

Arguments for Automation

Andrew Rae

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The problem

- **A common transition:**

Manual Task \longrightarrow Automated Task

- **Flight control \Rightarrow Autopilot**
- **Train driving \Rightarrow Automatic Train Operation**
- **Street directories \Rightarrow GPS Navigation**
- **Manual testing \Rightarrow 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**

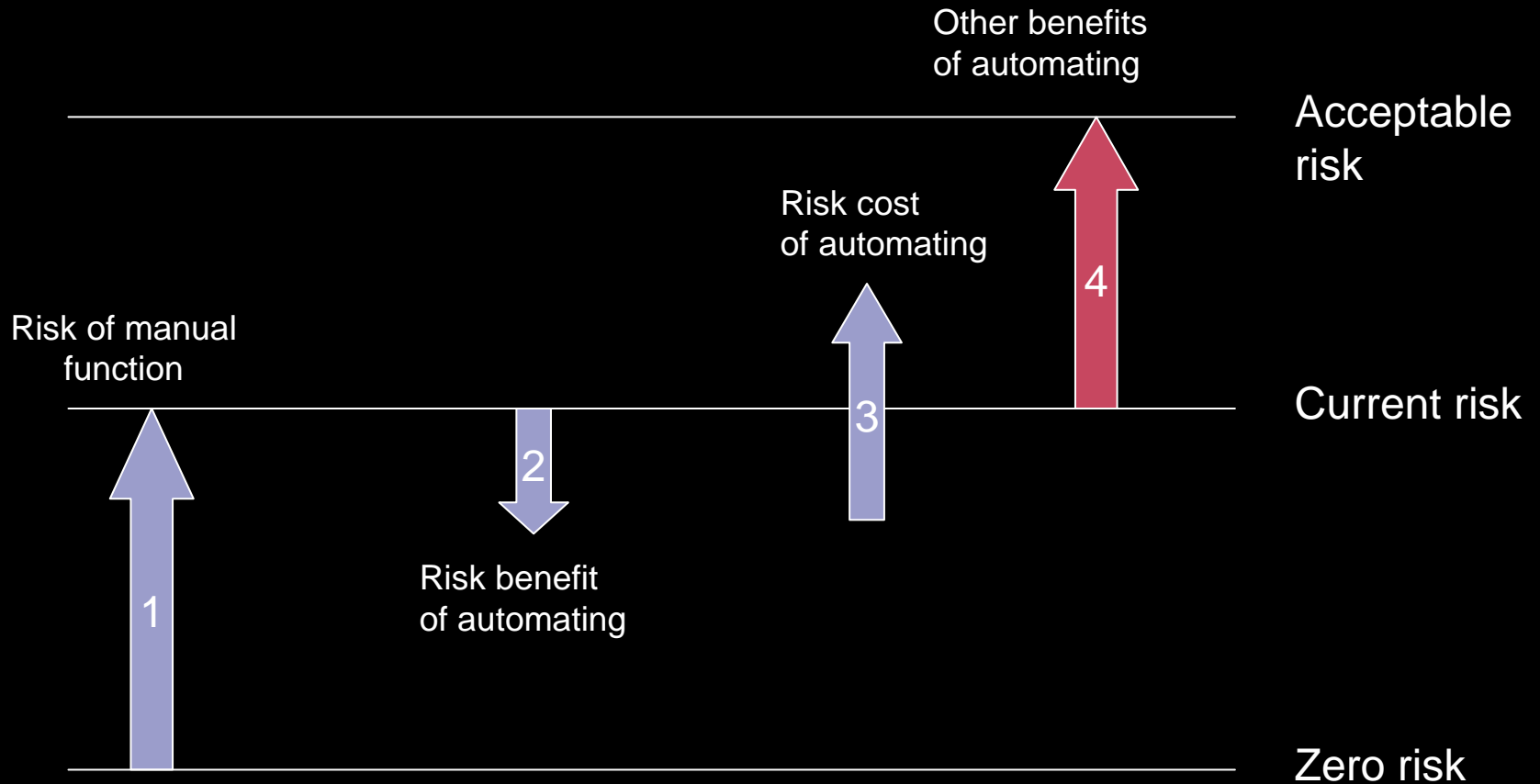
What's wrong with ALARP?

