Skilling or deskilling when working with collaborative robots?

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- Published 1983
- More than 2800 citations

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Brief Paper

Ironies of Automation*

LISANNE BAINBRIDGE†

Key Words—Control engineering computer applications; man–machine systems; on-line operation; process control; system failure and recovery.

Abstract—This paper discusses the ways in which automation of industrial processes may expand rather than eliminate problems with the human operator. Some comments will be made on methods of alleviating these problems within the 'classic' approach of leaving the operator with responsibility for abnormal conditions, and on the potential for continued use of the human operator for on-line decision-making within human–computer collaboration.

Irony: combination of circumstances, the result of which is the direct opposite of what might be expected.
Paradox: seemingly absurd though perhaps really well-founded statement.

THE classic aim of automation is to replace human manual control, planning and problem solving by automatic devices and computers. However, as Bibby and colleagues (1975) point out: "even highly automated systems, such as electric power networks, need human beings for supervision, adjustment, maintenance, expansion and improvement. Therefore one can draw the paradoxical conclusion that automated systems still are man–machine systems, for which both technical and human factors are important." This paper suggests that the increased interest in human factors among engineers reflects the irony that the more advanced a control system is, so the more crucial may be the contribution of the human operator.

designer errors can be a major source of operating problems. Unfortunately people who have collected data on this are reluctant to publish them, as the actual figures are difficult to interpret. (Some types of error may be reported more readily than others, and there may be disagreement about their origin.) The second irony is that the designer who tries to eliminate the operator still leaves the operator to do the tasks which the designer cannot think how to automate. It is this approach which causes the problems to be discussed here, as it means that the operator can be left with an arbitrary collection of tasks, and little thought may have been given to providing support for them.

1.1. *Tasks after automation.* There are two general categories of task left for an operator in an automated system. He may be expected to monitor that the automatic system is operating correctly, and if it is not he may be expected to call a more experienced operator or to take-over himself. We will discuss the ironies of manual take-over first, as the points made also have implications for monitoring. To take over and stabilize the process requires manual control skills, to diagnose the fault as a basis for shut down or recovery requires cognitive skills.

1.1.1. *Manual control skills.* Several studies (Edwards and Lees, 1974) have shown the difference between inexperienced and experienced process operators making a step change. The experienced operator makes the minimum number of actions,

The ironies

A shift from manual execution to automation:

- Workers are left with two main tasks:
  - Monitoring
  - Problem solving
- Most industrial processes are complex and require extensive operator experience
  - Monitoring does not contribute to experience as much as manual execution

The ironies

A shift from manual execution to automation:

- Work
  - Mon
  - Prob
- Most
  extens
  - Monitori al execution

Irony: We are left with long-term inexperienced workers asked to assess and address increasingly complex problems in automated processes

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Ironies of Automation 4.0

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Abstract: This paper revisits a truly classic publication: Bainbridge's *Ironies of Au*
it also aims to make the point that the insights gained many years ago are
important than ever. As we all know, it is due to technological advances that a
increasingly complex systems which considerably raises the impact of the poter
insights originated from manufacturing processes, but they equally apply to
and to vehicle control, e.g., airplanes, road vehicles or trains. This pap
observations can be reported and suggests a human-centered approach to ove

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Keywords: Cognitive Aspects of Automation, Human-Centered Systems

1. INTRODUCTION

We are largely designing automation systems aiming at full automation: Experiences with increasing degrees of automation have been described for many areas of application and the key insights have always been the same. They were first described by the very observant Lisanne Bainbridge as the "Ironies of Automation" (1983) in the context of process and vehicle control.

2.

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ARTICLE

Ironies of artificial intelligence

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ABSTRACT

Bainbridge's *Ironies of Automation* was a prescient description of automation related challenges for human performance that have characterised much of the 40 years since its publication. Today a new wave of automation based on artificial intelligence (AI) is being introduced across a wide variety of domains and applications. Not only are Bainbridge's original warnings still pertinent for AI, but AI's very nature and focus on cognitive tasks has introduced many new challenges for people who interact with it. Five ironies of AI are presented including difficulties with understanding AI and forming adaptations, opaqueness in AI limitations and biases that can drive human decision biases, and difficulties in understanding the AI reliability, despite the fact that AI remains insufficiently intelligent for many of its intended applications. Future directions are provided to create more human-centered AI applications that can address these challenges.

Practitioner summary:

Artificial intelligence (AI) creates many new challenges for human interaction. Five ironies of AI are discussed that limit its ultimate success, and future directions are provided to create more human-centered AI applications that can address these challenges.

