Final Exam

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# Question 1

i) Initial exponential growth often becomes exponential as exemplified by Moore's Law because of, 1, the positive feedback loop: technology builds on previous success by leveraging techniques, methods, and best practices (standing on the shoulders of giants), and 2, success creates its own critical mass which attracts money, interest, and further development (as well as often creating a market).

ii) Eventually it is assumed that there will be limits to growth. We can point to, 1, physical limits, and 2, economic limits of scale. With physical, sometimes the limitations of physics dictate diminishing returns after a point and it takes far longer development cycles to produce increases in results. With economic, there are limits to markets, pressures from outside forces (economic downturn, increased jobless rate, currency fluctuations), and real-world limits to investment in ongoing R&D and production capacity.

# Question 2

Technology forecasting is important to the DoD for at least 2 reasons. First, this is a critical step in planning R&D. Without a good understanding of where technology is headed it is unlikely that the DoD would be able to align its future development with available technology. Second, technology forecasting helps the DoD make strategic decisions on technology licensing and joint ventures.

# Question 3

The Delphi panel would consist of a panel of experts selected principally from the field of high energy physics.

First round of questions would be designed to elicit responses about the probability and maturity of different high energy technologies.

After surveying the responses and tallying a ranked consensus, the results are fed back to the panel to re-evaluate their answers.

The hope is that the responses to the original question will eventually converge (which they usually do quickly).

# Question 4

Backcasting is a form of forecasting that works backward from assumptions about the future states of technology and attempts to describe the possible roadmaps at which the technological assumptions could be arrived.

# Question 5

Phase 1 is characterized by "no response."

Phase 2 is the logical/rational phase.

Phase 3 is characterized by name calling and outward hostility.

# Question 6

The method creates a 2-dimensional matrix with scales along the axes for 1, the technology's utility to a military service or DoD agency, and 2, the technology's market breadth. Then the matrix field is overlaid with the third criteria, the Management Domain, consisting of Lead, Initiate, Participate, and Monitor.

# Question 7

Argument for a lasting benefit: Some technologies provide such a decisive advantage as to increase the level of warfare beyond its previous reach. Examples might include the introduction of gunpowder, rifled barrels for firearms, effective use of wireless communications, the hydrogen bomb, and the transistor (in no specific order). An adversary lacking the ability to effective use any of these technologies (if they are applied in battle) would be at such a disadvantage as to be in dire risk of losing due to overwhelming strength of their opponent.

Argument for a transient benefit: On the other side of the argument we see examples like the Battle of Little Big Horn (studied in a previous class) where GEN Custer was bested by a technologically inferior Sioux. In this case it is likely that, despite the technology imbalance, the Sioux were better suited to win due to their internal organization (starfish vs. spider). While Custer's troops were hierarchical, the Sioux adopted a looser structure, one that facilitated action by individual groups in absence of direction from above... spontaneous militarization. Furthermore, proponents of the transience of technological benefits in war like to stress the importance of diplomacy in negotiating victory.

# Question 8

One huge advantage of evolutionary acquisition is that it facilitates a strategy of risk minimization over risk management. With "big bang" acquisition, risk has to be managed. With an evolutionary acquisition strategy, risk can be minimized through the iterative steps inherent in its process exercised to achieve a fieldable product. This is preferred as it often provides a more reliable solution sooner to the warfighter.

# Question 9

i) TRLs provide a way of describing the relative maturity of a given technology at a given time in such a way that it is not technology-specific. This allows all DoD agencies to utilize a standards-based language when discussing the fieldability of technology. The scale runs from 1 to 9 where 1 is the very beginning of basic research and 9 is a system used successfully in mission operations. In the Army, Army Research Labs (ARL) operates mostly in TRLs 1-3. CERDEC transitions basic research from ARL, DARPA, and the private sector and "productizes" this (TRLs 4-6). Immature products are then transitioned to the PM shops for maturing and fielding (TRLs 7-9).

ii) TRL only describes the relative maturity at a given point in time and does not describe the level of effort required to reach the next level. Also, while there is guidance regarding the application of TRL to a given product at a given time, there is much subjectivity in this application and, in my experience, TRLs are often applied optimistically.