The Safety-to-Autonomy Curve
an incremental approach to introducing automation to the workforce

Daniel Theobald, CTO, Vecna

ICRA, May 30, 2015
Agenda

• A little about Vecna
• Mass Robotics update
• Safety to Autonomy
About Vecna

• Privately funded automation company
• Founded in 1998 by MIT engineers
• Focus on advanced technology with applications in healthcare and logistics
• Hundreds of implementations worldwide
• Strong track record of commercializing R&D
• 10% working time devoted to community service
Vecna’s Mission

To create robots that provide real economic value by working safely alongside humans
Community Service Challenge

• For the past 17 years, Vecna has paid its employees to spend up to 4 hours of every work-week doing community service projects.

• To date, Vecna has provided nearly 100,000 hours of community service to communities around the world. Imagine what could be accomplished if every organization did this.

• The challenge: Convince yourself and your company leadership to adopt socially responsible practices and give back.

• The research is clear: people and companies that regularly engage in community service are healthier, happier, more productive, more prosperous, live longer, more respected, more fun to work with, and the list goes on.
MassRobotics Update...
Massachusetts.
Leading the Robotics Revolution?

Daniel Theobald
CTO, Vecna
The Opportunity

- Trillions of dollars of unmet market needs
- The ability to empower the human race to accomplish more than ever before
- The opportunity to create prosperity for all segments of society
2016 Industrial Robots
Estimated yearly shipments

Global Market Values

Service Robotics
$3.4 Billion

Industrial Robotics
$8.5 Billion

USA
Europe
China
Japan
South Korea
McKinsey's Report: Twelve potentially economically disruptive technologies

- Advanced robotics across health care, manufacturing, and services could generate a potential economic impact of $1.7 trillion to $4.5 trillion per year by 2025, including more than $800 billion to $2.6 trillion in value from health-care uses.

- Industrial robots with features such as machine vision and high-precision dexterity typically cost $100,000 to $150,000. These prices will come down substantially opening many new markets.
The world's largest robotics cluster

Over 150 innovative companies over 11 different markets
Over 35 robotics R&D programs across 18 institutions
The Problem

• Lack of a strong support ecosystem for robotics and automation industry and startups.

Results in poor startup performance and poor investor confidence
The Solution: MassRobotics

To 'nurture' the world's largest robotics cluster.

- Independent non-profit industry association
- Designed with input from investors to reduce risk
- Information sharing, standards and contract support
- Quality & cost-effective prototyping and testing facilities
- Curated business services & mentorship
- Introductions to strategic contacts & investors
- STEM education support
MassRobotics: The Robotics Hub

- Entrepreneurs
  - Resources & Exit
  - Opportunities & Innovation

- Talent
  - Co-founding & Employment
  - Energy & Time
  - Leads

- Service Providers
  - Professional Services
  - Leads

- Mentors
  - Reputation & Boards
  - Advice & Connections
  - Research & education
  - Academic

- MassRobotics
  - Cash & Connections
  - Exit Options & B2B Leads
  - R&D & Acquisitions
  - commercialization

- Corporations

- Investors & Funders
  - ROI
The Business Model

Startups & Service Providers

Rent & Services

Sponsored Spaces

Sponsorship

Grants

MassRobotics

Capital Expenditures:
- Build out & renovation
- Office furniture & equipment
- IT infrastructure
- Prototyping equipment & Labs
- Capitalizable labor

Operating Expenditures:
- Staff
- Contractors
- Consumables
- Facility lease & Utilities
- G&A
Initial Demand & Cash Sponsors

Potential Initial Residents:
1. Acorn PD
2. Empire Robotics
3. Flextronics
4. LaxeeEye
5. MeetingOwl
6. Neurala
7. Panoptes
8. Paracosm
9. Rise Robotics
10. Sonzia
11. Panasonic
12. FoxConn
13. Amazon
Initial Board of Directors

Ken Gabriel, *Draper Labs*
Jay Ash, The Commonwealth
CA Web, New England VC Society
Colin Angle, *iRobot*
Tim Rowe, *CIC/LabCentral*
Tom Hopcroft, *MassTLC*
Daniel Theobald, *Vecna*

Next Step:
Hire Dedicated Leadership Team
Please Help
"Nothing is more powerful than an idea whose time has come."

Victor Hugo
Safety to Autonomy
Robots will instantly and dramatically change the way we work.

