Technological Distraction

Kenneth H. Funk II

Mechanical, Industrial, and Manufacturing Engineering
Oregon State University

4 August 2008

Definitions

- Technology
  - *techne*:
    - art, skill, craft;
    - the means by which a thing is gained.
  - *logos*:
    - word, speech, utterance;
    - order, reason
    - Latin *ratio*
  - Rationally developed means of transforming the physical world to achieve what we judge to be good ends.
- Technological Object
  - A specific instance of such a means: a tool, device, machine, engineered system, software program, procedure, or method to realize valued material ends.

British Midland Airlines Boeing 737-400, East Midlands Airport, 8 January 1989

- Enroute from London to Belfast.
- Fan blade fractured in left (# 1) engine.
- Flight crew misdiagnosed it, shut down right (good) engine.
- Diverted to EMA.
- Increased power to left engine caused secondary damage, loss of thrust.
- Crashed short of runway.
  - 39 passengers died at scene, 8 died later in hospital
  - 74 occupants seriously injured
  - 5 occupants received minor injuries

Photo of BMA B737-400.

http://www.airliners.net/photo/British-Midland-Airways/Boeing-737-4Y0/0588296/L/

Photo of crash scene.

http://www.airliners.net/photo/British-Midland-Airways/Boeing-737-4Y0/0509995/L/

British Midland Airlines Boeing 737-400, East Midlands Airport, 8 January 1989

- "There can be little doubt … that the *high workload* in the cockpit contributed to the failure of the crew to notice the abnormally high reading on the No 1 engine vibration indicator that was evident for nearly four minutes after the initial vibration." (Air Accident Investigation Branch 1990, 104; emphasis added)
- First Officer was *"programming" Flight Management System* (FMS) to see EMA approach pattern on electronic map display.

Photo of B737-400 flight deck.

FMS Control-Display Unit

Aviation Incidents from the US Aviation Safety Reporting System

- Aircraft on takeoff nearly collides with taxiing aircraft. (ASRS #85206)
  - Latter's FO programming FMS.
- Climbing aircraft overshoots cleared altitude. (ASRS #245915)
  - FO reprogramming FMS while C was adjusting VOR receiver.
- Aircraft misses crossing restriction.
  - C helping FO reprogram PMS. (ASRS #63592)
- Aircraft descends below cleared altitude.
  - C programming FMS for approach/landing (ASRS #405080)
- Aircraft exceeds permitted speed.
  - FO reprogramming FMS. (ASRS #412420)
- Aircraft lands without ATC clearance.
  - C "engrossed" with FMS malfunction. (ASRS #395563)
- Flight crew accepts late runway change, then lands on wrong runway.
    - Attention diverted while reprogramming FMS. (ASRS #63447)

Cockpit Distractions Research

- Aviation Safety Reporting System incident study (Wilson & Funk 1998).
  - Task prioritization errors occurred more frequently in reports from advanced technology aircraft.
- Flight Deck Automation Issues meta-analysis (Funk et al 1999).
  - Top-ranked issue, based on multiple criteria: The attentional demands of pilot-automation interaction may significantly interfere with performance of safety-critical tasks.

Medical Distractions

- British study: High frequency of distractions and interruptions in the operating room. (Healey et al 2006)
  - Mean 0.29/minute.
  - Highest frequency events included “bleepers”
    - (21 calls in one operation!).
  - Bleepers caused high levels of interference.
- Minnesota surgeon removes wrong kidney. (Lerner 2008)
  - Distracted by beeper calls while marking patient’s chart prior to surgery.

Summary of the Cases

- Pilot:
  - Should attend first to aircraft control tasks.
  - Other tasks (navigation, communication, non-essential system management) serve good ends.
    - Instrumental to greater good of safe flight.
    - Subordinate to it.
  - Must be scheduled & performed so as not to interfere with control.
- Surgeon
  - Should attend first to patient at hand.
  - Schedule & perform other tasks so as not to interfere.
- Summary
  - Distractions by technological objects.
  - Attention diverted from more urgently important tasks to less urgently important tasks.
  - Tragedy – or a near miss – ensued.

Greater Good vs. Lesser Good

Jesus:

… Martha, Martha, you are worried and bothered about so many things; but only one thing is necessary, for Mary has chosen the good part, which shall not be taken away from her.

(Luke 10:38-42)

Greater Good vs. Lesser Good

Augustine:

… he who inordinately loves the good which any nature possesses, even though he obtain it, himself becomes evil in the good, and wretched because deprived of a greater good.

City of God XII.8

Greater Good vs. Lesser Good

Leibniz:

… as a lesser evil is a kind of good, even so a lesser good is a kind of evil if it stands in the way of a greater good.

