MAXIMIZING YOUR ROBOTICS INVESTMENT
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Introduction

In the world of robotics, you can do three things:
1. Move through the world
2. Perceive the world
3. Interact with the world

From warehouses to operating rooms, robotics and automation are changing the way businesses plan, operate workflows and deliver services to customers—and a number of industries are already enjoying the benefits that robotics can provide. Globally, the use of robotics continues to rise exponentially, with experts forecasting that the industry will reach more than $97 billion by 2026.* Accordingly, businesses recognize that they must remain at the forefront of technology and automation to stay competitive.

In this eBook, we discuss the reasons that companies turn to robotics, as well as the concerns and considerations that businesses must evaluate before implementing robotics. In particular, we address the fixed costs associated with traditional robots and then discuss how cutting-edge robotic systems can help to offset those costs. We also address how advancements in human-like robotic technology are allowing more businesses to automate their operations than ever before.

In the Appendix, you will also find a printable worksheet that can help you identify the business considerations and potential costs for investing in robotic development.

*Source: Industrial Robotics - Global Market Outlook (2017-2026)
Factors Driving Robotic Investment
While traditional robotics have long been optimized for targeted applications in the automotive industry, newer, human-like technologies are rapidly permeating the commercial market, disrupting conventional industries like agriculture, construction, logistics and health care. Human-like robotics, which mimic human scale as well as a human’s physical and cognitive performance, have now come of age. These human-like robotic systems also are assisting in industries where labor shortages or on-the-job injuries are of primary concern.

In our research, we have found that there are typically four primary reasons why businesses pursue the implementation of robotics. While every industry has its unique challenges, these factors directly affect the operations across all businesses, no matter how large or small. They include:

1. Globalization and competitive pressures
2. Labor costs and shortages
3. Safety and work-place risks to workers
4. Technology “FOMO” (Fear of Missing Out)
Driving Factors

<table>
<thead>
<tr>
<th>GLOBALIZATION</th>
<th>LABOR COSTS</th>
<th>SAFETY CONCERNS</th>
<th>FOMO</th>
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<tbody>
<tr>
<td>Rapid advancements in technology and automation are changing the face of the global job market.</td>
<td>Research shows that implementing advanced robotics can save a company 20-40% over human labor.*</td>
<td>Robotics can enhance safety by offloading dangerous or injury-inducing repetitive tasks to machines.</td>
<td>Businesses must evolve with advancing technologies or risk falling behind.</td>
</tr>
</tbody>
</table>

*Source: Industrial Robotics Market in the U.S. 2016-2020
Driving Factor #1: Globalization

WHEN, NOT HOW

Rapid advancements in technology and automation are changing the face of global markets, affecting everything from manufacturing output to the demand for skilled labor. To stay competitive, an increasing number of industries are turning to human-like robotics to supplement or replace their labor forces, and this trend will only become more widespread as the cost of implementing robotics falls. Across every industry, the question is no longer “how” a business will implement robotics, but “when.”
Driving Factor #2: Labor Costs

As robots become more advanced and affordable, many industries are turning to robotics and automation to cut expenses. While the cost of robotics and automation has decreased, the cost of human labor continues to climb at a rate of about 2-3% a year.* While there are obvious expenses associated with the care and maintenance of robotic technology, the costs are minimal compared to those associated with hiring human workers, such as onboarding, training, retraining, insurance and benefits. In fact, studies indicate that implementing advanced robotics system can save a company as much as 40% over human labor.

Some industries, however, are not just looking to robotics for potential labor savings. Rather, they are considering robotics as a way to offset the absence of manual laborers. When an economy is strong, workers have many options for work. Laborers may, for example, avoid taking up work that is physically demanding. This factor has contributed to the adoption of robotics in many non-traditional industries that are struggling to fill hiring gaps, such as agriculture, construction and the service industry.

Robotic technology also improves efficiency and accuracy, especially when it comes to repetitive, high-volume tasks, which can improve a business’ profit margin. And while workers fear that they may lose their jobs to robots, advanced technology provides new opportunity, as workers will be needed to build, maintain and train those robots, or even work alongside collaborative robots, whether on the plant floor or elsewhere. Moreover, by alleviating physically demanding tasks, robotics may actually allow older manufacturing workers to stay on the job longer than they would have been able to in the past.