Too much hype
Barriers to Adoption

• 41% of manufacturing companies surveyed said they do not currently use robotics technology and they don’t intend to in the next three years

• What they think about robots:
  – Robots are not cost effective
  – Robots will displace workers and affect morale
  – Staff are not skilled enough to run the robots
  – Robots break
  – Robots are not safe
Workplace Fatalities

- **4,585** workers killed on the job in 2013
- **$188.9 billion** in productivity and wages are lost each year in the U.S. due to safety-related death and injury
- Powered industrial trucks are #5 on OSHA’s list
Forklifts injuries – by the numbers

• 110,000 major forklift accidents occur every year
• Forklifts account for 1 in 6 workplace deaths and 34,900 serious injuries
• 90% of all forklifts will be involved in some type of serious accident during their useful life

<table>
<thead>
<tr>
<th>Fatal Accident Type</th>
<th>%</th>
<th>Where fatalities occur</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushed by vehicle tipping over</td>
<td>42%</td>
<td>Mining</td>
<td>1.2</td>
</tr>
<tr>
<td>Crushed between vehicle and a surface</td>
<td>25%</td>
<td>Construction</td>
<td>23.8</td>
</tr>
<tr>
<td>Crushed between two vehicles</td>
<td>11%</td>
<td>Manufacturing</td>
<td>42.5</td>
</tr>
<tr>
<td>Struck or run over by a forklift</td>
<td>10%</td>
<td>Transportation</td>
<td>11.0</td>
</tr>
<tr>
<td>Struck by falling material</td>
<td>8%</td>
<td>Wholesale trades</td>
<td>12.5</td>
</tr>
<tr>
<td>Fall from platform on the forks</td>
<td>4%</td>
<td>Retail trade</td>
<td>9.0</td>
</tr>
</tbody>
</table>
## Accident: 201924669 - Employee Is Killed When Caught Between Forklift And Vehicle

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Open Date</th>
<th>SIC</th>
<th>Establishment Name</th>
</tr>
</thead>
</table>

At approximately 1:40 a.m. on or about November 27, 2008, Employee #1, a forklift operator, had dismounted a manually operated forklift that he had used to retrieve a pallet of product from space EEA02F. An automatically guided vehicle (AGV), operating in the same area as Employee #1, turned a corner, failed to detect the manually operated forklift, and collided with it, striking Employee #1. Employee #1 was caught between the AGV (HK Systems Model Number 35/LCF-257Q, serial Number 4330050, Frito-Lay Unit Number 19) and his manually operated forklift (Cascade Side Shifter Number 55E-SS-A062, Truck Type E, Model Number RC3020-40-S, Serial Number 1A194660, Frito-Lay Unit Number 53). Employee #1's head was crushed, and he was killed. The AGV's laser collision avoidance system did not sense the presence of older type forklifts. The company required forklift operators to set a single plastic cone a distance from the manual forklift. The presence of the cone was intended to increase the probability that the AGV's presence sensing field would detect the cone, causing the AGV to stop. Employee #1 had not set the cone.

**Keywords:** caught between, crushed, industrial truck, vehicle, unmanned, ind trk operator, head, work rules

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Age</th>
<th>Sex</th>
<th>Degree</th>
<th>Nature</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>311960876</td>
<td></td>
<td>Fatality</td>
<td>Fracture</td>
<td>Occupation not reported</td>
</tr>
</tbody>
</table>
The Safety-to-Autonomy Curve

The glide path on which an organization successfully adopts robotic systems

Focus on safety, add autonomy incrementally with safety always coming first.
Manned Vehicles
Forward collision avoidance

Sideview assist
Unmanned Vehicles
Safety to Autonomy

• Sensorize first, improved safety is something everyone can buy into. The ROI is clear.
• Don’t just use sensors to sense the environment, actually *make sense* of the environment
• Agility to address new applications quickly requires general purpose world models rather than 'hard coded' safety sensors
• Work as an industry to establish reasonable standards
• Buy time for industries and workforces to adopt and accept sensorized platforms, achieve early ROI and incrementally adopt autonomy
Let's make safety a top priority

• Avoid direct industry set backs
• Avoid unnecessary interference and regulation
• Avoid bad PR and public opposition to robotics
• Most importantly, avoid hurting people and causing pain
Daniel Theobald
t&o@vecna.com