

# Technology Trends: Working Life with ‘Smart Things’

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**Abstract** This chapter examines current information technology trends, including mobile, wearable and distributed computing, social networks, crowdsourcing, the Internet-of-Things, and social machines, and discuss their current and potential incremental and transformative influence on daily life and work using such technology. We outline several scenarios of working life, and raise questions and issues about the future of the working life.

**Keywords** Technology trends • Smart things • Ubiquitous work • Crowdsourcing

## Introduction

Much has been written about work in the future, the future of work or whether work has a future. End of work stories abound. Oxford University researchers noted that with the development in robotics technology, about 47 percent of U.S. jobs would be at risk, with higher probabilities of computerisation (and so, job losses) in the areas of services, sales and construction occupations.<sup>1</sup> This is a rather alarming figure (for humans) based on the current technological context, considering that robotics technology has yielded products though seems to still have a long way to go before reaching the capabilities in recent movies such as *I, Robot* (<http://www.imdb.com/title/tt0343818/>) and *Chappie* (<http://www.imdb.com/title/tt1823672/>).

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<sup>1</sup>Full report at [http://www.oxfordmartin.ox.ac.uk/downloads/academic/The\\_Future\\_of\\_Employment.pdf](http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf), September 2013.

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This raises questions for countries, such as China, with a much larger labour force and whose economy depends on many labour-intensive jobs. The impact could be larger, though the nature and type of work could shift. Jobs less threatened by machines are those requiring creativity and social skills, and so, creative work and human presence would still be highly valued. What would young people do then, when the jobs are replaced by machines? Perhaps as noted by Martin Ford, the author of the recent book *Rise of the Robots* (Ford 2015), young people in their twenties could get a guaranteed income as a minimal income (possibly by government) and then be encouraged to start businesses to earn on top of that, noting that entrepreneurship would then be encouraged.

As noted in the book *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* (Brynjolfsson and McAfee 2016), “in the next twenty-four years”, there could be a thousand-fold increase in computer power world-wide, and all humans could be connected via a common digital network, with unprecedented effects on the planet’s economics. This invites many questions: for example, what kind of new work or new jobs will such a digital network create? How will people use such a digital network in their work? And will the effects be transformative for all types of work or just some? And if for some, which types of jobs?

In Nagasaki, Japan the Henn-na Hotel is run completely by robots.<sup>2</sup> How far can this idea go? Could we have petrol stations, restaurants, tour groups, and shops completely run by robots? In China, the Internet boom will create 3.5 million employment opportunities by 2020.<sup>3</sup> Hence, while labour-intensive jobs could be replaced by robots in the future, affecting labour-intensive economies, a new digital economy could create new work for the many in the near future.

In the future of work report by PWC,<sup>4</sup> one of three possible scenarios of work in 2022 is the collaboration networks of small organizations—indeed, the power of social networks and similar technologies of the future can facilitate such a scenario. But it is also noted in the report that technology breakthroughs will be the dominant factor that will influence how people work in the future. The rise of Internet based jobs in the digital economy in China as noted above is perhaps evidence in support of this. Future technologies will further transform how we work and what we do, perhaps in some ways unanticipated, simply because some of the technological breakthroughs of the future might be unanticipated.

The notion of loosely collaborative networks of workers fuelled by emerging technology trends seems to be a direction of the future.

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<sup>2</sup><http://www.abc.net.au/news/2015-08-19/japanese-hotel-run-by-robots/6706822>.

<sup>3</sup>This is based on a Boston Consulting Group study, see [http://europe.chinadaily.com.cn/business/2015-08/13/content\\_21583905.htm](http://europe.chinadaily.com.cn/business/2015-08/13/content_21583905.htm).

<sup>4</sup><http://www.pwc.com/en/gx/managing-tomorrows-people/future-of-work/assets/pdf/future-of-work-report-v16-web.pdf>.

## Changing Trends at Work

There are at least three trends in work worth noting:

- Work will happen anytime anywhere in the future, or at least can happen and will do so if management permits it. The notion of hot-desking, working from home, and working remotely are notions of work that goes beyond the typical scenario of people sitting physically in the same office or building. With advances in virtual reality, high bandwidth communications, wearable devices with various sensors and interaction modes, robotic telepresence, and collaborative systems, the notion of being there, without being there, will become an increasing possibility. People in physical and virtual environments can be co-present, blurring the distinction between the physical presence and the virtual presence.
- Rapid learning on the job will become an increasing possibility. The extreme scenario of getting a job before getting qualifications for it seems absurd. However, many people do have jobs doing work that they learn skills for while on the job. The increasing number of online courses is only a beginning of a shift in learning, when on-demand or on-the-fly learning might be part of work. Having the desired background and related skills will help, but a question remains as to how far rapid learning technologies can go to helping people get equipped on-the-fly. Changes in career pathways accompanied by uptake of new skills will become easier, perhaps only to be slowed down by the need for experience.
- Customising work will be an interesting possibility in the future. A job that needs to be done by someone can be decomposed in a number of different ways. The same job can be done in many different ways and by varying numbers of people, depending on how it is configured. Future technology in coordinating work might accommodate greater flexibility in this matter.

