

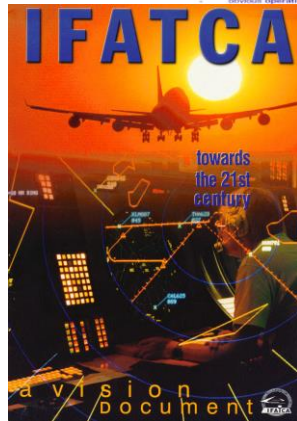


The human machine hybrid approach
Digitalisation in ATM –
Joint Human Machine System The only way forward?

Marc Baumgartner

SESAR / EASA coordinator IFATCA
ATCO / Centre Supervisor Geneva ACC





1997-98



2017/18



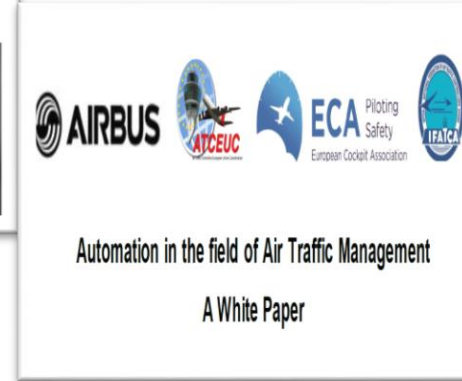
2003



2007



2008



2015



2015



31.1.2018

The operator in the future system



10.10.2018

Possibilities and limitations of new technology



1.2.2019

Digitalisation in ATM – Joint Human Machine System
The only way forward?

IFATCA

INTERNATIONAL FEDERATION OF AIR TRAFFIC CONTROLLERS' ASSOCIATIONS

WWW.IFATCA.ORG



PASS YOUR MESSAGE #2

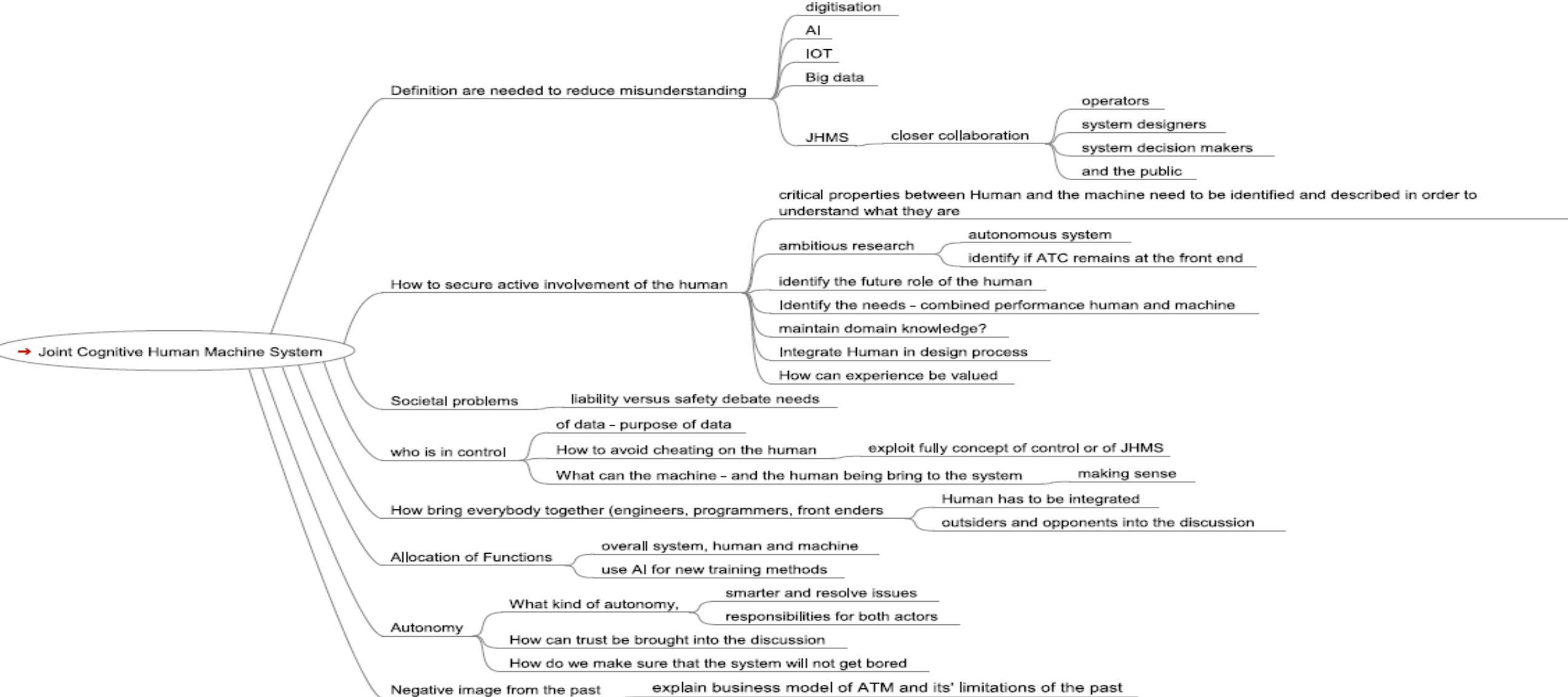
Second IFATCA workshop on Digitalisation in ATM
February 2019, Geneva

DigitATMisation Newsletter

IFATCA is the recognised international organisation representing air traffic controller associations. It is a non-political, not-for-profit, professional body that has been representing air traffic controllers for more than 50 years, and has more than 50,000 members in over 120 countries.

