Arguments for Automation

Andrew Rae
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The problem

• A common transition:
  Manual Task → Automated Task

• Flight control ⇒ Autopilot
• Train driving ⇒ Automatic Train Operation
• Street directories ⇒ GPS Navigation
• Manual testing ⇒ Automated test framework

• Transition results in a change in Risk Profile
Conventional hazard analysis?

• Identifies a certain set of safety risks associated with the new system
  • May be based on the functions of the new system
  • May be based on the design of the new system
  • May be based on the history of similar systems

• Does not necessarily
  • Capture all of the generic risks associated with any automation

• Does not directly
  • Address the acceptability of the new risk profile
Outline

PART ONE

• Why ALARP isn’t a good test for automation acceptability

• Risk-Benefit Equation for Automation

• Generic Hazards of Automation

• Generic Benefits of Automation

PART TWO

• Ethics of Weighing Risks and Benefits
What’s wrong with ALARP?

• ALARP – Reduce risk “As Low as Reasonably Practicable”

• It is almost always practicable, in the legal sense, to abandon the current endeavor

• Sometimes abandoning the endeavor is a risk minimising option

• So why do so many risk analyses NOT consider the mitigation of abandoning the whole project?
The reality

• Social and individual safety risk is not, and should not be, monotonically decreasing

• Sometimes extra risk is justified because of the benefits that come along with the risk

• This trade off should be explicitly recognised, analysed, and included in safety arguments
Introduction to risk equation

1. Risk of manual function
2. Risk benefit of automating
3. Risk cost of automating
4. Other benefits of automating

Zero risk
Current risk
Acceptable risk

Other benefits of automating
Risk equation

• Risk is acceptable if and only if

  • The Increase in Risk (risk cost – risk benefit)
  • Is Less Than (some sort of comparison)
  • The Increase in Benefit (in some suitable units)

• Increase in Risk and Increase in Benefit are hard to quantify – so we won’t do it

• That means that the comparison is NOT traditional Cost-Benefit Analysis
Generic hazards of automation

- Early automation involved **physical** tasks
  - Cars, elevators, powered manufacturing

- **Modern automation involves** **mental** tasks
  - Navigation, flight control, medical dosages

- So the hazards that are encountered are ones involving poor decision making:
  1. Poor decision making by the automation
  2. Poor shared decision making
  3. Degraded decision making when automation becomes unavailable
Poor decision making by the automation

- Requirements error
  - Underspecified requirements
  - Incorrectly specified requirements
- Implementation error
- Execution error
- Lack of human capability
Poor shared decision making

• Over-trust in the automation
  • IRAN Air Flight 655 shot down by USS Vincennes
  • Royal Majesty grounding

• Automation surprise, including mode confusion
  • Toulouse A330 test flight accident, June 1994
  • Strasbourg A320 accident, 1992

• Clumsy automation
Loss of capability in the absence of automation

- Short-term (loss of situation awareness)
- Long term (loss of practice and experience)
Benefits from Automation

• Best seen in the case of total autonomy …

• Human operator is removed from all danger
• Human operator is eliminated as a source of error

• … but not usually this simple
Realistic automation

• Typical automation doesn’t achieve these objectives

• Humans are still exposed, perhaps even more so in the case of maintenance of automated systems

• Humans are still a source of error … their role is changed, rather than removed
Risk equation revisited

- Zero risk
- Current risk
- Acceptable risk
- Risk of manual function
- Risk benefit of automating
- Risk cost of automating
- Other benefits of automating
- Acceptable risk
- Other benefits of automating
- Risk cost of automating
- Risk benefit of automating
- Risk of manual function
END OF PART ONE
Weighing risks and benefits in a safety argument

Arguments for Automation PART TWO
Outline

1. What’s wrong with quantified Cost Benefit Analysis?
2. Approaches to ethical theory
3. Legal and public policy approaches
4. An alternative to CBA
Cost Benefit Analysis (CBA)

COST / RISK
- List and quantify
- Translate into present-day money

BENEFIT
- List and quantify
- Translate into present-day money
Problems with CBA

• Quantifying value of reduction/increase in risk
  • Placing a dollar value on commodities not traded in the market
  • Willing to pay vs Willing to sell values are different
  • Is a dollar worth the same to a rich person as to a poor person?

• Translating into present dollars is a value judgment
  • Inter-generational equity vs project based discounting

• Difference between efficiency and equity
  • It’s unfair if the people paying aren’t the people gaining
  • Availability of “risk-dumping” leads to sub-optimal risk management

• Economists have answers to all of these issues…

… but your choice of answer is a value judgment
The two minute introduction to ethics

• Consequential ethics
  • Actions and intentions don’t matter, only consequences
  • Specific school of consequential ethics is utilitarianism
    • “THE GREATEST GOOD TO THE GREATEST NUMBER”

• Deontological ethics
  • Some actions are just plain wrong, regardless of the outcome
  • “ATTEMPTED MURDER IS JUST AS BAD AS MURDER”
An illustration – the moon landing or the dish
Legal approaches

• Rights against harm or risk as “trumps”

• Balance of rights approach
  • Risk causer has a right to autonomy and free action
  • Risk taker has a right to freedom from harm
  • These rights must be balanced in a sensible fashion
The “open balance” approach

• List risks and benefits, and quantify only where possible and appropriate
• Indicate uncertainty where uncertainty exists
• Don’t convert non-traded commodities into dollars
• Don’t discount future risks and benefits
• Spend time and energy on open discussion rather than obtuse calculations
  • Engage stakeholders in the safety debate, rather than excluding them as “non-experts”
Problems with the open balance approach

• “Risk perception is irrational and inconsistent”
  - If a value is highly sensitive to how you measure it, maybe it can’t be measured.
  - Instead of searching for a “rational” balance of risk and benefits, accept the subjective nature of risk and live with the uncertainty
  - NB: This is very hard for scientifically minded people to do

• “Open balance doesn’t make a repeatable decision”
  - Neither does cost-benefit analysis
  - CBA is value-laden and subjective, it just hides the fact well
Conclusion

- Risk is acceptable if and only if
  - The increase in risk
    - Poor automated decision making
    - Poor shared decision making
    - Poor decision making when automation taken away
  - Is less than the increase in benefit
    - Cost benefit analysis?
    - Ethical and legal approaches
    - Open balance alternative