- **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



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)**

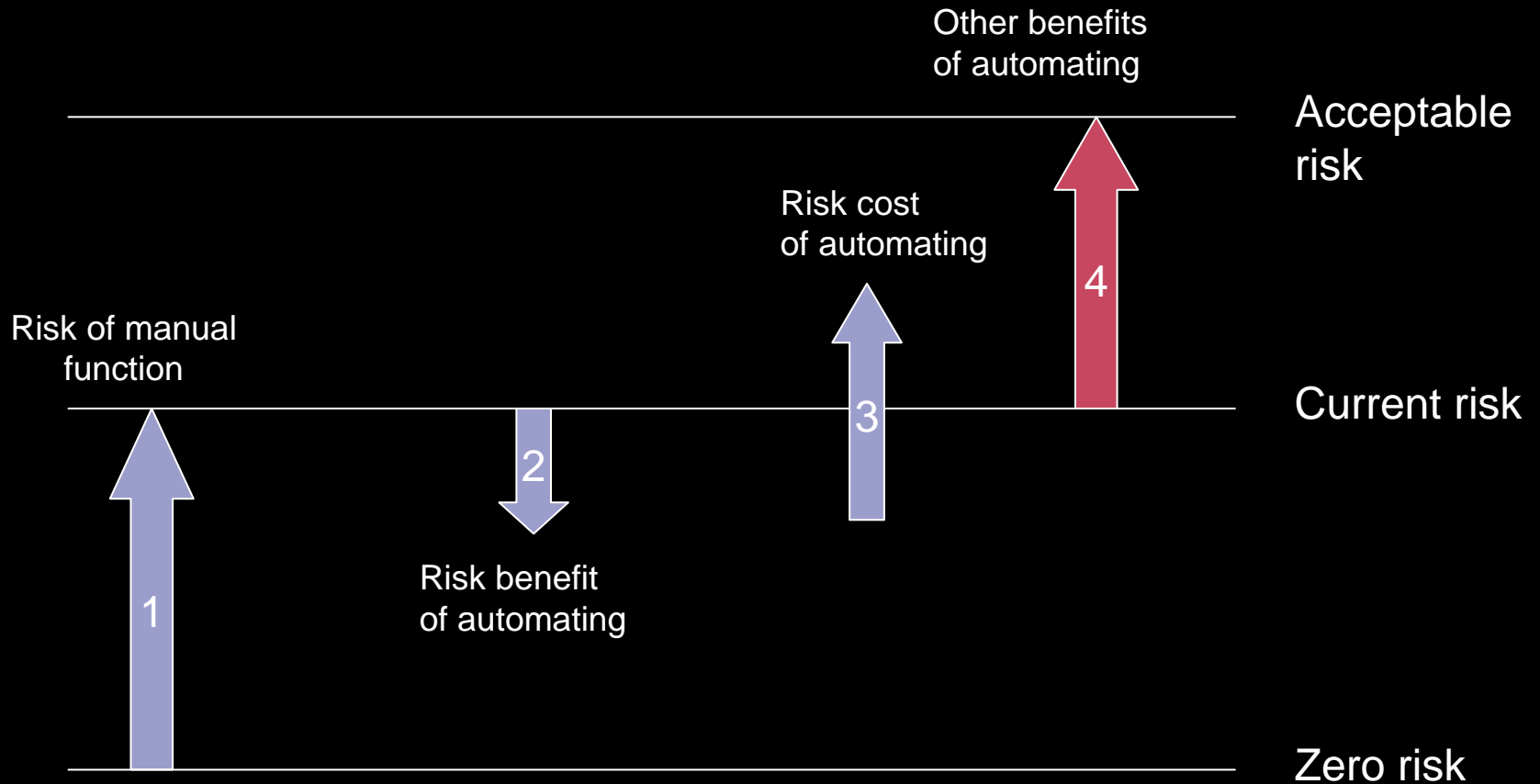
Benefits from Automation

- **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



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

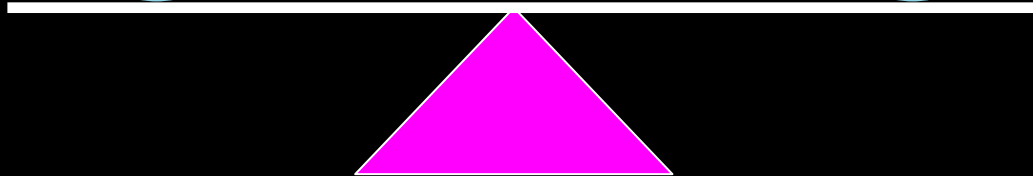
Translate into present-day money



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