*Source: Bureau of Labor Statistics
Driving Factor #3: Safety Concerns

Manufacturing remains one of the most hazardous occupations in the United States, with incidents ranging from sprains and strains from heavy lifting to fatal accidents from equipment malfunction. Therefore, more companies are turning to robotics to protect their workers from workplace injuries or hazardous situations. Many businesses cite safety concerns as a primary reason for implementing robotics, since they offload dangerous or injury-inducing repetitive tasks to machines.

Traditional in-factory manufacturing is not the only industry that can benefit from the use of robotics. Any industry that exposes employees to “dull, dirty or dangerous” tasks, such as those that involve toxic chemicals or heavy lifting, are ripe for the use of robotics, as are industries that frequently experience labor shortages, such as agriculture, construction and the service industry. Other industries, such as health care, are turning to robotics to improve surgical accuracy and, patient safety. And robots have long been in use by the military; for instance, RE2 Robotics’ Maritime Dexterous Manipulation System (MDMS) is designed to detect Waterborne Improvised Explosive Devices (WBIEDs), using the same technology as its dual-arm Highly Dexterous Manipulation System. Both systems are designed to quickly and efficiently perform a variety of complex and dangerous tasks from a safe, remote distance.
No business wants to be left behind—and FOMO, or the fear of missing out, is a valid concern throughout every industry. Once a business decides to automate its operations via robotics, its competitors will be forced to evolve or risk falling behind.

By resisting change, whether due to cost concerns or the impact it will have on your workforce, your business runs the risk of becoming outdated or even obsolete. This is especially true as your corporate culture evolves to include a generation of people—both customers and employees—who were raised on technology and automation and are, therefore “digital natives.” As evidence, one needs to look no further than the impact that e-commerce is having on brick-and-mortar retail. Businesses that are competing against evolving technologies are closing stores, falling behind and filing for bankruptcy.
Evaluating whether robotics is a good fit for your business might seem like a complex and daunting task, but it does not have to be. A number of topic areas are gathered below that can help minimize the “unknowns” and anxiety associated with pursuing a robotics investment. In addition, a printable checklist is included in the Appendix of this eBook.

As one can imagine, there are a number of costs that should be considered prior to purchasing your first system. Generally, these costs are typically bundled into two types of costs: **fixed** and **variable**.

**Fixed costs** are costs that occur as a part of the initial upfront investment and do not reoccur with time over the life of the system. Fixed costs are generally treated as capital expenditures and are typically larger when compared to variable costs.

**Variable costs**, on the other hand, are costs that will reoccur over the life of the robotic system. These costs include factors like energy to power the robot, as well as ongoing system maintenance. As noted above, variable costs are generally much lower than the fixed costs, but can still add up over the life of the system. As a general guide or estimate for variable costs, including year-over-year maintenance, one should annually budget approximately 10 to 15 percent of the initial system investment.

As with any new project, a thorough analysis should be conducted to evaluate the potential impact of robotics on your business. The following descriptions of the costs associated with robotic development should be treated as a general guide to get started, but not as an exhaustive list.
## Fixed Costs of Traditional Robots

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>HARDWARE/SOFTWARE</strong></td>
<td>Costs associated with the base robotic hardware, as well as the software to operate it.</td>
</tr>
<tr>
<td><strong>FACILITIES UPGRADES</strong></td>
<td>This can include upgrades to infrastructure, network communications and data hosting.</td>
</tr>
<tr>
<td><strong>FIXTURES &amp; FIDUCIALS</strong></td>
<td>Many robotic processes need fixed structures for optimal performance, whether as hard fixtures or through fiducials.</td>
</tr>
<tr>
<td><strong>END OF ARM TOOLING</strong></td>
<td>You may need to purchase specific end effectors or other specialty tools for your base robot.</td>
</tr>
<tr>
<td><strong>INSTALLATION</strong></td>
<td>Significant effort may be required to complete the installation.</td>
</tr>
<tr>
<td><strong>SOFTWARE INTEGRATION</strong></td>
<td>This may include additional tuning and personnel to optimize the robot's movements.</td>
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There are a number of costs that must be considered when making an upfront investment in a robotic system. To the surprise of many, these costs often extend beyond just the scope of the robot itself. While human-like robots are designed to operate in spaces that were built to accommodate humans, traditional robots typically have a larger footprint and therefore require more significant (and therefore expensive) facility and infrastructure upgrades.