Theodicy

Broader Implications

- Do cockpit and surgery distractions generalize to broader activities?

- Yes, I think so.

Two Greater Goods and Some Activities That Serve Them …

- God and His Kingdom (Mt 6:33; 22:38)
  - Private, family, and corporate worship.
  - Private, family, and group Bible study.
  - Prayer.
  - Christian scholarship.
  - Serving the church.
  - Teaching Christian principles.
- Other People (Mt 22:39)
  - Providing for the welfare of my family.
  - Providing for the welfare of others.
  - Fulfilling the responsibilities of my calling.
    - Teaching young engineers useful knowledge and skills.
    - Research to enhance human material welfare.
    - Service to the university and the profession.

… and a Few Examples of How Technological Objects Have Distracted Me From Them

- Distractions From Serving God and His Kingdom
  - Developing candidate evaluation spreadsheet distracts me from pastoral search.
  - Software error distracts congregation from worship.
  - Learning keyboard/sequencer distracts me from developing keyboard skills.
  - Setting up broadband service distracts me from preparing for this presentation.
- Distractions From Serving Others
  - Printer, software problems distract me from my family.
  - Sorting through hundreds of ballet recital digital photos distracts me from my family.
  - MS Office 2007 distracts me from my university work.
  - Searching the web for a good used computer deal distracts me from my consulting.

Technological Distraction

Attention to the use of a technological object as a means to a lesser good, to the extent that a greater good is compromised.

The Pattern of Technological Distraction

- Technological object recognized as means to some material good that can be instrumental to a greater good.
- Takes time and attention to
  - Learn enough to acquire it.
  - Acquire it.
  - Learn how to use it.
  - Prepare it for use.
  - Use it.
  - Overcome difficulties using it.
  - Deal with negative consequences of its use.
  - Maintain it.
  - Dispose of, recycle, donate, sell it.
- Technological object, instrumental value, can take on “intrinsic” value
- Technological object opens up possibilities for many other lesser goods.
- Greater good is compromised.

Reasons for Technological Distraction

1. We have limited attentional capacity.

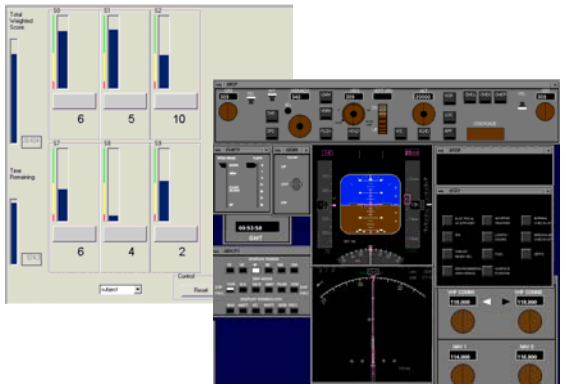
- Cognitive bottleneck theory (Broadbent 1958).
- Limited working memory capacity and duration (Miller 1956).
- Cost of concurrence. (Wickens and Hollands 2000).
- Multiple Resource Theory (Wickens 1984).
- Automatic vs. control processing (Schneider and Shiffrin 1977).
- Stress-induced narrowing of attention, “cognitive tunneling” (Wickens and Hollands 2000).

We are severely limited in our ability to do more than one thing at a time that requires conscious, effortful thought.

Reasons for Technological Distraction:
2. We are not optimal prioritizers.

- Research findings suggest that
  - we are sub-optimal task prioritizers (Shakeri and Funk 2007)
  - we prioritize tasks/activities based on
    - perceived importance of tasks,
    - perceived status of tasks,
    - perceived urgency of the task,
    - salience of task-related stimuli.

    (Colvin et al 2005, Chen and Funk 2003)



  - our perceptions/judgments of task importance, status, and urgency are subject to cognitive biases, e.g.
    - Anchoring
    - Confirmation bias
    - Recency bias
    - Availability bias
    - Absence of cues

    (Wickens and Hollands 2000)

Reasons for Technological Distraction:
3. Technological objects are distracting.

- They are ubiquitous.
- They are conspicuous .
- They are cool!
- Our culture pushes them on us.
- Their use demands attention
  - for accurate operation,
  - for safety,
  - because of noise and other salient stimuli they generate.
- They are often difficult to use due to poor design (designed by engineers, not users):
  - overly complex,
  - difficult to learn,
  - hard to re-learn after periods of non-use,
  - inefficient, cumbersome,
  - vulnerable to user errors.

What Can We Do About Technological Distraction?