<https://www.ifatca.org/digitalisation-in-air-traffic-management/>





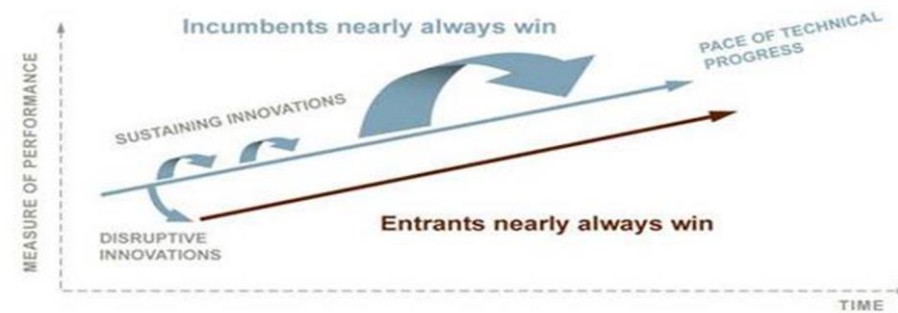
“The modernisation of the ATM system is and will be the cornerstone of the implementation of the SES initiative in the future.”



TECHNOLOGY

DIGITATMISATION

IS A RADICAL REFORM OF THE TECHNOLOGICAL PILLAR NEEDED?
OR IS IT TOO LATE?

