

Adopting a human-centric approach to robot design

ABB

WBCSD Future of Work case study

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Summary

Over the last years, labor market experts and media are increasingly portraying robots as a potential danger to people's employment, and job loss due to automation is one of workers' biggest concerns. ABB believes in a future where people and machines are both vital contributors to manufacturing, and in fact, that robots help protect and create new jobs and lead to safer and more interesting work for people. In large part this is driven by the increasing need for mass customization in everything from automobiles to personal electronics. This requires manufacturing flexibility, which can only be achieved from the collaboration between people and robots. People provide adaptability to constant change and problem-solving skills, while robots provide tireless endurance and accuracy for repetitive tasks.

ABB's dual arm robot named *YuMi* is the world's first truly collaborative robot, highlights the potential of true human-robot collaboration and adds a positive perspective and outlook to the debate.

Company background

ABB is a pioneering technology company in power grids, electrification products, industrial automation and robotics with over 130 years of history. Serving customers in utilities, industry and transport & infrastructure globally with two clear value propositions: bringing electricity from any power plant to any plug and automating industries from natural resources to finished products. ABB operates in more than 100 countries with about 147,000 employees.



Future of Work challenge

Highly intensive manufacturing jobs

Today, electronics manufacturing is characterized by short lead times, high production volumes, decreasing product lifecycles and increasing consumer demand for customized goods. In this context, the pressure on assembly line workers increases, adding further risks to the physical and mental health of workers in already repetitive, physically demanding and low-paid jobs. Ultimately, this means that the current manufacturing system is neither scalable nor sustainable.

Robot-driven job-displacement or job-creation?

Fears of robots replacing workers is a common public perception, often fueled by unsubstantiated predictions and provocatively alarming media coverage. However there is ample historical evidence that countries who invest in robotics and advanced automation tend to lose fewer jobs than those who do not, and that heavily automated industries not only add jobs faster but that they add better paying jobs. According to the International Federation of Robotics,¹ the countries with the highest robot density, notably Germany, Japan and South Korea, have among the world's lowest unemployment rates.

Skills gap

Thirdly, more and more companies report difficulties in filling jobs that require specific manufacturing skills, either due to skills shortage², or because certain jobs are not attractive to people. The latter includes jobs which are perceived as dull and repetitive, dirty, dangerous or in extreme or hazardous environments such as frozen food lockers, hot metal foundries or high on warehouse shelves.

In some of these cases, robot-assisted process automation is pointed to as a potential solution to fill labor gaps and ensure business continuity.³

Business case

ABB foresaw a need for more flexible small parts assembly applications to support the growing trend of mass customization in mobile phones especially, but also other electronics such as tablets, smart watches and personal fitness devices (among others).

Mass customization requires constant change that is unpredictable and sporadic. This is difficult to automate, and in the past could only be answered through manual small parts assembly.

ABB foresaw an opportunity to automate such small parts assembly by allowing people and robots to collaborate, and established an incubator in its Robotics business – basically an internal start-up. As a starting point, ABB recognized that the safe but productive collaboration of people and robots would require a new type of robot that could work ergonomically with human bodies and ensure complete safety even in the event of unintended contact.

The robot required extreme precision to work with the many small and delicate parts that go into modern electronics, from semiconductor chips to high-tech films. It was also important that the robot had the right accessories (such as parts feeding belts, vision systems etc.) so it could be a complete and standalone solution, not only a robot component. Lastly, as *YuMi* would target many first time robot users with no previous implementation experience, it was also critical that it was easy to install, program and use.

¹ International Federation of Robotics (2018)

² See for example PwC (2016)

³ Reuters (2018)

By taking over more mundane tasks, *YuMi* helps create more interesting cognitive challenges for its human collaborators, as well as reducing the risk of injury from repetitive delicate tasks and poor ergonomics. For example, *YuMi*'s ease of programming means that a factory worker, even without specialized training, could focus on programming and supervising *YuMi* as it tightens small screws rather than having to turn a screwdriver themselves for an entire eight hour shift.

In 2015 ABB successfully introduced *YuMi*, strengthening the market position of the company as leading innovator in the field of robotic automation and a pioneer in collaborative automation.

ABB's solution

What if the future of robotics and automation in fact depended on humans and robots working together, leveraging their respective strengths to create better quality products with fewer resources? What if robots were designed to create jobs and improve the working conditions of workers?

A human-centric approach to designing collaborative robots

In 2006, guided by the conviction that the future of manufacturing was in the automation of small parts assembly, and driven by the belief that a solution needed to be one of human-robot collaboration, ABB started developing the concept for what later came to be launched as *YuMi*. From the onset, ABB's target was to create the world's first robot that would truly allow for humans and robots to work side-by-side.

