Should we automate?

Professor Duncan McFarlane

Alumni Festival



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Auto Pilot



Source: Wikimedia Commons







Retail checkout



Souce: Daily Telegraph, 14 10 13 examining the rise of the supermarket "robot"



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Lights Out Factory



Source: Wikimedia Commons





Lights Out Factory

Overview

What is Automation? Why do we Automate? Where do we Automate? Where will we Automate? Should we Automate?





What is Automation?





Oxford English Dictionary:

The use or introduction of automatic equipment in a manufacturing or other process or facility

Oxford English Dictionary, https://en.oxforddictionaries.com/definition/

Broader:

The part or full replacement of human based functions with machine, computer or other device





What Aspects of an Operation to Automate?



Some "Automation" Technologies – One page of Buzz Words only!!

- Sensing: bar code, RFID, vision systems, Augmented Reality/Virtual Reality, Internet of things – IoT
- Analysis: Cloud computing, Mobile phone, big data analytics
- Decision: Machine learning, optimisation, AI, decision support
- Actuation: Robots, Human Machine Interfaces, Drones, AGVs, storage / retrieval systems, 3D printing



A T Kearney, Shaping the future of Production, World Economic Forum, 2016



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Automation & Digitalisation?



IT and Automation are closely linked ... and getting closer!

Source: McFarlane & Thorne, 2017, IFM Report, Automation 2050





What is Automation?

- Not just about robots
- Not just about doing but also about sensing and thinking / deciding
- Automation and Computerisation/Digitalisation are increasingly intertwined





Why do We Automate?





Why Automate?

Backdrop

- Competing against low cost countries
- Increased wage expectation
- Reduced funds available
- Desire for greater profits
- Tasks unsafe / unhealthy
- Impossible any other way







Why Automate?

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- labour productivity
- speed
- efficiency
- reliability / repeatability

- Health & safety
- infeasible







Example: Auto Pilot



Source: Wikimedia Commons



Source: Wikimedia Commons







Example: Auto Pilot

What?

- Sensing: position, angle
- Decision: control adjustments
- Action: aileron, thrust



Source: Wikimedia Commons





Source: Wikimedia Commons

Why?

- accuracy
- reliability / repeatability
- safety?





Example: Retail checkout







Example: Retail checkout

What?

- Sensing: Product bar code
- Analyse: locate price
- Decision: Sell?
- Action: Permit sale or set alert



NB: This is not just automation, it is a <u>shifting</u> of manual effort from retailer to the customer



Why?

- labour reduction
- accuracy
- speed



Example: Underground ticket inspection



Source: Wikimedia Commons









Example: Underground ticket inspection

What?

- Sensing: ticket read
- Decision: pass/fail
- Action: open door



Source: Wikimedia Commons



Why?

- efficiency
- labour reduction
- reliability / repeatability







Example: Nuclear reactor





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Source: Wikimedia Commons

Example: Nuclear reactor

What?

- Sensing: state of fuel rods, equipment
- Decision: shut down, repair decisions
- Action: replace





Source: Wikimedia Commons

Why?

- accuracy
- reliability
- repeatability
- safety



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Example: Food Packaging









Example: Food Packaging

What?

- Sensing: bottle present
- Decision: correct position
- Action: apply lid

Why?

- labour reduction
- Speed
- Quality
- Health and safety





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Example: Exam Marking



Workbooks to compare: Correct Version: Addocuments and settings\tahill Student Folder: c:\documents and settings\tahill	(desktop)(Illiana correct.×Is
(All student tiles in Grade scale: 100 Percent deducted per error type: 25 % Labels and Numbers 35 % Formulas 30 % Formatting (Fonts/Borders/Colors) 10 % Charts	USE of the same tolder)







Example: Exam Marking

What?

- Sensing: Student response
- Decision: correctness?
- Action: Award marks





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downloadable automated marking system

Why?

- labour reduction
- accuracy
- Speed
- fairness



And there are downsides from Automation too

- Job losses and knock on effects
- Capital cost
- Increased complexity
- Lack of flexiblity
- Lost learning opportunity, lost skills
- Missed faults and errors
- Health impact

Why Automate?

• Often to make tasks more *productive:*

Output

[Labour] Productivity = -----

No of workers

• Sometimes for better outcomes

• Sometimes for human convenience





Where Do We Automate?





Almost Everywhere ...

- Industry
- Military
- Transport
- Government
- Education
- Health
- Home
- Agriculture
- Cities



Booking.com

lew booking

LIVING ROOM

20.0°

18.0°



Thanks Duncan! Your booking in Singapore is confirmed.