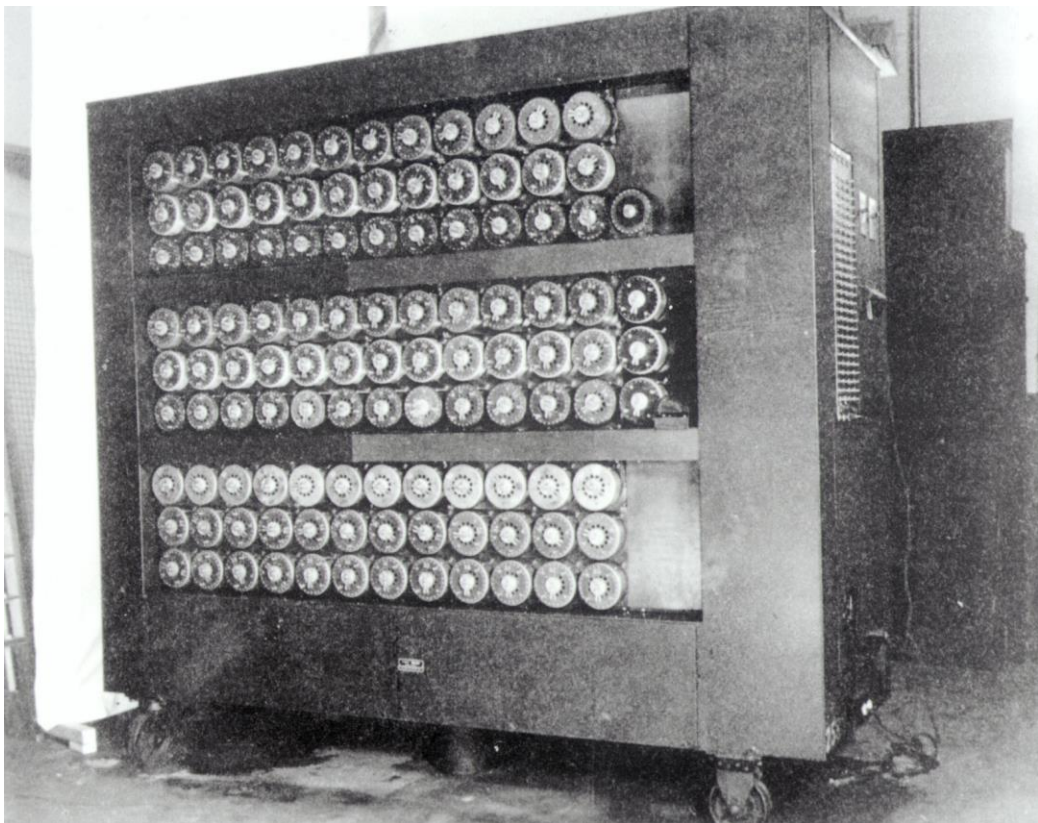


OPERATIONAL CONCEPTS Seminar
ABBAYE du VAUX de CERNAY

TEN COMMANDMENTS
for
Air Traffic Control Automation

- 1) The controller is responsible for the safe, orderly and efficient flow of air traffic. She has final authority with adequate information and means to exercise this authority.
- 2) The full authority, when required, is obtained with simple intuitive actions, while aiming at eliminating the risks of adverse effect.
- 3) The design accommodates for a wide range of controller skill levels and experience.
- 4) The design is dictated by safety and efficiency in that order of priority.
- 5) The design aims at simplifying the controllers' tasks, by enhancing situational and system status awareness.
- 6) The automation is considered as a complement available to the controller, who can decide when to delegate and what level of assistance is desirable, according to the situation.
- 7) The human machine interfaces are designed considering system features, together with controller's strengths and weaknesses.
- 8) State of the art human factors considerations are applied in the system design process to manage the potential human errors.
- 9) The overall design favours collaborative communication.
- 10) The use of new technologies and implementation of new functionalities are dictated by
 - significant safety benefits
 - obvious operational advantages*
 - a clear response to the controller's needs

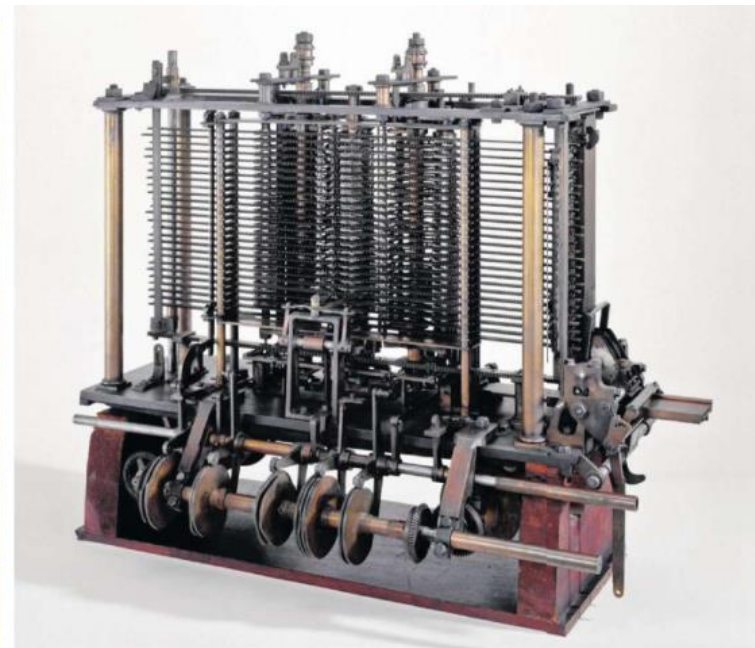
100



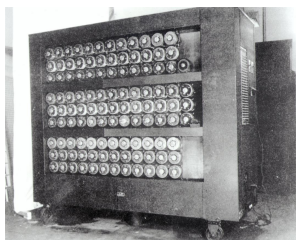
Turing machine



National museum of American History



the board of trustees of the science museum, NZZ 21.12.2018



AI/ML is not new



Automation is not new



Blockage?
Barrier?



Always different than imagined



"Tame" complexity (cybernetics)



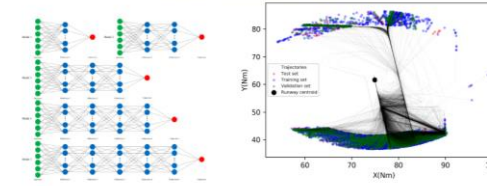
ATCO vs Change

Regulator vs platforms

Incumbent vs disruptor

Data-driven automated prediction on aircraft estimated

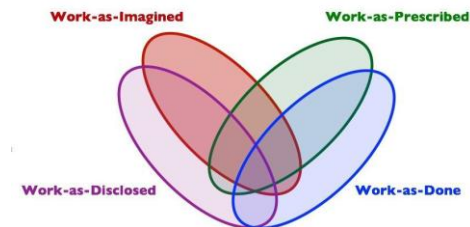
time of arrival (ETA)



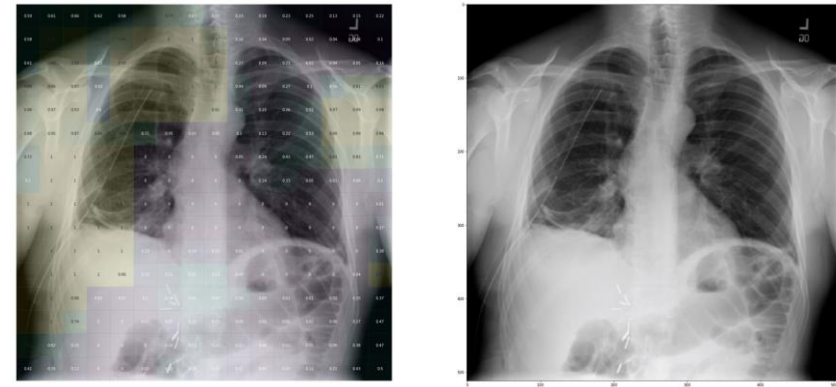
$$y = W_k \sigma_k (W_{k-1} \sigma_{k-1} (W_{k-2} \sigma_{k-2} (\dots W_1 \sigma_1 (W_0 X + b_0))) \dots) + b_k$$