## New Work

There are a number of technological trends that could impact work as we know it.

- **Crowdsourcing.** Crowdsourcing is a combination of outsourcing and the crowd, that is, getting work done by a crowd of people, typically via an online platform (Brabham 2013; Howe 2009; Ren et al. 2015), where humans are employed to do computational work that machines might find difficult to do, including translation, image recognition and others. Consider sorting a bunch of pictures of animals according to cuteness—this is not easy for a computer to do but can be done by humans. Another example is sorting a bunch of video clips

according to “funnybess”. The work on human sorts and joins involves humans in typical database operations (Marcus et al. 2011), and platforms such as Amazon Mechanical Turk<sup>5</sup> allow large jobs to be broken down into small pieces of work (aptly called *microtasks*) to be done by crowds of people. For example, to translate a book, break it up into 100 sections to be translated, each section to translate is packaged as a microtask. Some people, especially, in the developing world, have begun to make a living on such crowdsourcing work alone—they might perform a series of microtasks, each microtask is done in exchange for a small payment. But doing enough of such microtasks and being paid in a strong foreign currency could just be enough to make a living in their world.

With people having idle or spare resources (e.g., a car not so often used or an empty bedroom), and a platform to advertise such resources to the public, and for people to find such resources, new markets might be created (e.g., AirBnB<sup>6</sup> and Uber<sup>7</sup>) (Chase 2015). Indeed, this model can be extended to all sorts of resources, including excess or unused bandwidth, or idle CPUs, on the mobile or at home. People with idle resources can be pooled together to create new markets, enabled by Web and mobile technologies, and people with idle time can work to obtain resources or for monetary benefits. Can this way of marketing idle resources help someone make a living without a 9 am to 5 pm job? Mobile and wearable technologies are allowing such crowdsourcing anytime anywhere but also enabling the context of workers to be an advantage when performing certain work. Simply being at the right place at the right time could be enough qualification for a worker to do a crowdsourced task (e.g., to see if there are parking spots nearby). Indeed, maps of various location-dependent situations can be created, e.g., carpark maps, bandwidth maps, maps of quiet places in a city and so on, via such crowdsourcing and perhaps updated real-time. Such maps could be useful for people to optimise their life, e.g., find carpark spaces faster, find a quiet spot to work, and go to the currently highest bandwidth hotspot, and hence, possibly bring economic benefits to society as a whole.

Social networks will play an important role in crowdsourcing opportunities. An individual belongs to multiple social networks, and while time will tell how they will grow, given the relatively young large-scale social networks that exist today, crowdsourcing tasks and obtaining advice via social networks can become a game-changing approach to problem-solving (Zoref 2015).

Many questions arise as to where crowdsourcing could go. For example, how will this way of making a living scale to richer nations? And what will crowdsourcing enable that previous ways of working could not? Also, how can

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<sup>5</sup><https://www.mturk.com>.

<sup>6</sup><https://www.airbnb.com>.

<sup>7</sup><https://www.uber.com>.

we measure the economic value of crowdsourced maps of car parks, bandwidth, noise and pollution, and if such maps bring economic benefits to society as a whole, how will contributors be encouraged and compensated? Will the economic value of such maps be high enough to motivate government subsidies (e.g., tax deductions) or payments that will at least initiate the creation of such systems? What new models of markets and work will emerge with such crowd-based models? Can one work full-time sustainably as a contributor, information provider, and helper in his/her own social network (say if the social network has a large enough number of members)? Indeed, crowd work has a future (Kittur et al. 2013).

- **Social Machines, Human and Machine Synergies.** In recent workshops,<sup>8</sup> a paper introducing the notion of social machines (Buregio et al. 2013), and in *Reinventing Discovery: The New Era of Networked Science* (Nielsen 2011), the notion of systems that utilise human-machine synergy has been proposed. Information systems such as Wikipedia,<sup>9</sup> Galaxy Zoo,<sup>10</sup> and EyeWire<sup>11</sup> employ advanced machine processing but also human input in order to scale and to deal with problems current computer algorithms cannot do well in. Where such systems create information that can be reused over and over again, the effort of one person is multiplied many times, yielding a cornucopia of the commons (Loke 2015), as long as individuals are compensated and motivated (perhaps altruistically) to contribute such information. Even when individuals are self-interested, their own contributions contribute towards information bases that eventually benefit themselves as much as it benefits others. Questions arise as to how such systems will evolve and develop. For example, can one work sustainably as part of one or more of such systems, being a contributor to one or more such social machines, and make a living doing that? Also, how will human-robot synergies enable new ways of working and living?
- **Making Smart Things at Home.** Personal fabrication<sup>12</sup> and mass customization have been concepts that current modern technology has made possible. With 3D printers widely available at reasonable costs, and a huge range of printable materials, from plastic, fabric, conductive ink, to biological tissue, there is a large range of highly personalized and customized products that one can make today at home, compared to years ago. There are still relatively high costs of raw materials to be fed into such printers, but the potential for new ways of work this facilitates is greater than ever.