Save confirmation to phone

- Ambassador Transit Hotel Terminal 3 is expecting you on 17 February
- You'll pay the property directly. Ambassador Transit Hotel Terminal 3 handles all payments, so please check below for more information
- You can cancel for FREE until 15 February 2017 23:59. <u>Make changes to</u> your booking or ask the property a question in just a few clicks











Levels of Automation Adoption in Different Sectors Today

	Discrete Industry	Military	Transport	Government	Environment	Healthcare	Educa1on	Food and Resources	Ci1es
SENSE	M-H	м	M	L	L	Μ	L-M	М	Μ
ANALYSE	L-M	М	L	L-M	Μ	Μ	L	L	М
DECIDE	М	L-M	M-H	L	L	L	L	L	L
ACTUATE	н	Н	н	L	L	L	Μ	М	L





Integrated Sensor Deployments

Registered Vehicles with IoT Application by Region

World Market, Forecast: 2013 - 2030







Smart Developments on your Phone

Number of available apps in the Apple App Store from



Robots In and Beyond the Factory

and

Leisure





Evolution of levels of Automation







Automation Trends in Short Term

- Out of the factory
- Big focus now on sensing & analysis
- Next: decisions

Where Will We Automate?





The World in 2050?



Source: The Jetsons, 1967









Challenges in 2050 by Sector



Source: McFarlane & Thorne, 2017, IFM Report, Automation 2050





Automation Meeting the Challenges?





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Yours, Cambridge

City Automation 2050?







Health Automation 2050?





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Evolution of levels of Automation







Where Automation is the only Option?

INCREASINGLY DIFFICULT TO PERFORM MANUALLY IN 2017	LIKELY TO BE DIFFICULT TO PERFORM MANUALLY BY 2050
Coastal Surveillance	Support aged population
Material Recovery from Waste	Flood, earthquake recovery
Disassemble and repair domestic	Secure energy, water supplies
appliances	Police Cities
Care for Refugees	
100% Check of origins of food	
Cleaning of oceans	
Counter measures for guerrilla warfare	
Clean / treat atmosphere	

Source: McFarlane & Thorne, 2017, IFM Report, Automation 2050

Automation Trends in Long Term

- In all aspects of life
- Critical to survival
- Needing some regulation?

Should We Automate?





Balancing Benefits and Downsides

- Labour productivity
- speed
- efficiency
- reliability / repeatability

- Job losses and knock on effects
- Capital cost
- Loss of skills etc







Quick reminder...

<u>Tasks</u> get automated not jobs

No of people on Tasks can be reduced / eliminated without automation (efficiencies, outsourcing)





Automation and Jobs



McKinsey, (2016) Where Machines Could Replace Humans And Where They Cant Yet http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/where-machines-could-replacehumans-and-where-they-cant-yet



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Automation and Jobs



Source: Frey, Osborn, The Future of Employment – How susceptible are jobs to computerisation, 2013

Automation and Types of Tasks





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Automation and Jobs/Skills

From brawn to brains The impact of technology on jobs in the UK

This new work paints a positive picture: while technology has potentially contributed to the loss of approximately 800,000 lower-skilled jobs, there is equally strong evidence to suggest that it has helped to **create nearly 3.5 million new higher-skilled ones** in their place.

Deloitte, From Brawn to Brains : The impact of technology on jobs in the UK, 2016





Automation and People

Skills

- Many roles reduced to exception handling
- Simplification of skills needed
- Computer readiness skills not yet well understood

Health

- Much of automation reduces human exertion
- Fitness opportunity losses in
 - Transport
 - Workplace
 - Home
 - Leisure





Automation Priorities?

Survey of European attitudes to use of robots	In which areas do you think that robots should be used as a priority?	In which areas do you think that use of robots should be banned?
Space exploration	\$2%	1%
Manufacturing	50%	4%
Search and rescue	41%	3%
Military and security	41%	Z%
Domestic use, such as cleaning	13%	8%
Agriculture	11%	6%
Transport logistics	11%	6%
Healthcare	225%	27%
Leisure	3%	20%
Education	3%	34%
Care of children, elderly and the disabled	4%	60%







Automation Priorities?

High?

- *Like for better* task replacement
- Scale too great for manual solution
- Tasks that enhance (human) life
- Tasks that humans can't/wont do

Low?

- Like for like or like for worse task replacement
- Convenience automation
- Health reducing automation
- Approaches not covering the *full cost* of automation





Ways to Influence Priorities?

Why robots should be taxed if they take people's jobs Robert Shiller

Bill Gates says governments could use a robot tax to fund human services - it would also help remedy income inequality



Source: Guardian, 2017

Ways to Influence Priorities?

- ... Tax breaks to high priority areas only
- R & D support only where societal impact
- Holistic cost benefits
 - Cost of redundancy, retraining, unemployment
 - Benefit to society not just immediate user from new developments
- "Clinical" trials





Should we Automate?

- We <u>are</u> automating in many ways and forms
- Be suspicious of IT / automation developments justified on job creation
- There are some choices
 - Whether to regulate
 - Whether to prioritise
- Positive encouragement for priority areas for society





The tip of the iceberg?