ARTICLE HISTORY
Received 14 April 2023
Accepted 21 July 2023

KEYWORDS
Automation; artificial intelligence; human-centered AI; situation awareness; bias; transparency

Introduction

Lisanne Bainbridge's 1983 paper, the *Ironies of Automation* (Bainbridge 1983), was a telling and prescient summary of the many challenges that arise from automation. She pointed out the ways in which automation, paradoxically, make the human's job more crucial and more difficult, rather than easier and less essential as so many engineers believe. Not only does automation introduce new design errors into the control of systems, but it creates very different jobs that have many new problems, with the result that people may be less able to perform when needed. They need to be more skilled to understand and [illegible] automation, while simultaneously [illegible] leads to skill atrophy [illegible]

needed for manual performance and decision-making have been reported in aviation (Jacobson 2010; National Transportation Safety Board 2010; Wiener and Curry 1980), information automation (Volz et al. 2016), and vehicle automation (Nordhoff et al. 2023), among others. Inadequate training on automation has been found to be a critical problem associated with many aviation automation accidents (Funk et al. 1999; attention to automation training has [illegible] ticularly [illegible] ing (Strauch 2017). Increa[illegible]

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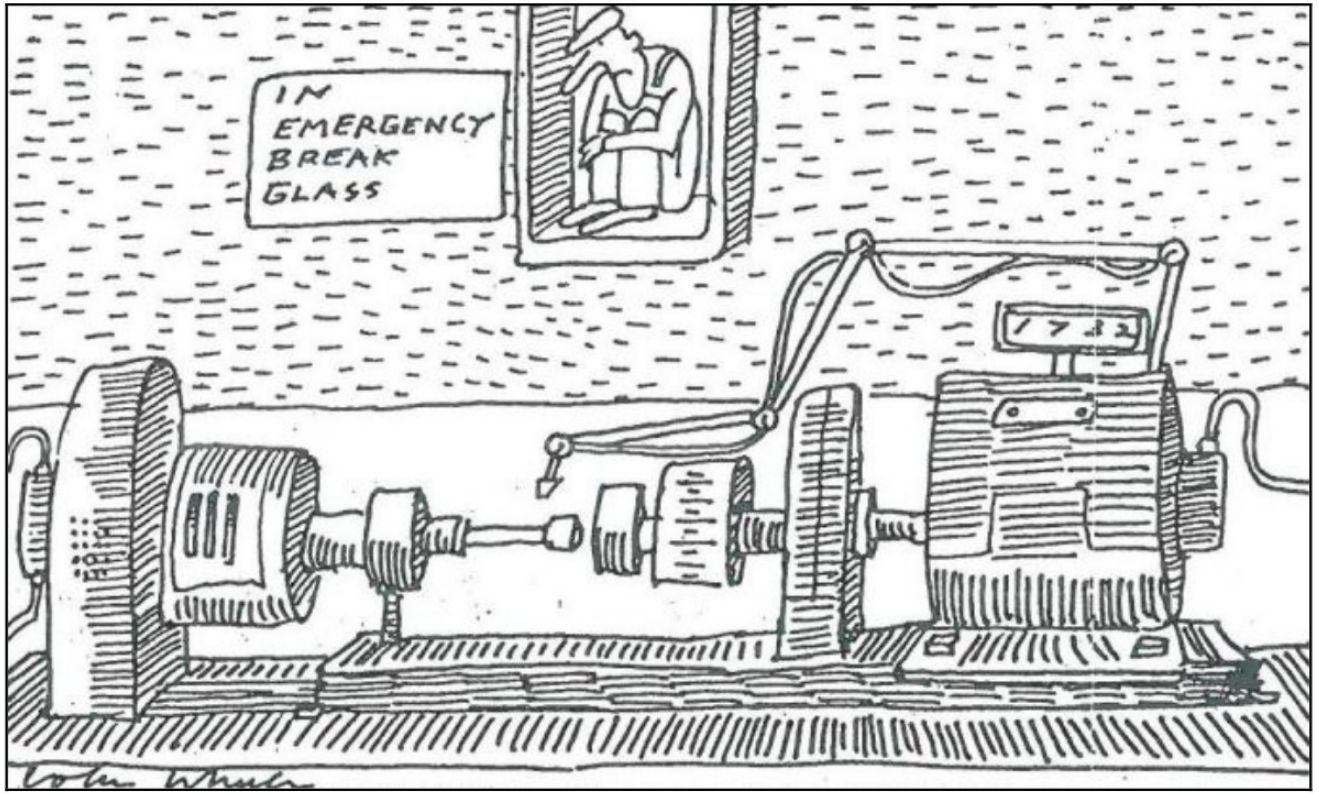
Operation in different phases:

- Learning
- Operation
- Disruptive

Li et al. (2022)



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LÄGET I SVENSKA SKOLAN

Forskare dömer ut svenska skolan: Eleverna blir ”funktionella analfabeter”

Stora delar av undervisningen i svenska skolan bygger på undermåliga lärotrender som i många fall är skadliga. Det säger tre forskare inom kognitionsvetenskap enligt tidningen Vi Lärare.

