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PATTERNS OF INNOVATION AT NASA: EXPLAINING SWITCHBACKS IN MATURITY

Abstract

RD management practices often conceptualize technology innovation as a stage-gate process whereby novel concepts are matured through a succession of development stages and progressively winnowed down at each sequential gate. This view implicitly assumes that maturity is a monotonically increasing function of the technology, and that partially matured technologies can be restored from the “shelf” for future maturation, barring obsolescence. However, in practice, the pathways taken by new capabilities do not respect these assumptions, with important implications.

- Rather than being a monotonically increasing function in time, particular innovations draw simultaneously from funding mechanisms, targeted at different Technology Readiness Level (TRL) ranges, and loop back to win “early stage” grants decades into their development.
- Rather than being a purposeful management decision, getting shelved is something that happens to innovation teams. The time that a capability can survive on the shelf is as much related to team cohesion as it is to the rate of technical obsolescence.

Based on evidence from a detailed process study of innovation in NASA’s science directorate – including more than 100 hours of interviews, 250 archival documents and 2 months of informal observations – this paper explains the observed dynamics in terms of an “Epoch-Shock” model of the pre-infusion technology development process. The Epoch-Shock model identifies four epochs of persistent behavior, punctuated by shocks that induce transitions from one epoch to another. While the ordering of the epoch-shock sequence differs from case to case, key patterns can be observed across multiple cases.

- For example, if there is a lag between a technical breakthrough and the next mission opportunity, new capabilities are relegated to an epoch of treading water, regardless of the usefulness of the innovation. The strategies used by technologists to survive this epoch generate the non-linearity in TRL noted above.

More generally, the paper illustrates how this new conceptualization of the technology development process can inform how a space sector RD organization should be structured and managed.