RESEARCH & DEVELOPMENT DEGREE OF DIFFICULTY
(R&D^3)

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John C. Mankins
Advanced Projects Office
Office of Space Flight
NASA Headquarters

Introduction

A measure of how much difficulty is expected to be encountered in the maturation of a particular technology is needed to complement the existing Technology Readiness Levels (TRLs) metric. TRL's are a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology. A measure characterized as the "Research and Development Degree of Difficulty" (R&D^3) is proposed as an additional measure.

R&D^3 Summary

R&D^3 – I A very low degree of difficulty is anticipated in achieving research and development objectives for this technology.
Probability of Success in "Normal" R&D Effort 99%

R&D^3 – II A moderate degree of difficulty should be anticipated in achieving R&D objectives for this technology.
Probability of Success in "Normal" R&D Effort 90%

R&D^3 – III A high degree of difficulty anticipated in achieving R&D objectives for this technology.
Probability of Success in "Normal" R&D Effort 80%

R&D^3 – IV A very high degree of difficulty anticipated in achieving R&D objectives for this technology.
Probability of Success in "Normal" R&D Effort 50%

R&D^3 – V The degree of difficulty anticipated in achieving R&D objectives for this technology is so high that a fundamental breakthrough is required.
Probability of Success in "Normal" R&D Effort 20%

R&D^3 – Level I
Probability of Success in "Normal" R&D Effort 99%

A very low degree of difficulty is anticipated in achieving research and development objectives for this technology (including both the system concept, as well as performance, reliability and cost goals). Only a single, short-duration technological approach needed to be assured of a high probability of success in achieving technical objectives in later systems applications.

For example, a simple interpolation of an existing capability (e.g., an RF device at a new frequency, but one that is bracketed by the frequencies of past devices) or a modest extrapolation (e.g., a new engine at a thrust of N lbs, where an existing engine exists at a thrust of N/2 lbs for the same propellant and with similar other performance/cost goals).

R&D^3 – Level II
Probability of Success in "Normal" R&D Effort 90%

A moderate degree of difficulty should be anticipated in achieving R&D objectives for this technology. A single technological approach will probably be sufficient; however, this R&D should be conducted early to allow an alternate approach to be pursued if needed in order to be assured of a high probability of success in achieving technical objectives in later systems applications.

For example, a significant, but not extreme extrapolation from some existing capability (e.g., an RF device at a new frequency that is significantly different from current frequencies in use, but which should be achievable with devices similar to those already in use) or a modestly new capability (e.g., a new engine that is somewhat reusable — say a few firings — with some degree of integrated health management, where an existing engine exists that is expendable for the same propellant and with similar other performance goals).

R&D^3 – Level III
Probability of Success in "Normal" R&D Effort 80%

A high degree of difficulty could be anticipated in achieving R&D objectives for this technology. At least two technological approaches will probably be needed and these efforts should be conducted early enough to allow an alternate subsystem approach to be pursued to be assured of a high probability of success inachieving technical objectives in later systems applications.

For example, a very significant extrapolation from some existing capability (e.g., an RF device at a new frequency that is quite different — e.g., a factor of 5 — from current frequencies in use, and requires new RF devices, possibly operating on different physical

principals from those already in use) or a significantly new capability (e.g., a new engine that is very reusable — say a 10s of firings — with a high degree of integrated health management, where the existing engine is expendable, possibly with a different propellant, but still with similar other performance goals).

R&D^3 – Level IV

Probability of Success in "Normal" R&D Effort 50%

A very high degree of difficulty should be anticipated in achieving R&D objectives for this technology. Multiple technological approaches need to be pursued. These activities should be conducted early enough to allow an alternate system concept to be pursued in order to allow managers to be assured of a high probability of success in achieving technical objectives in later systems applications.

For example, a dramatic extrapolation from some existing capability (e.g., an RF device at a very different frequency — e.g., factors of 10 — than those in use, and requiring completely new RF devices, operating on different physical principals from those already in use, as well as various other new subsystems/component technologies, such as heat rejection) or a significantly new capability (e.g., a new engine that is air breathing as well as very highly reusable — say a 100s of firings — with a very high degree of integrated health management, where the existing engines are expendable rockets, possibly with different propellants, and with other different performance goals).

R&D^3 – Level V

Probability of Success in "Normal" R&D Effort 10%-20%

The degree of difficulty should be anticipated in achieving R&D objectives for this technology is so high that a fundamental breakthrough in physics/chemistry/etc. is needed. Basic research in key areas needed before feasible system concepts can be refined.