From the start, therefore, *YuMi* had safety as a primary design focus. This meant it needed good ergonomics for working close to people, and also an anatomical form factor that was welcoming and not intimidating. *YuMi* has soft padded arms and joints and can stop its motion in milliseconds to keep people safe even in the case of inadvertent contact. It also has no

'pinch points' for fingers or skin folds which is quite a feat considering the 14 axes of movement between its two arms.



Photo 1 *YuMi*'s soft padded arms and joints. Source: ABB

These safety features meant that *YuMi* could do most applications without the need of the safety barriers or fences that traditional industrial robots often require. Fixed safety fences are expensive to install, time-intensive to move, and restrict available floor space. *YuMi* on the other hand can be installed in desks and workstations originally designed for people with no special modifications, it allows open and flexible production flows, and it can also be relocated within a factory without disrupting production or adding costs.

Human-centric features of *YuMi*

Thirdly, the combination of constant and rapid changes in production needs and the high output levels under tight time constraints often result in pressure on assembly line workers. Some features of *YuMi* contribute to shift that pressure away from human workers – these include firstly its flexibility to perform different sets of tasks and the agility of *YuMi* in terms of being easily reprogrammed by its human operators to meet new production

requirements. Its innovative programming method results in very short time needed to adapt *YuMi*'s task at hand. In fact, *YuMi* can be taught to perform a specific task by physically guiding the robot through the motion, eliminating the need for complex and time-consuming coding, and reducing the need for extensive and special training of workers. Secondly the often-cited benefits of robots apply for *YuMi* as well:

- high precision work, resulting in higher quality products,
- reduced waste and inefficiencies,
- increased productivity



Photo 2 *YuMi* and human collaborating on small parts assembly. Source: ABB

ABB has already introduced a second member of the *YuMi* family, a single arm collaborative robot designed to complement *YuMi* and offer even greater manufacturing flexibility.

ABB also has a software solution called *SafeMove2* that allows people to safely co-exist with traditional industrial robots by limiting the robot's speed and position. Co-existence is a critical type of collaboration these days as mass customization requires frequent human intervention.

ABB's investment in developing a truly collaborative robot is in that sense a recognition of the fact that humans and robots both have their own strengths, and when working together, shoulder-to-shoulder, in a safe manner, the workplaces of the future will be more flexible, produce better quality products with fewer resources, provide a safer working

environment, improve employee quality of life, and make companies more competitive.

Results

YuMi has been well received in its intended electronics assembly market: a customer in the Netherlands for example is using *YuMi* to assemble USB memory sticks. The added flexibility to accommodate small or large batches of constantly changing shapes helps give them a competitive edge and makes manufacturing economically viable in a relatively high wage country compared to lower cost overseas competitors. This is helping them prosper and create even more jobs.

But *YuMi* is also used by ABB customers in applications from eyeglass and luxury pen assembly to packaging sweets and assembling designer kitchen fixtures: A small family business in Italy is using *YuMi* to manufacture high-end kitchen fixtures. *YuMi*'s ease of use makes it possible for workers without special training to operate collaborative applications that improve productivity and quality while also providing more interesting work and better workplace ergonomics.

Several ABB customers including major automotive and electronics companies have purchased a *YuMi* without a specific application in mind – they wanted to get one into their R&D labs to explore the possibilities of collaborative automation.

We expect *YuMi* to continue transforming the way humans work and what types of work are considered valuable: shifting from repetitive, physically demanding work, to tasks that require more thought and creativity and are more rewarding in terms of physical and mental health.

Challenges

One of the biggest barriers to entry, especially for small and medium enterprises (SMEs), is a lack of robot installation or programming

experience in-house. A good example is a small bakery that could benefit by having robots automate some of their more mundane or strenuous tasks. Bakers know how to bake bread but not how to program robots. Intuitive robots would allow the bakers to focus on doing what they do best while still taking advantage of robots' flexibility and scalability to grow.

It's also natural that employees have some fear of being replaced by robots or working besides machines that have traditionally been behind fences. ABB's experience is that once workers understand that *YuMi* is intended to be a co-worker who can augment their own abilities, help their company grow and keep them safe, the robot is quickly welcomed. Several ABB customers have reported that their employees independently came up with the idea of a contest to give their *YuMi* robots a name, a sure sign that the new robot co-worker has been accepted as part of the team.

Key success factors

The first key to success was developing and creating a market-oriented solution that filled a critical gap and allowed a new generation of small parts assembly applications to flourish.

An equally important factor was the recognition from ABB's team that - from the beginning - people would play a critical role in the future of automation. This was crucial to ensure the robot was designed with operator safety as a key design criterion.

Last but not least, a strong focus on simplicity allowed ABB to extend the benefits of robotics to many new users, especially SMEs.



(Click to watch) YuMi in an electronics factory. Source: ABB

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