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<sup>8</sup>See UbiComp 2015 Workshop on Towards Wisdom Computing: Harmonious Collaboration between People and Machines at <http://www.irc.atr.jp/en/event/1452/> and social machines at <http://www.sociam.org>.

<sup>9</sup>Encyclopaedia done by the crowd, <https://www.wikipedia.org>.

<sup>10</sup>A system for understanding galaxies, <http://www.galaxyzoo.org>.

<sup>11</sup>A system to map out the neurons in the brain, <http://eyewire.org>.

<sup>12</sup>See <http://www.media.mit.edu/personalfab/> and <http://fablabadelaidelab.org.au/what-is-a-fab-lab/>.

There have been various cottage industries, from making cuckoo clocks to artistic wooden products, in settlements in rural Europe to villages in developing countries, but personal fabrication devices such as appropriate 3D printers can amplify creativity and enable new making that wasn't previously possible.

The Internet-of-Things<sup>13</sup> refers to an Internet consisting of things or everyday objects with computational and networking capabilities. Everyday objects, from sprinklers to umbrellas, can be Internet connected and have behaviours adapted to and enhanced with current information. The books *Smart Things: Ubiquitous Computing User Experience Design* (Kuniavsky 2010) and *Enchanted Objects: Design, Human Desire, and the Internet of Things* (Rose 2015) provide an extensive review of the range of products with not only Internet capabilities but also sensors and reasoning capabilities, yielding intelligent objects or smart things that can work together. Producing such smart things or enchanted objects at home will be an interesting scenario of work—a teenage kid could create a smart walking stick (endowed with sensors to capture surrounding information and to provide audio weather reports) for his/her visually-impaired grandfather, and perhaps for all the elderly in his/her village. A mother could design and print out a new digital fabric bracelet for her young daughter, that is not only decorative and comfortable to wear, but doubles as a communication device with basic Internet phone capabilities, using her nephew's electronic 3D component printer and her sister's 3D fabric printer. A range of 3D printers and objects created using 3D printing is gradually emerging in the market place.<sup>14</sup> What new enchanted objects and smart things will be fabricated in new cottage industries?

- **Helping Information Grow.** In the book *Why Information Grows* (Hidalgo 2015), MIT Researcher Hidalgo pointed out the idea that knowledge and know-how is somehow embodied in the social networks of humans. The information worker is one who creates new capabilities, partly by creating new networks of capabilities, “stored” in social networks. The complexity of producing complex products can be aided by appropriate networks of resources that can provide expertise and crowdsourced components. Will future workers contribute to information growth and economic opportunities via such networks? How far can such social networks empower the individual in creating and consuming new information? How can new social networks of capabilities be formed on demand and ad hoc for producing particular products? How does that affect the flow of expertise and the nature of work? What new jobs in the 22nd century will emerge for making information grow?

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<sup>13</sup>See <http://www.theinternetofthings.eu>, and <http://www.cisco.com/web/solutions/trends/iot/overview.html>.

<sup>14</sup>For example, see <http://www.cubify.com>.

## Conclusion

Predicting the future of work is difficult. It does not seem the end of work but perhaps the end of work as we know it; this chapter has only painted a small part of the possible future landscape of work. Despite various ways that work might be forecasted to end, there is new work that could emerge in the future.

A domestic worker could invent and create a new generation of cleaning and tidying-up tools (or robots) or start a business making smart crafts. We have already seen virtual reality glasses made from cardboard<sup>15</sup>; what new innovations within the constraints of an economy can be created by millions of equipped people in developing countries or villages? Future cheap 3D printers which can make use of raw materials available in the natural settings around and within households could empower them. Crowdsourcing and social machines can empower communities, young and old, locally or across international borders, to coordinate and share resources, and to invent tools and solutions, in order to solve local problems or improve efficiencies, in urban environments, but also in villages, from issues of safety as people walk through quiet places at night or walk through long distances of un-policed areas (e.g., to wells to get water), local health issues, to issues of food security and farming. It would not just be harnessing idle human creativity, but creating work by bridging the gap between collective human creativity and everyday life problems. What would happen if schools of bright students (across disciplines) and “unemployed” people in a rich nation are allowed to invent solutions to attack problems and issues in a less educated village in a poor nation? What if such solutions then become customisable packaged solutions forming a basis for a business? Could people with idle time in rich nations be synergised to form the engine of a crowd machine acting as “teachers” mediating education for a village in a poor nation or for poor people in a rich nation? How could technologies amplify the resources of the rich and educated minds so that poor nations and the uneducated will benefit? Could an appropriate knowledge-network platform be built so that villages can exchange knowledge they gained?

It can be argued that technology is neutral but making it work best for all of us is a key challenge for global understanding.

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<sup>15</sup><https://www.google.com/get/cardboard/>, see also 10 gadgets made from cardboard—<http://www.pcmag.com/article2/0,2817,2340487,00.asp>.

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