- Users of Technological Objects (all of us)
  - Be aware of Technological Distraction.
    - Good task prioritization can be trained (Bishara and Funk 2002; Hoover and Funk 2005)
    - Resolution of internet setup distraction.
  - Set functional, temporal, and spatial boundaries on their use.
  - Relinquish and reject ones that are particularly problematic.
- Developers of Technological Objects (applied scientists, engineers)
  - Be motivated by genuine need, not just feasibility or profit.
  - Reduce attentional demands of technological objects:
    - Limit complexity.
    - Design for compatibility with users' mental models.
    - Design for consistency and standardization to maximize transfer of training.
    - Apply other human factors/usability engineering principles.
    - Use a human-centered approach to design.

Summary

- Technology
  - is rationally developed means of transforming the physical world to achieve what we judge to be good ends.
- Technological distraction
  - is attention to the use of a technological object as a means to a lesser good, to the extent that a greater good is compromised.
  - is a kind of evil.
- Human Factors Engineering and Engineering Psychology
  - provide metaphors, explanations, and countermeasures for technological distraction.
- Technological distraction can be avoided or mitigated
  - by users, through awareness and prudence
  - by product developers through human-centered design.

References (1/3)

Air Accident Investigation Branch, Department of Transport – England.1990. *Report on the accident to Boeing 737-400 G-OBME near Kegworth, Leicestershire on 8 January 1989; British Midlands Ltd; AAIB Report 4/90*. AAIB Report 4/90. London: Department of Transport.

Augustine. trans. *1950. The city of God*. Translated by Marcus Dods. New York: The Modern Library.

Aviation Safety Reporting System. http://asrs.arc.nasa.gov/overview/database.html.

Bishara, S. and K. Funk. 2002. Training pilots to prioritize tasks. In *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting*. Santa Monica, CA: The Human Factors and Ergonomics Society. 96-100.

Broadbent, D.E. 1958. *Perception and communications*. New York: Pergamon.

Chen, J. and Funk, K., A fuzzy model of human task management performance. In *Proceedings of the IIE 2003 Annual Conference*, Portland, OR, May 17-21.

Colvin, K., K. Funk, and R. Braune. Task prioritization factors: Two part-task simulator studies. *International Journal of Aviation Psychology 15*, 4:321-338.

Ellul, Jacques. 1964. *The Technological Society*. New York: Vintage Books.

Funk, K., B. Lyall, J. Wilson, R. Vint, M. Niemczyk, C. Suroteguh, and G. Owen. 1999. Flight deck automation issues. *International Journal of Aviation Psychology 9*, 2: 109-123.

Healey, A.N., N. Sevdalis, and C.A. Vincent. 2006. Measuring intra-operative interference from distraction and interruption observed in the operating theatre. *Ergonomics 49*, 5-6: 589-604.

References (2/3)

Hoover, A. and K. Funk. 2005. Experimental analysis of task prioritization training for a group of university flight technology students. In *Proceedings of the 2005 International Symposium on Aviation Psychology*, ed. By Richard S. Jensen. Columbus, OH: The Ohio State University. 247-252.

Liebniz, G.W. trans. 1951. *Theodicy: Essays on the goodness of God the freedom of man and the origin of evil.* Edited by Austin Farrer and translated by E.M. Huggard. London: Routledge & Kegan Paul.

Lerner, Maura. 2008. Surgeon who removed wrong kidney blames distractions. *Minneapolis-St. Paul Star Tribune*, July 2, http://www.startribune.com/22795054.html (accessed July 24, 2008).

Miller, G.A. 1956. The magical number seven plus or minus two: some limits on our capacity for processing information. *Psychological review 63*: 81-97.

Schneider, W. and R.M. Shiffrin. 1977. Controlled and automatic human information processing I: Detection, search, and attention. *Psychological Review 84*: 1-66.

Shakeri, S. and K. Funk. 2007. A comparison of human and near-optimal task management behavior. *Human Factors 49,* 3:400 - 416.

Wickens, C.D. 1984. Processing resources in attention. In *Varieties of attention*, ed. By R. Parasuranam and R. Davies, 63-101. New York: Academic Press.

Wickens, C.D. and J.G. Hollands. 2000. *Engineering Psychology and Human Performance*, third edition. Upper Saddle River, NJ: Prentice Hall.

References (3/3)

Wilson, J. and K. Funk. 1998 . The effect of automation on the frequency of task prioritization errors on commercial aircraft flight decks: An ASRS incident report study. In *Proceedings, second workshop on human error, safety, and system development, Seattle, WA, USA, April 1-2*. Seattle: University of Washington Department of Computer Science and Engineering. 6-16.