

ANDREW HOFFMAN

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SUMMARY

Responsible for the technical direction of all production software at Kiva Systems (now Amazon Robotics) and advisor to our most senior technical managers. Designed and implemented unique, patented technologies that have revolutionized warehouse automation, and that led to our acquisition by Amazon.com for \$775M in 2012. A generalist with industry-founding experience solving large scale, time-sensitive optimization problems, building distributed collaborative systems, and managing human/robot interaction. A strong, well-respected technical leader with a consistent ability to turn business vision into software reality.

WORK EXPERIENCE

2004–2015: Principal Software Architect, Amazon Robotics (formerly Kiva Systems)

Amazon Robotics (AR) uses semi-autonomous robots to lift and carry shelves of product to human workers, giving them fast, efficient access to any item in a building at any time. (See goo.gl/L0g74e for videos.) Our technology transforms a traditional warehouse into self-configuring, massively parallel, general-purpose inventory movement engine.

At AR, I was responsible for the technical design of our production software. I also designed and built many of our fundamental system components, and led our largest software initiatives as we grew from 5 to over 600 employees. I contributed to many of our technical innovations, including:

- Algorithms and software necessary to efficiently coordinate the movement of 1000's of semi-autonomous robots within a complex and dynamic shared workspace.
- Software and technologies that enable highly efficient human/machine interaction, a cornerstone of our solution.
- Framework components that enable robust, self-healing software to be developed and deployed in a warehousing environment.
- Emulation tools and techniques that enable large-scale simulation and testing.

I am currently a named inventor on 14 key patents with Kiva/AR, including key design elements of our robot motion planning and control system. Major projects and milestones are listed below (in chronological order):

Prototype System (2004)

In 2004, we constructed our prototype system to validate our engineering concepts and to prove that the idea of using robots to move shelves to workers was not just viable but also highly profitable for Kiva and our customers. Using the prototype system, we secured our first two paid production system agreements (*Staples* and *Genco*) and secured a critical round of \$6M in funding with excellent valuation. I also shipped our first orders using the prototype equipment - greeting cards for goodthings.com.

Some notable contributions include:

- Designed and implemented the software infrastructure and major software components of our prototype system (using C++, MySQL, and custom messaging infrastructure).
- Designed many core data structures and data models that remain central to how Kiva's technology operates today.
- Designed and implemented or helped implement nearly all software components in the prototype. This includes software that: monitors and controls the robots; prevents robot collisions; controls the workstation, user interfaces, and user hardware; selects and assigns work to robots and users; collects and reports order progress with existing customer warehouse management systems; and supports system maintenance and administration workflows.
- Created and maintained our initial IT infrastructure, including email service, user account management, version control systems, and backup systems.

First Production System (2005-2006)

After securing customer contracts and funding, we started developing our production system. Much

of the production infrastructure I developed has been in use for the past 10 years, and remains in use today. This includes establishing mechanisms for configuration, component messaging, system deployment and bootstrapping, database and data access, software upgrading and patching, and even software reset and failure management.

As with the prototype system, I also developed many of the first production system application components. My focus tended to be on the robotic control system, authoring our workstation control software (which manages human/robot interaction) and several key planning and allocation components that assign work to robots and humans.

Core Feature Development (2007-2009)

From 2007 to 2009, we expanded our initial product offering to include many new features, and continued to generalize our product so that it could also be used by an increasingly larger segment of the warehousing and logistics market. In this time, we implemented an endless list of features for our growing customer base, including Walgreens, OfficeDepot, Diapers.com, Zappos, The Gap, Quiet Logistics, Gilt Groupe, and many others.

Generalized Motion Control (Late 2009 to Mid 2010)

On a very aggressive timeline, I led a team of ~15 developers that re-designed and re-implemented a more feature-full version of our robot movement planning and anti-collision system. To do this, I took the team to an off-site location to isolate them from other day-to-day demands. We successfully delivered the new system on time and within the estimated labor budget, and the new system has proven to be an excellent upgrade to the original system.

Additional Automation, IPO Preparation (Late 2010 to Early 2012)

Following our successes and a return to stability in the financial markets, we started to prepare for a potential IPO. During this time, I added another set of generic features to the system, including support for Kiva Vertical Lifts (elevators for robots) that allowed robots and shelves to move between floors. I also worked on a CE-compliant safety system that we developed, allowing us to deploy our systems into European and Canadian markets.

Amazon.com Integration (Early 2012 to Mid 2012)

In 2012, I facilitated the technical vetting required by Amazon.com during acquisition negotiation. We were ultimately acquired at a value of \$775M. Immediately following the acquisition, I facilitated a fast and successful integration of our solution with Amazon.com, and we launched our first Kiva-style Amazon warehouse within months. In recognition of my skills and value to the company, I was designated as an Amazon.com Principal Software Engineer, a very highly valued role within Amazon.

