Cost Reduction Strategies for Future Space Missions (From Technological innovation Perspective)

February 8 , 2017

Yasuaki Iwabuchi

introduction

Japan Aerospace Exploration Agency （JAXA）
Research and Development Directorate

Specialty ： Management , Planning
（regional development, venture, gender-equality。。。）

The University of Tokyo,
Graduate school of public policy（FY25～28）
Aoyama Gakuin University,
College of Economics/Engineering（FY25～28）

space craft/equipment : characteristic

＜How difficult is it？＞

- large scale and complex system

  ex) number of parts :

  H-IIA/earth observation satellites ⇒ about 300 thousand

  Japanese Experiment Module (JEM) ⇒ about 2 million

  cf) passenger car ⇒ about 20～30 thousand
- multi-product small volume production : one or two flight/year
- special environment (microgravity, ultra high vacuum, radiation。。。)

  vibration, thermal, radiation, vacuum (outgas)
- difficulty in practical use test
- difficult to repair

One item production（Not a Catalog item）

space craft/equipment : characteristic

one item production
a typical 2 ton weighing satellite
⇒ half of development costs and material costs
⇒ from second machine : ▲15% cost reduction

But : How scale is the product or development cost ?
⇒ (So to speak。。。) **Prophetic cost**
(It is determined by the budget as a precedent)

＜spacecraft ⇒ for cost reduction＞

- development cost : ability to estimate budget
- material cost : review of parts for space and manufacturing facilities, domestic production and global strategy
- test cost : review of standard, facility and method

◎ ability to grasp, analyze and planning these as a system

players（related to space development）
－understanding the current situation－

＜Current status＞

The government, Large companies and Universities is the center in Japan

- Non-space organization ⇒ Companies require excessive costs
- Space organization

  ⇒ It becomes technology center and cost-effectiveness is reduced

⇒ Collaboration required。。。

⇒ **However, cost information is overwhelmingly in companies, both of which generally have low ability to estimate costs.**

＜From now on＞

Efforts by JAXA, academia and venture companies（especially venture）

（In the case of Japan, it can also be viewed as a problem of the generation gap）

（※）Kenneth J. Arrow（Economist）

⇒ Venture companies tend to innovate more than large companies.

space product strategy

＜Michael E. Porter　:　Competitive strategy＞

（1） Cost leadership strategy

（2） Differentiation strategy

（3） Focus strategies

First of all, Increase players
Next, switch from buy to make

＜Space product strategy＞ Focus on the following

- **Rocket（increase the number of players）**
  Heavy industry＋venture（invest 3 to 4 companies and promote it）
  （※） Stop the desk marketing theory

- **Satellite（switch from buy to make）**
  Engineering test satellite manufactured in-house
  （※） ETS-V ⇒ CS-4（communication）/DS2000

learning from ESA and NASA

Japan ： subsidy and special zone。。。(mind of mercy/handouts budget)

⇒ It is important to construct a platform structure in the medium to long term
(management, policy, distribution and acquisition method, evaluation)
It is not competitive in the center of large companies.

⇒ It is important not to compete but to build a competitive environment.

＜ESA ： European Space Agency＞

This is the front-loading

Invest in two companies in parallel until the preliminary design.

One company adopted is used for government satellites.

One company not adopted is used for private satellites.

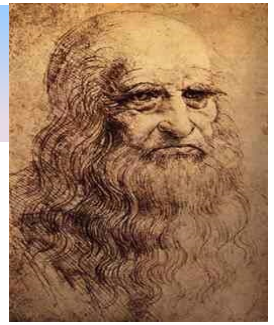
⇒ And it will reverse in 5 to 10 years.

(The reason is ？) The winner relaxes. The loser learns.

＜NASA ： National Aeronautics and Space Administration＞

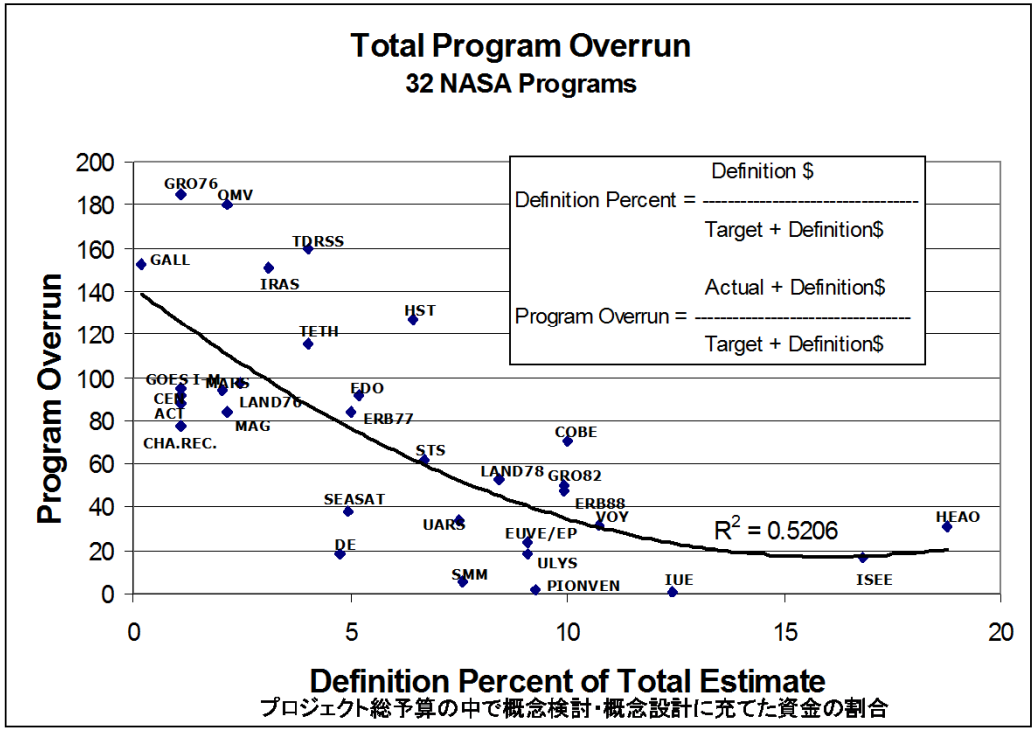
SBIR/STTR(Small Business Innovation Research and Small Business Technology Transfer programs) ： NASA has awarded Boeing Co. a contract and rival Space Exploration Technologies Corp.

