



## The Herding Cats Column of Glen Alleman

# On Integrated Project Management and Systems Engineering A Recent “Encounter”

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Carl Gustav Hempel (1905 – 1997) posed a paradox. If we want to prove the hypotheses such as “all ravens are black,” we can look for many ravens and determine if they all meet the blackness criteria. Hempel suggested changing the hypothesis to its counter positive (rewording with identical meaning) would be easier. The new hypothesis is: “all non-black things are non-ravens.” This transformation, supported by the laws of logic, makes it much easier to test. Unfortunately, the premise is ridiculous. Hempel’s Raven paradox points out the importance of common sense and proper background exploration, even in subjects as complex as project management. [\(1\)](#)

I have recently been engaged in a conversation of sorts based on the statement — “PERT/CPM fails as a predictive tool is quite obvious and has been proven ad nauseam.” The author of this statement firmly believes, following Hempel’s inverted logic that unequivocal statements make common sense, when in fact the statement above is ridiculous.

This roundabout introduction comes from my recent stint as an “IMP/IMS” provider to a spacecraft program. IMP/IMS is the acronym for Integrated Master Plan / Integrated Master Schedule, which is a process of developing costs and schedules in aerospace and government procurement contracts. Although the approach provided by IMP/IMS seems obvious, it is not. More on that later, but first a quote from a book I finished - Execution: The Discipline of Getting Things Done, Larry Bossidy and Ram Charan.

“You cannot have an execution culture without robust dialogue – one that brings reality to the surface through openness, candor, and informality. This is call “truth over harmony.”

### **Integrated Program Management and Systems Engineering**

Integrated Program Management (IPM) is the foundation for IMP/IMS. Systems Engineering (SE) is the foundation of IPM. NASA defines SE as “an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and life-cycle balanced set of system people, product, and process solutions that satisfy customer needs.

The objectives of SE is to design, build, and operate a system so it accomplishes its purpose in the most cost-effective manner possible, considering cost, schedule, and risk. It is the cost and schedule aspects of SE that I am most interested in.

Cost and schedule development as well as the technical feasibility and viability of the project are based on the “Doctrine of Successive Refinement.” This doctrine says that the realization of a system over its life cycle results from a succession of decisions among alternative course of action. When these alternatives are defined and understood enough to be differentiated in a cost-effectiveness space, the Systems Engineer can make choice among them with a known confidence.

A core activity in SE is harmonizing goals, work products and the organizations that deliver these products. This involves managing the Systems Engineering process which in turn involves managing the work. Work in SE is represented by a Work Breakdown Structure (WBS) along with a Product Breakdown Structure (PBS), and Organization Breakdown Structure (OBS) and their associated Cost Accounts.

As a short diversion, there are three (3) major errors that can occur with developing a WBS:

1. The WBS describes functions, not products. This makes the project manager the only one formally responsible for products.

2. The WBS has branch points that are not consistent with how the WBS elements will be integrated. For example in a guidance, navigation and control system with a distributed architecture, there is usually software associated with hardware items. It would be inappropriate to separate hardware and software as if they were separate systems to be integrated at the system level.

3. The WBS is inconsistent with the PBS. This makes it possible that the PBS will not be fully implemented and generally complicates the management process.

### **Integrated Master Plan**

Integrated Master Plan (IMP) – provides a single plan describing the fundamental structure of the program.

Focuses the integrated product team (IPT) on the customer requirements through deliverables rather than through tasks

Establishes an agreement between all members of the IPT on these deliverables

Defines the program in terms of events, accomplishments, and criteria for judging the completion of these accomplishments

Establishes the criteria and objectives for program success

Integrated Master Schedule (IMS) – provides a task and calendar based schedule at a level necessary for day-to-day execution of the program

### **Integrated Master Schedule**

Products described in the WBS are the result of activities – tasks. An orderly and efficient SE process requires these tasks take place in the right order with the least cost and duration. Arranging this order, cost and duration takes place in a “network schedule,” which explicitly takes into account the dependencies of each task. Building a “network schedule” is the result of the IMP/IMS process. IMP decomposes a project into “program events” (milestones), “significant accomplishments,” and “accomplishment criteria.”

The IMS supports the events, accomplishments, and criteria with detailed tasks, activities, and milestones with dependencies. With these entities in place an accurate critical path can be calculated. The Critical Path is the sequence of activities that will take the longest to accomplish. Activities not on the critical path have “float.”

Using the IMP/IMS approach there are size steps in establishing a “networked schedule” – the IMS. This schedule is composed of four layers

Events that are assessment points which occur at the conclusion of significant program activities

Significant accomplishments are the desired results prior to an event. For each event these accomplishment demonstrate an understanding of the requirements

Criteria for these accomplishments provide definitive evidence that a specific accomplishment has been completed. Accomplishment Criteria must:

- Measure success or product maturity over time
- Provide objective, explicit proof of completion

- Highlight specific areas of effort for tracking, monitoring risk, or incrementally verifying a process of product development
- Relate directly to accomplishments
- Answer “how do I know when accomplishment has been completed”?
- Focus on exit criteria
- Express entrance criteria as predecessors in the IMS

4. Tasks are time phased, detailed activities (where work is accomplished and funds are expended) required to support the IMP criteria and accomplishments. Individual tasks in the IMS:

- Identify activities and dependencies needed to complete each WBS element
- Identify and negotiate external dependencies
- Provide estimated durations of all activities
- Are derived from a WBS element to obtain a network schedule and an estimate of the critical path for the element.
- **Are integrated into schedules of lower level WBS elements.**
- Are reviewed for resource and funding profiles and with adjustments made to logic and durations.

So why all this formality for making a simple schedule from a plan?

Objective		Implementation
Construct an Event driven plan rather than a schedule driven plan. Task completion is the criteria for event completion	▶	Separate plan (IMP) from schedule (IMS) but link elements with numbering system
IMP/IMS is a condensed, easy to read “plan” showing “events” rather than effort against tasks. It converts “level of effort” into actionable outcomes	▶	Indented, outline format (not text) for Event, Accomplishments, Criteria rather than tasks
Pre-defined entry and exit conditions for major program events rather than the passage of time as a measure of progress	▶	Significant Accomplishments (SA) for each key event (submitted in proposal)
Objective measure of progress/ completion for each accomplishment	▶	Pre-defined accomplishment criteria (AC) for each SA
Stable, contractual plan flexible enough to portray program status	▶	IMP is part of contract, IMS is data item used to manage the project after award
Capture essence of functional processes without mandating a particular process be imposed on the project	▶	Split IMP into Product and Process sections. These processes are not “project management” processes but product development processes.

### What’s Next?

Once the IMP/IMS process is in place, managing the project takes. Program Controls is usually the formal name. More about this next time

( 1 ) Abstracted from the Foreword of NASA Systems Engineering Handbook, SP-610S, June 1995.

( 2 ). More on PM Tools and Resources

<http://www.niwotridge.com/Resources/PM-SWEResources/PMTools.htm#IPM>