Today ATM process « innovations »

- US NAS in Jovial still in operation , ERAM ?
- MADAP in IBM assembleur still in operation, ITEC ?
- UK FDP in Jovial still in operation, ITEC?
- CAUTRA IV in LTR, COFLIGHT?
- SATCA in ADA, ITEC?
- VAFORIT?

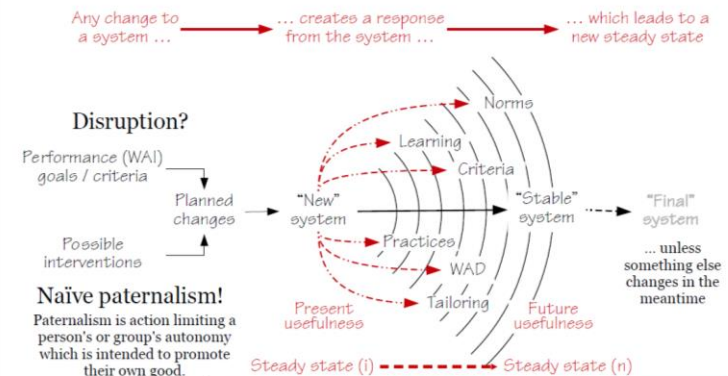


other sectors



System change is disruptive

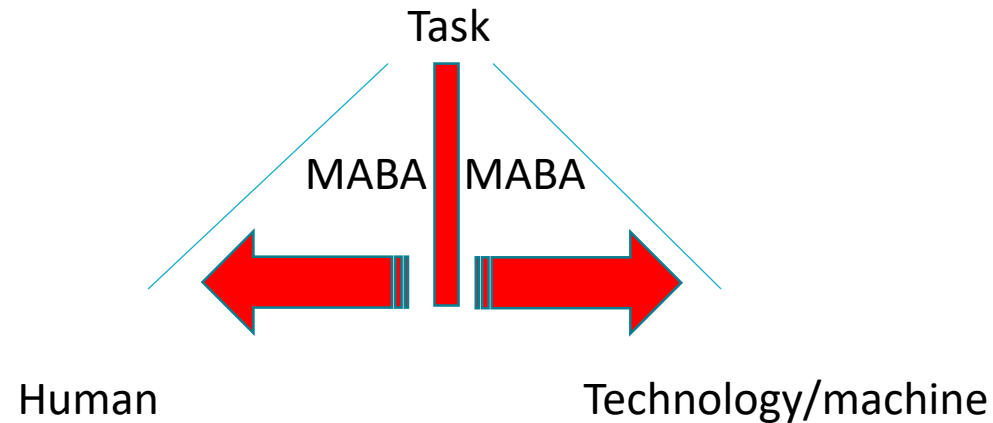