– Den bygger på myter om hjärnan och är pseudovetenskaplig, ibland även vetenskapsfientlig, säger Agneta Gulz, professor vid Lunds och Linköpings universitet.

Digitalisering, individualisering och minskat fokus på läs- och skrivundervisning i lärarutbildningen är tre av trenderna som döms ut. Till skillnad från tidigare två-tre procent som gick ut skolan med lässvårigheter lämnar i dag 20 procent av eleverna grundskolan som ”funktionella analfabeter”, menar Agneta Gulz.

Menar också att lyssning inte kan ersätta läsning

www.vilarare.se

Av Johanna Hansson

Publicerad 16 november, 22:18

Dela

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Spara artikel

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Relaterade ämnen

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What happens when we collaborate?

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OKAVIM

Operator competence in automated and virtual environments

Assoc. Prof. Erik Billing
Patrick Oden
Maurice Lamb
Peter Thorvald

afa

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“When we can’t use robots, we must make humans into robots”

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What happens to the workers?

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What does the literature say?

Increased support is good!

- VR and AR allows for situated learning
- Improved performance here and now
- Reduced mistakes
- Faster on-boarding
- Better compliance with standards

Learning requires retrieval!

- Retrieval practice improves learning and retention
- More support can lead to less memory retrieval, and has been linked to reduced retention
- Increased support may have negative effects on problem solving
- Increased dependency on instructions

Karpicke and Roediger (2008), Wiklund-Hörnqvist et al. (2021), Stillesjö et al. (2022).

Testing effect Karpicke, J. D. & Roediger, H. L., Science (2008)

- 40 undergraduate students were engaged in word pair learning (Swahili-English)
- Rehearsing was conducted in four conditions:
  - ST: Repeat all 40 words independently of performance
  - S_NT: Drop learned words during study, but repeat all words during test
  - ST_N: Repeat all words during study, but drop learned words from test
  - S_NT_N: Remove learned words from both study and test sessions

Testing effect (Karpicke, J. D. & Roediger, H. L., Science (2

- 40 un ged in word pair learnin
- Rehearsing wa nducted in four conditions:
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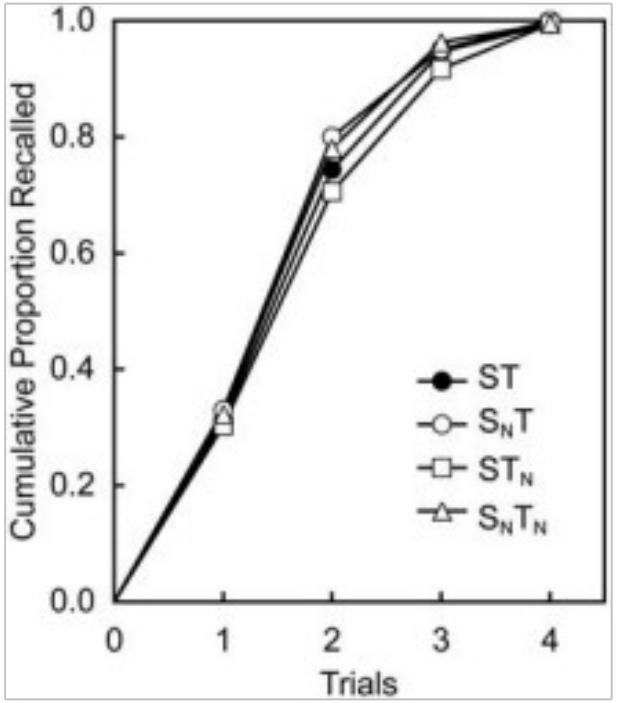
  - ST$_N$: Repeat all words during study, bu
  - $S_N T_N$: Remove learned words from both st

Naïve approach, everyone do the same independently of skill.