Think about the End before the Beginning

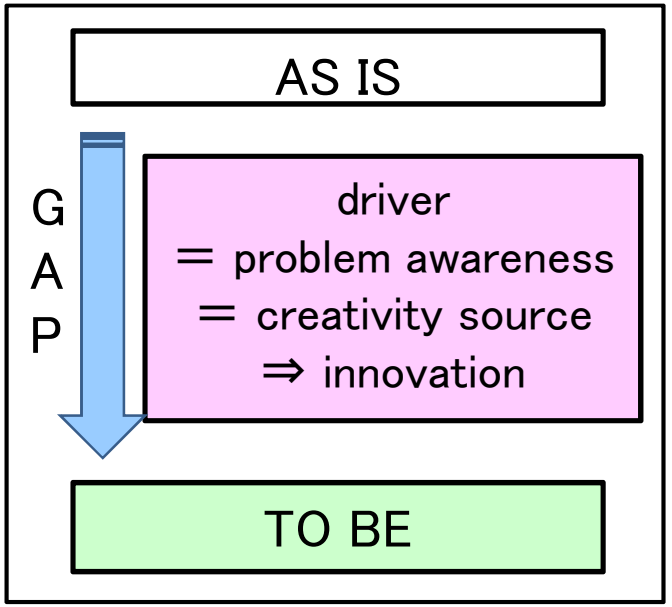


Leonardo da Vinci

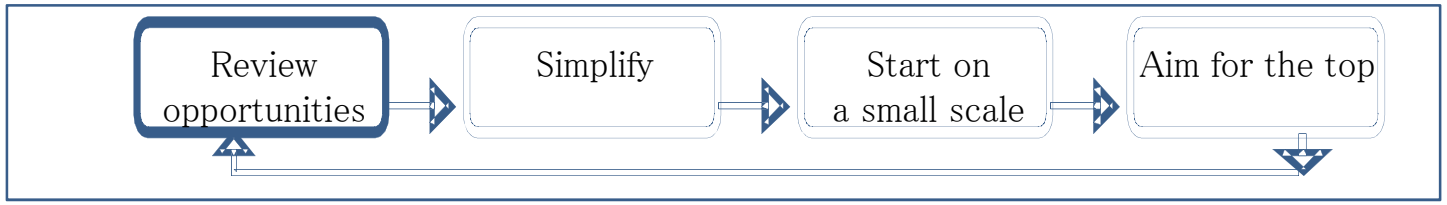
Cost input effect to the initial stage of development



出典： Value of Systems Engineering, technical report by Lean Aerospace Initiative Consortium, October 2004



Peter F. Drucker ： Innovation process



problem identification

There is no magic in the technology and cost of space development.

When emphasizing cheapness。。。

⇒ Government support, technology transfer or development costs **are hidden**.

Ability to formulate a program/technology transfer know-how。。。

For that purpose :

(1) Having **problem** awareness and planning the **program**.

(2) Abandoning recourse loan（mortgage） and conservatism（⇒ **non-recourse**）

(3) **Going out** without staying inside.

- **between companies, space/non space sector and academia**
- **international cooperation**
- **traditional space technology and state-of-the-art technology**
- **component ⇒ sub-system/system**
- **large scale, heavy industry ⇒ small scale, IT/service industry**

A lot of players are necessary for space development.
Personal and organization brainwashing/inward mind is a problem.

Redefine the cost ！　Change your mind ！

Japanese can not put economic theory into practical use.

Cost ≠ Cash

(Japanese have not won the Nobel Prize in economics.)

(1) opportunity loss (current-value accounting, management accounting)

(2) loss cut (difference between research cost and development cost)

(3) discount rate (periodically, the previous example → rather bad ！)

＜Redefine the cost＞ He did it at the cost of his life ！

Cost＝decision making (differences in position and choice of decision makers)

To reduce costs, we need commitment (game theory) from larger decision makers.

In addition, motivation, prospect/expectation and portfolio of risk diversification is necessary.

After all, management is important, and you need an understanding

- strengths and weaknesses(Peter F. Drucker)
- positioning(Michael E. Porter)
- business analysis and roadmap

Edward J. Hoffman（NASA's Chief Knowledge Officer）

: All system engineers should be cost engineers.