verification of a Phase-Locked Loop*", Frontiers in Analog Circuit (FAC) Synthesis and Verification, co-located with Computer-Aided Verification (CAV) 2011, Snowbird, UT.

C2. Ajinkya Bhave, David Garlan, Bruce H. Krogh, Sarah Loos, André Platzer, **Akshay Rajhans**, Bradley Schmerl, "*Multi-View Consistency in Architectures for Cyber-Physical Systems*", Safe and Secure Systems & Software Symposium (S5) 2011, Beavercreek, OH.

C1. Ajinkya Bhave, David Garlan, Bruce H. Krogh, **Akshay Rajhans**, and Bradley Schmerl, "*Augmenting Software Architectures with Physical Components*", in Proceedings of the Embedded Real Time Software and Systems Conf. (ERTS^2), 2010.

Other Miscellaneous Writing

O1. **Akshay Rajhans**, "*EGO Insider's Guide*", ECE Graduate Organization (EGO), Carnegie Mellon University, 2012. Contributor and Editor. Available at `http://www.ece.cmu.edu/~ego/files/insiders/guide2012.pdf`.

Student Advising and Teaching

Ph.D. Thesis Committee

- Yi Deng, ECSE Department at Rensselaer Polytechnic Institute. **Advisor**: Prof. A. Agung Julius. **Thesis Title**: "*The Application of Trajectory-Based Analysis for Hybrid Systems*." Defended July 2015.

Student Competitions

- (2017) **MathWorks Technical Lead**, *CAT Vehicle Challenge*, an autonomous vehicle student research competition: simulation rounds hosted online in the Cyber-Physical Systems Virtual Organization (CPS-VO) Portal, along with the final round held on an actual autonomous vehicle (CAT Vehicle) at the University of Arizona, **Instructor**: Prof. Jonathan Sprinkle.
- (2017, 2016) **Judge**, *CPS V&V Grand Prix*, Formal Methods Research Course Competition for 15-424/15-624/15-824: Foundations of Cyber-Physical Systems, Carnegie Mellon University, **Instructor**: Prof. André Platzer.

Teaching Assistantship

- **18-474: Embedded Control Systems**, Electrical and Computer Engineering Department, Carnegie Mellon University, Spring 2011.
- **18-474: Embedded Control Systems**, Electrical and Computer Engineering Department, Carnegie Mellon University, Spring 2010.
- **MATH 114: Calculus II**, Mathematics Department, University of Pennsylvania, Spring 2008.
- **MATH 114: Calculus II**, Mathematics Department, University of Pennsylvania, Fall 2007.
- **ESE 210: Introduction to Dynamic Systems**, Electrical and Systems Engineering Department, University of Pennsylvania, Spring 2007.
- **ESE 301: Introduction to Probability**, Electrical and Systems Engineering Department, University of Pennsylvania, Fall 2006.
- (Grader) **OPIM 101: Introduction to Computer as an Analysis Tool**, Operations and Information Management Department, (now called the Operations, Information and Decisions Department), Wharton School, University of Pennsylvania, Spring 2006.

Guest Instructor

- (2009) **Laboratory Instructor**, *Summer Engineering Experience for Girls (SEE)*, a day-long summer camp for high-school students at Carnegie Mellon University, **Primary Instructor**: Prof. Bruno Sinopoli.
- (2002) **Instructor**, *Social Educational Activity*, organized by the IEEE Bombay Section Region 10 to create awareness amongst high-school students, **Topic:** *Mobile Communications*.

Honors

- Invited participant at an NSF/DoD/NIST workshop to chart out the future of simulation and machine learning in robotics, 2018. See:
  `https://www.nist.gov/news-events/events/2018/04/simulation-and-machine-learning-robotics`
- Selected on ACM's **Global Practitioner Advisory Community**, 2017.
- Work featured as **Research Highlight** in *Communications of the ACM* magazine, 2013.
- Work featured in ***Innovation with Impact***, Carnegie Mellon University, 2013.
- William J. McCalla **Best Paper Award**, ACM/IEEE International Conference on Computer-Aided Design, 2011.
- Carnegie Institute of Technology **Dean's Fellowship**, August 2008–May 2013.
- Ranked in **top 0.48%** in India (percentile score of 99.52), Common Admission Test, 2005.
- National Talent Search (NTS) Scholarship, finalist, India, 1997.
- Maharashtra Talent Search (MTS) Scholarship, State-level rank: **35** (1996), **15** (1995).
- Middle School Scholarship, Maharashtra, India. State-level rank: **16** (1991-1994).

Software

Developer: Simulink, Stateflow, SimEvents, STRONG.

Languages: MATLAB, C++, C, some Java.