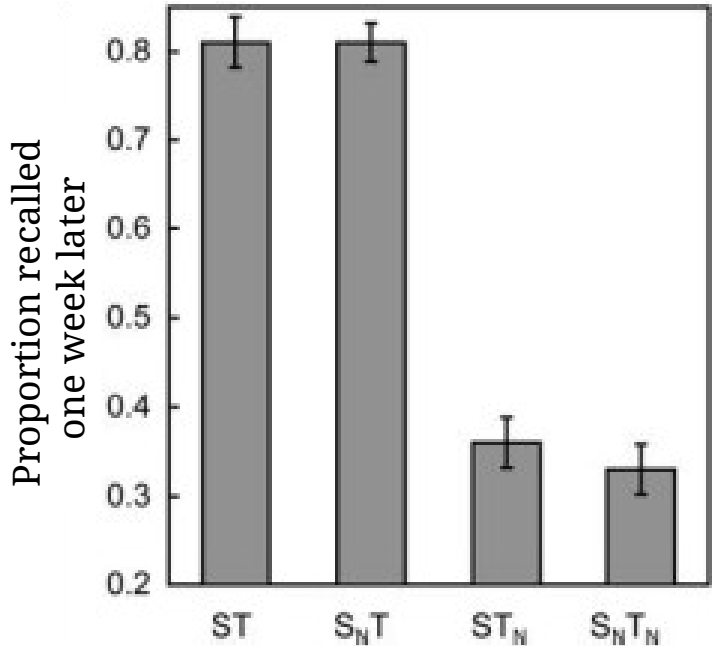
Individualized approach: Focus on what the student does not know!

Testing effect Karpicke, J. D. & Roediger, H. L., Science (2008)



- ST – repeat all
- S_NT – dropped when learned, come back in later sessions
- ST_N – Dropped in all later sessions
- S_NT_N – Dropped entirely

Testing effect Karpicke, J. D. & Roediger, H. L., Science (2008)



- ST – repeat all
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Thank you!

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Testing the testing effect in VR

Session A

Initial training: Both groups receive training with instructions

Session B

Group 1 receives continued training with instructions

Group 2 receives testing without instructions

Pause

Session C

Final test: Both groups receive testing without instructions

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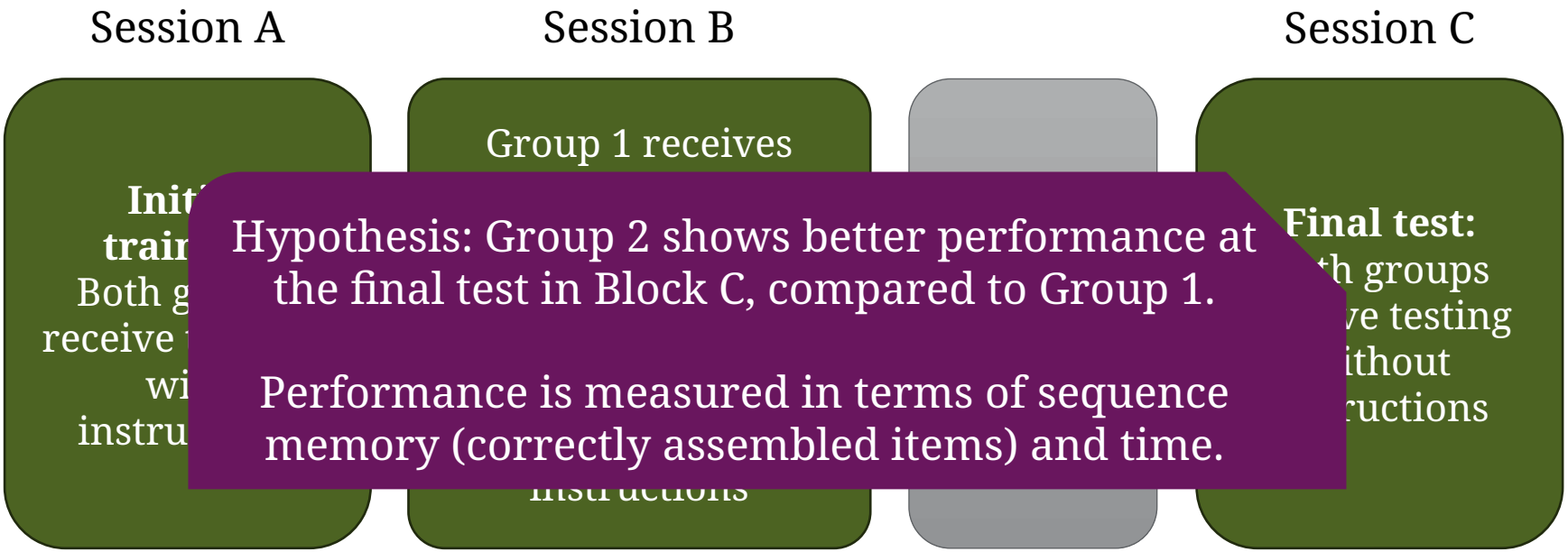
Testing the testing effect in VR



Design for competence!

- *Allow the user to do the task with the support of intelligent tools*
- *Fully or partly automated processes lead to deskilling*

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So where is the border between these two?

Design for competence!

- *Allow the user to do the task with the support of intelligent tools*
- *Fully or partly automated processes lead to deskilling*