Robot Hardware and Software Costs
These are the costs associated with the base robotic arm, its control cabinet and the software to operate it. In some cases, the control software is sold separately, adding to the cost of the upfront investment.

Facilities Upgrades for Traditional Robots
Depending upon the application, facilities upgrades can often add up to well beyond the cost of a robotic system. This is especially true for older businesses that have fixed infrastructures that accommodate humans, not robots. For these types of industries, the conversion can be especially challenging; however, given some of the modern manufacturing challenges noted above, robotics have become a necessity of the times.
When evaluating a facility for upgrades, you’ll need to consider the following requirements associated with traditional robotics:

**Infrastructure**
There are a number of requirements to keep in mind when implementing traditional robots—some of which may require significant facility upgrades. First, traditional robotics are often heavy and therefore, require a large, rigid mounting structure for the base of the unit. Second, many traditional robots require high-power mains to feed their control cabinets. This may require an electrician to update your facilities electrical service. Third, dependent upon the risk assessment associated with the application, hard guarding also may be required. Dependent upon the risk assessment, even collaborative robots, or "cobots," may still require hard guarding to keep nearby operators safe. Finally, unlike human-like robots, traditional robots require significant floor space to operate. Therefore, your facilities team may have to move assembly lines or existing operational flows to compensate.

**Network Communications and Data Hosting**
To take full advantage of many diagnostics and monitoring features associated with robotics, many systems must be networked over the company’s internet or internal communications system. Additional Ethernet lines may need to be installed to provide the necessary communications between systems. Similarly, additional data hosting may be required. This is particularly true for quality control processes. Data provided by robotic systems can provide automated statistical process control (SPC) data to be published on the fly; however, this requires additional server space, whether onsite or stored on a cloud service.

**Fixtures and Fiducials**
Many traditional robotic processes require fixed structures to perform optimally. These structures can be provided in a number of ways: with hard fixtures, which control how parts are presented to the robot, or through the inclusion of fiducials or other features such as 2D data matrices, which can be detected by computer vision systems and leverage artificial intelligence algorithms.
**End-of-arm Tooling**
Unlike human-like manipulator arms, traditional robotic arms typically do not ship with end effectors or the end-of-arm toolings needed to grasp a part. There are a myriad of specialty tools available in the market; depending upon their operation, they may require the addition of compressed air to be integrated to the arm. Specialty tools can also be quite expensive, and may cost 10 to 30 percent of the robotic manipulator.

**Installation**
Once a facility is properly prepared for a traditional robotic arm, there is still significant effort required to complete the installation. For example, specialty cranes might be needed to lift and position the robot into its new home.

**Software Integration**
After all of the mechanical components have been fully integrated into a facility, the final step is to integrate the system’s software. This may include additional tuning (and personnel) to optimize the robot’s movements, code to control specific sequences, and the integration of sensor data.
Both traditional and advanced robotic systems require ongoing operating and maintenance costs, which vary according to the size of the system. While these costs are typically lower than fixed costs, they are nevertheless important to consider when evaluating a robotic system.

**Labor Costs**
A common misconception is that robots can completely eliminate the need for labor. While robots can augment the labor required for specific manufacturing or assembly tasks, they will still require ongoing labor to support them—including additional skilled labor to diagnose, debug and troubleshoot problems as they arise. These individuals may be needed to make periodic modifications to code, integrate new sensors, and perform routine maintenance on the system.

**Operating Costs**
Operating costs can vary widely in terms of their impact and need, whether monthly, quarterly, or annually.

a. **Energy Costs**
Robots require significant electrical energy to operate; a standard budgetary figure based upon average electrical rates is 50 cents per hour of operation. If a robotic system is using a traditional hydraulic or pneumatic system to operate, the cost can exceed this figure, as fluid-based power systems are inherently inefficient. By comparison, advanced, human-like robotic systems require less energy than large-scale traditional robots and therefore will be more cost-efficient.

b. **Maintenance Costs**
As with energy costs, periodic maintenance costs can vary widely, depending on the application. The system may need to be periodically recalibrated for precision of motion, accuracy of sensing, or replacement of wear components. Other examples of maintenance costs include typical preventative measures, such as lubrication or replacement of seals.