Service-based Architecture (Late 2012 to July 2015)

Following initial integration with Amazon.com, we entered a new rapid phase of growth. I started a project to create a new vision for our software systems that aligns well with Amazon's software development and deployment philosophy, and that also addresses our organizational scalability goals. The new design targets global 24/7 operations, and makes heavy use of data centers (including AWS technologies) to move to a zero-planned-downtime model and enable continuous deployment of software changes. In this role, I was responsible for the technical vision for our ~160-person software development group.

2000–2004: System Architect, Interdimensions, Boston, MA and Washington, DC

As a system architect and developer at Interdimensions, I designed and developed many complex networked software systems, leading up to 20-person project teams for our largest consulting engagements. Performed extensive project estimation, software development, installation, and integration for many of Interdimensions' projects. Managed employees in junior developer and student internship positions. Contributed to business development efforts and managed client relationships. Completed over 9 major projects in a 4-year period. Notable clients and project contributions include:

Imagination & Ford Fusion: Led the design and development of a C++ based PocketPC app for a London-based client under a tight and demanding deadline. The software introduced Ford dealers in the U.K. to the new Ford Fusion vehicle by guiding them through a tour of the countryside in the new vehicle on a scavenger hunt. The application provided the car dealers with driving directions, key facts about the new vehicle, and quizzed them on their knowledge of the new Fusion. "Winners" of

the guided tour could be quickly calculated and awards given, based on number of questions they answered correctly and their completion times. The system was a resounding success.

Imagination & Samsung: Contributed to the design and development of a unique Palm-based snowball fight game showcased by Samsung at the 2002 Winter Olympics. Developed the server software to manage the gaming interaction and scoring between eight PalmOS gaming devices and the surrounding gaming environment, all attached via serial port. The resulting gaming environment operated flawlessly and created a positive, engaging experience for visitors at the 2002 Winter Olympics.

The M&A Group: Designed and directed the development and deployment of a \$3M Flash-based website to be used by a collection of the world's most powerful CEOs, dubbed 'For CEOs Only.' Utilized a rich and highly flexible multiple-tiered architecture and XML to deliver dynamic content through a Flash interface. Server-side software was designed and developed using proprietary C++ technologies on the Sun Solaris operating system.

Schlumberger Simagine Competition: Constructed a distributed transaction system in which a person's trusted personal web services (e.g. a banking or medical web transaction service) could initiate a high-bandwidth digitally signed transaction with another web service on behalf of an individual, but only if first approved and signed by a person's encryption key stored on their cellphone or personal computer. In an era before cellphone-based transactions, we showed that cellphones (and their built-in SIM cards) could be used to securely approve and digitally sign server-to-server transactions without having to push the to-be-signed documents through the cellphone devices themselves.

EF Education and Englishtown.com: Designed and directed the development of an online Java and Javascript-based testing engine used by EF Education to prep international exchange students for their travel to the US. The testing engine proctored tests, collected results, and even included a suite of online test authoring tools used by EF to create and update the online tests.

RELEVANT SKILLS

A strong generalist with an ability to specialize as needed to get the job done. Areas of technical experience and expertise include:

- Software Frameworks and Infrastructure
- System Flow Optimization
- Applied Heuristics
- Robot Coordination, Control
- Soft Real-Time Systems
- Data Collection and Analysis
- Application and Tools Design
- Human and Machine Interaction
- Testing and Simulation
- Project Scoping and Estimation
- Information Security and IT Infrastructure

Also an upbeat, passionate technical leader. Regularly applied soft skills include:

- Technical Vision and Direction
- Critical Design Review and Analysis
- Team Leadership
- Mapping Business Needs to Technical Needs
- Consensus Building
- Technical Development and Training
- Mentoring

EDUCATION

1998–1999 Cornell University, College of Engineering, Ithaca, NY

- Master of Engineering, Electrical Engineering, with System Engineering Option.
- Focus in Communication Systems, Biomedical Signal Processing, and Information Theory.
- World Champions, 1999 RoboCup Autonomous Robotic Soccer Competition.

1994–1998 Cornell University, College of Engineering, Ithaca, NY

- Bachelor of Science, Electrical Engineering.
- Focus in Communication Systems and Digital Signal Processing.

COMMUNITY OUTREACH

Launched a computer lab at CAPROFORS Vocational School in Mirebalais, Haiti.

Presented to students and supported job recruiting efforts at WPI, Cornell University.

Spoke on the Intellectual Property panel at the 2013 Future of Robotics Summit in Cambridge, MA.