Safe
syn
thesis



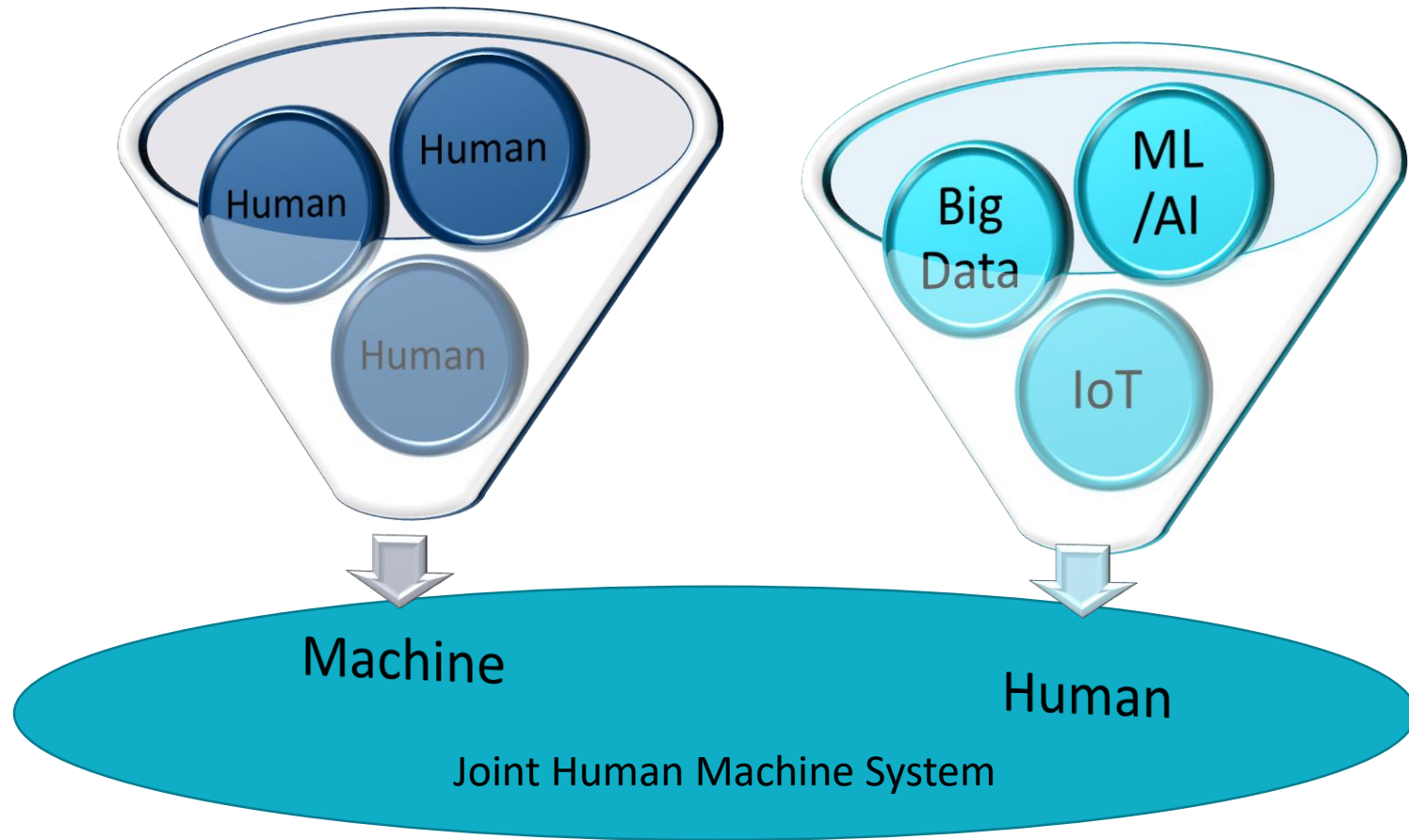
© Erik Hollnagel, 2019

Traditional Approach to implementing new technology

Men-Are-Better-At/Machines-Are-Better-At



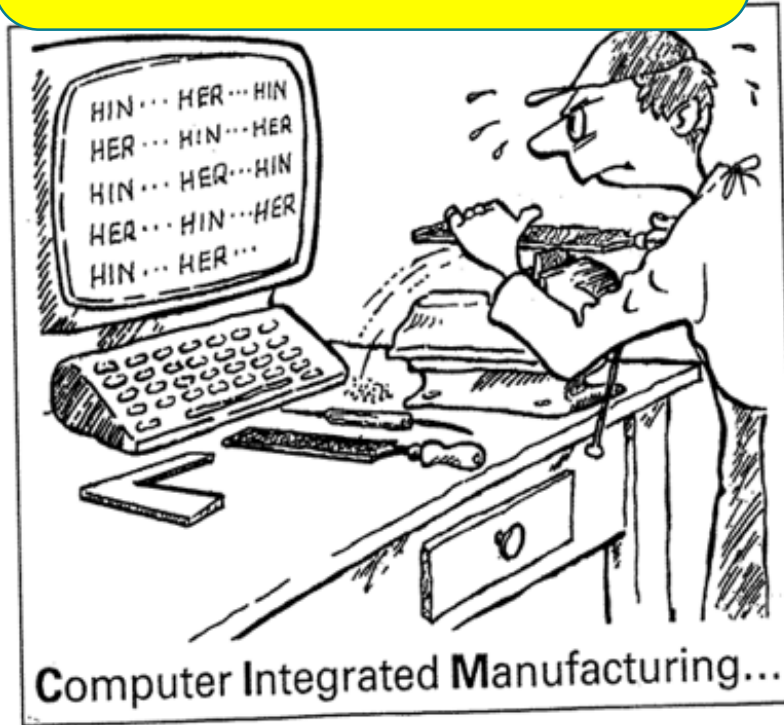
Fitts, P.M. (ed) (1951). Human engineering for an effective air-navigation and traffic-control system. National Research Council, Washington, D.C.