c. **Ongoing Software Support**
Depending upon the supplier of the robotic system, ongoing software support charges may apply. Should your on-site staff not be able to overcome a software fault or error, you may need to contact the OEM’s call-center support team, which can lead to additional support charges.
There is no doubt that investing in robotics can seem financially and logistically overwhelming, especially if your business is brand new to the field. The good news is, thanks to ongoing advances in human-like robotic technology, many of these costs can be reduced. These advances, including improved strength-to-weight ratios and advanced computer vision and autonomy algorithms, are making robots smaller, faster and more lightweight than ever before. Moreover, significant advancements in computational power, coupled with falling costs, have made the integration of computer vision algorithms for less-structured or unstructured applications possible. Many leading-edge robotics companies now offer computer vision and autonomy expertise that allows a robot to perceive as a human would, without the need for significant alterations to the environment.

In many cases, traditional robots have not been an option for many industries, given the underlying assumption that the manufacturing flow would be based around the robot, instead of having the robot adapt to existing infrastructure. With the emergence of human-like robots, these traditional industries now have options.
For instance, many traditional robotics systems were developed with the "typical" automotive production floor in mind, and those systems have long had negative strength-to-weight ratios, meaning that they weigh more than they can lift. As stated in previous sections, these robotics systems required numerous modifications and facility upgrades. However, human-like systems like those being developed by RE2 Robotics have neutral or positive strength-to-weight ratios. This capacity is revolutionary for those who want to use robotics for applications that require maneuvering heavy parts (20 kg+) in both fixed and unstructured environments that have historically been intended for manual, human operations. These newer robots can perform at a scale similar to that of a human in terms of weight and lift capacity—and they don’t require the structural modifications that traditional systems may have.

While newer human-like robotic systems might cost slightly more than traditional industrial robots, they enable manufacturers to take advantage of robots without significant, costly modifications to their infrastructure. Where in the past these modifications might have been cost-prohibitive, many businesses can now integrate more human-like robots into their operations.
As time progresses, robots are becoming more human-like. They’re also becoming easier to install and operate. As a result, businesses that once considered the technology cost-prohibitive have discovered that they now have the ability to revolutionize their business processes through robotics. A number of industries, including agriculture, construction, logistics, health care, maritime and service, have already begun to recognize the benefits that robotics can provide. Whether your goal is to reduce costs, improve operational safety, or disrupt your industry, the use of robotics can help your business maintain its competitive edge, reduce labor costs, and improve worker safety.

Any major investment obviously requires thorough planning, research and evaluation. We’re happy to provide you with the tools to help you decide whether robotics will be right for your business.

In the Appendix, you will find a printable checklist that you can use to identify your company’s goals and the projected costs associated with robotics implementation.

Are you ready to take the first step toward automating your business with human-like robots? Contact us today at myrobots@resquared.com so that we can discuss your unique business needs.
Venturing into robotics may sound complex and intimidating, but it does not have to be. Using its nearly two decades of experience in the robotics industry, RE2 Robotics has created the following checklist as a framework to use when examining the potential costs that can arise when incorporating robotics into your operation. The basic checklist below can help you determine whether an investment in robotics makes sense for your business.

Please use the following three questions to help guide you in your decision-making. Once complete, please call us at 412.681.6382 or email us at myrobots@resquared.com so that we can set up a time to review your unique business needs.

Check all that apply.

**What goals or business objectives do you wish to achieve?**
- [ ] Reduce operating costs
- [ ] Improve workplace safety
- [ ] Improve productivity
- [ ] Improve quality
- [ ] Reduce downtime
- [ ] Perform complex work functions
- [ ] Disrupt the industry with innovation

**What size robotic system do you think is required?**
- [ ] Small (objects weighing <10 lbs. or 5 kg and must move 30 inches or less)
- [ ] Medium (objects weigh more than 30 lbs. or 15 kg and must move 50 inches or 1.3 m)
- [ ] Large (objects weigh more than 30 lbs. or 15 kg and must move 60 inches or 1.3 m)
- [ ] I don’t know

**What barriers have prevented you from adopting robotics in the past or what potential challenges do you anticipate?**
- [ ] Facilities upgrade, including construction of new facility or work area
- [ ] Electrical upgrades to support high-voltage system
- [ ] Networking upgrades
- [ ] Hardware and installation costs
- [ ] Data hosting
- [ ] Additional fixtures and fiducials to support part presentation
- [ ] Additional hires to operate and support the system
- [ ] Ongoing software support and maintenance costs
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