Joint: Human and Machine

Human vs. Machine

Human manages Machine
Or vice versa



Human and Machine

Complementarity of
Human and Machine

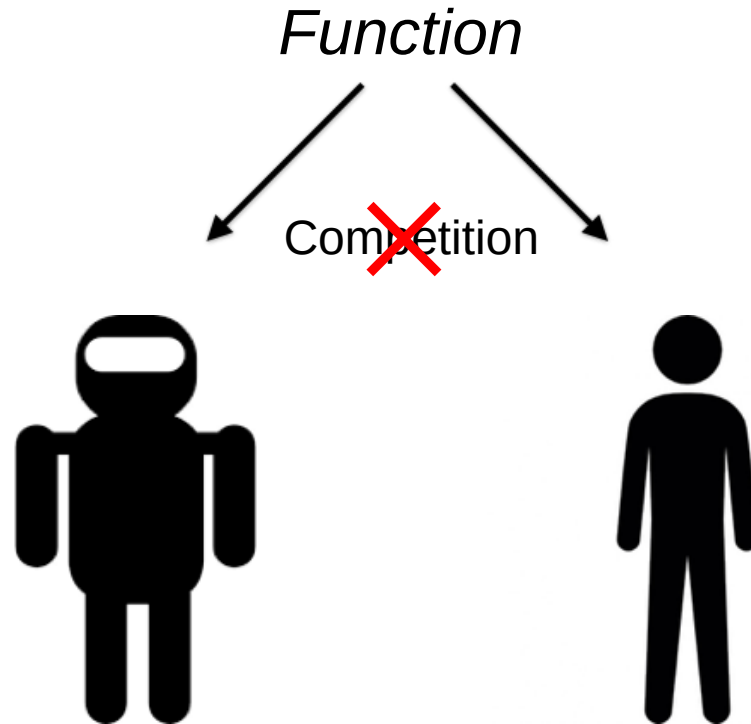


Hyundai

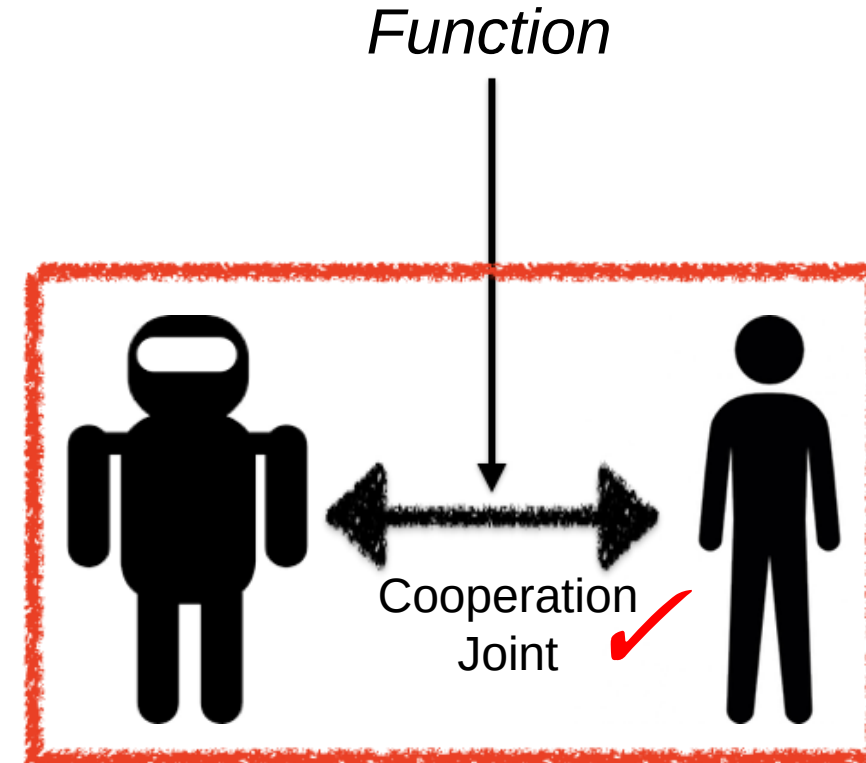
Function Allocation

(Wäfler et al., 2003)

Human vs. Machine
Human manages Machine
Or vice versa



Human and Machine
Complementarity of
Human and Machine



Joint Cognitive System

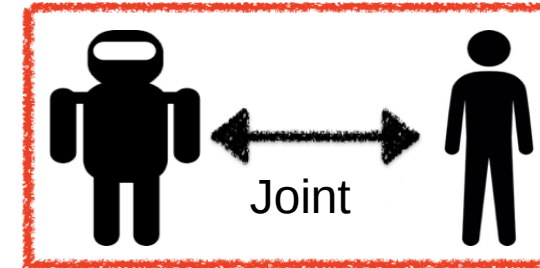
(Hollnagel & Woods, 2005)

- Goal oriented
- Adaptive
- Views problems in more than one way
- Uses knowledge about itself and the environment
- Maintains control of a dynamic process

**Human is not a user of the system
Human is an active part of JCS**

«Human does not interact with the interface, human interacts through the interface with the process.»

Joint Teaming



OECD
Everyday math

11% of adults
better than AI

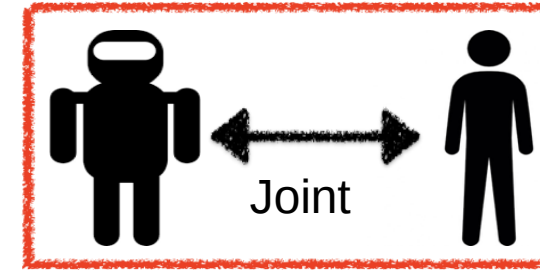
Japan: 37%
Sweden: 36%

(Elliott, 2017)

- Machines show amazing capability
- Still humans and machines are complementary
- Machine
 - Has deep “knowledge”
 - Calculates: May give good answers
- Human
 - Has cross-linked knowledge
 - Thinks: May ask good questions

(Brynjolfsson & McAfee, 2017; Floridi, 2015)

The Human Contribution



- Verification of technical decisions
- Improving technical system
- Learning from technical system

- Manage uncertainty

- Take responsibility
- Show commitment and dedication

- ...
- Empathy, creativity, improvisation

Preconditions

Clear human role in the system

Respective system design

- Avoiding deskilling
- Allowing continuous development of expertise (80% tacit)

- Job design required
- Ergonomics, UI/UX not enough

- Participatory approach a must

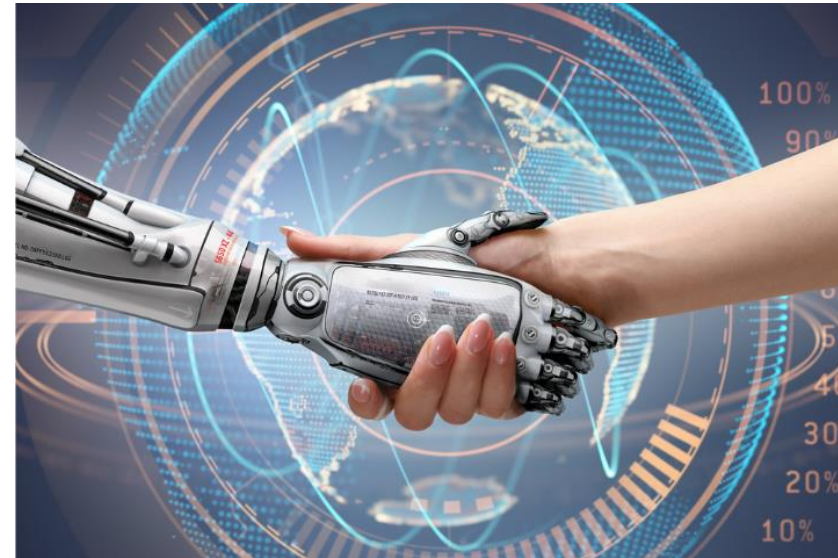
(Brynjolfsson & McAfee, 2017; Faust, 2007; Floridi, 2015, Manzey, 2012; Samek et al., 2017; Shively et al., 2017, Wäfler et al., 2003)

The Joint Human Machine System goal

Closer collaboration between operators, system designers, system decision makers and the public

Human and machine complement each other to achieve system goals

A humanistic design that allows humans to recover from the rare high-risk scenarios



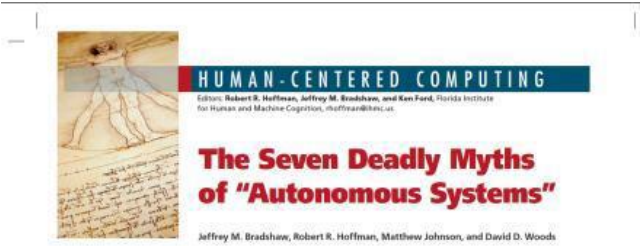
Automation should not be Human versus machine, automation should be seen as human-machine coordination as a team.

HALA, 2010



What is needed?

- Future technical improvements need to focus on systems rather than components and on tasks rather than structures to be able to cope with complexity and deliver the expected benefits
- A participatory design or co-operative design, that actively involve all stakeholders (e.g. employees, partners, customers, citizens, end users) in the design process to help ensure the result meets their needs



In this article, we explore some widespread misconceptions surrounding the topic of "autonomous systems." The immediate catalyst for this article, like a previous article that appeared in this department,¹ is a recent US Defense Science Board (DSB) Task Force Report on "The Role of Autonomy in DoD Systems." This report affords an opportunity to examine the concept of autonomous systems in light of the new DSB findings. This theme will continue in a future column, in which we'll outline a constructive approach to design autonomous capabilities based on a human-centered computing perspective. But to set the stage, in this essay we bust some "myths" of autonomy.

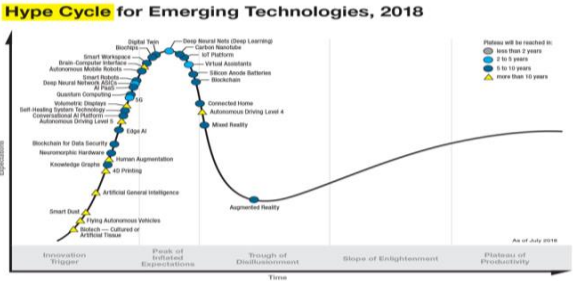
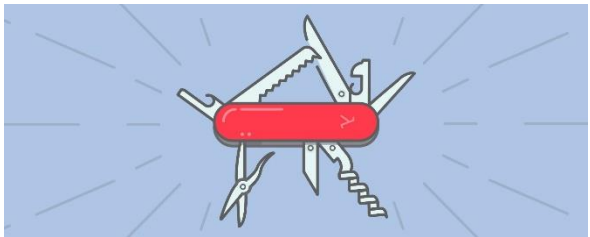
Myths of Autonomy

The reference in our title to the "seven deadly myths" of autonomous systems alludes to the seven deadly sins. The latter were so named not only because of their intrinsic seriousness but also because the commission of one of them would engender further acts of wrongdoing. As designers conceive and implement what are commonly (but mistakenly) called autonomous systems, they

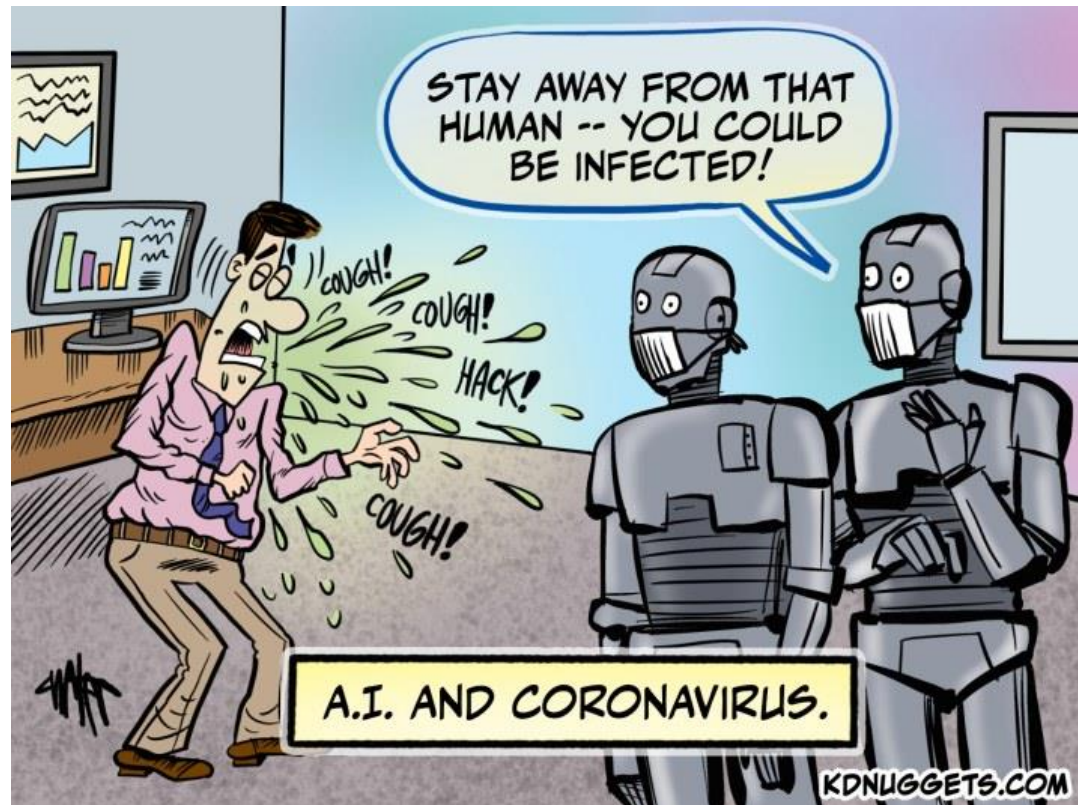
an entity to take care of itself. This sense is present in the French term *autonome* when, for example, it's applied to an individual who is capable of independent living. The second sense refers to the quality of self-directedness, or freedom from outside control, as we might say of a political district that has been identified as an "autonomous region."

The two different senses affect the way autonomy is conceptualized, and influence tacit claims about what "autonomous" machines can do. For example, in a chapter from a classic volume on agent autonomy, Svatoslav Bratner and Henry Hexmoor² emphasize how varying degrees of autonomy serve as a relative measure of self-directedness—that is, independence of an agent from its physical environment or social group. On the other hand, in the same volume Michael Luck and his colleagues,³ unsatisfied with defining autonomy in such relative terms, argue that the self-generation of goals should be the defining characteristic of autonomy. Such a perspective characterizes the machine in absolute terms that reflect the belief of those researchers in autonomy as self-sufficiency.

It should be evident that independence from







Thank you
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