FAIRCHILD
SPACE COMPANY

THE RESUPPLY INTERFACE MECHANISM

By

Barney F. Gorin

Presented By Stewart Jackson

Fairchild Space Company
Germantown, MD 20874

At

Technology for Space Station
Evolution Workshop

Dallas, Texas/January 16-19, 1990

WHY SERVICE?

FAIRCHILD
SPACE COMPANY

Spacecraft servicing is much the same as servicing any major asset. We service our plant and equipment, our automobiles, our aircraft - all our major assets - expressly for the economic benefit. Spacecraft Servicing will be done for the same reason. Only the location - and therefore the difficulty of servicing - will change.

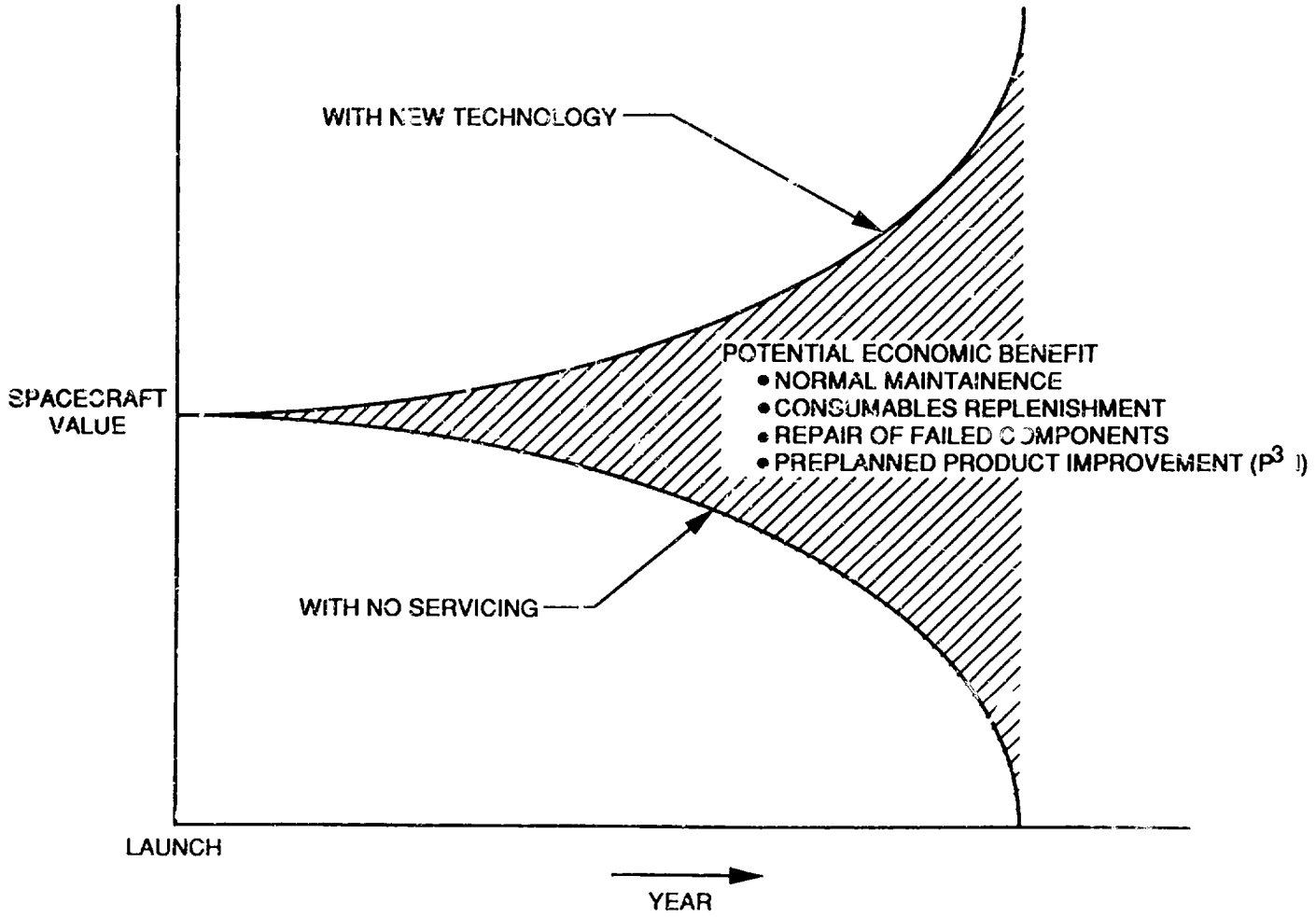
The major servicing activities for any major asset are:

- Normal Maintenance
- Consumable Replenishment
- Repair of failed components
- PrePlanned Product Improvement (P3I)

This will be true for spacecraft as well.

SPACECRAFT SERVICING VALUE

FAIRCHILD
SPACE COMPANY



SERVICEABLE SPACECRAFT

FAIRCHILD SPACE COMPANY

Each of the catagories has its own charateristics:

Normal Maintenance

- Items with reliably known wear or degradation rates
- In an automobile this includes tires, break pads, belts, hoses and windshield wiper blades.

Consumables Repienishment

- Materials - usually liquids - which are used as a natural part of a mission.
- In an automobile this is gasoline.

Repair of Failed Components

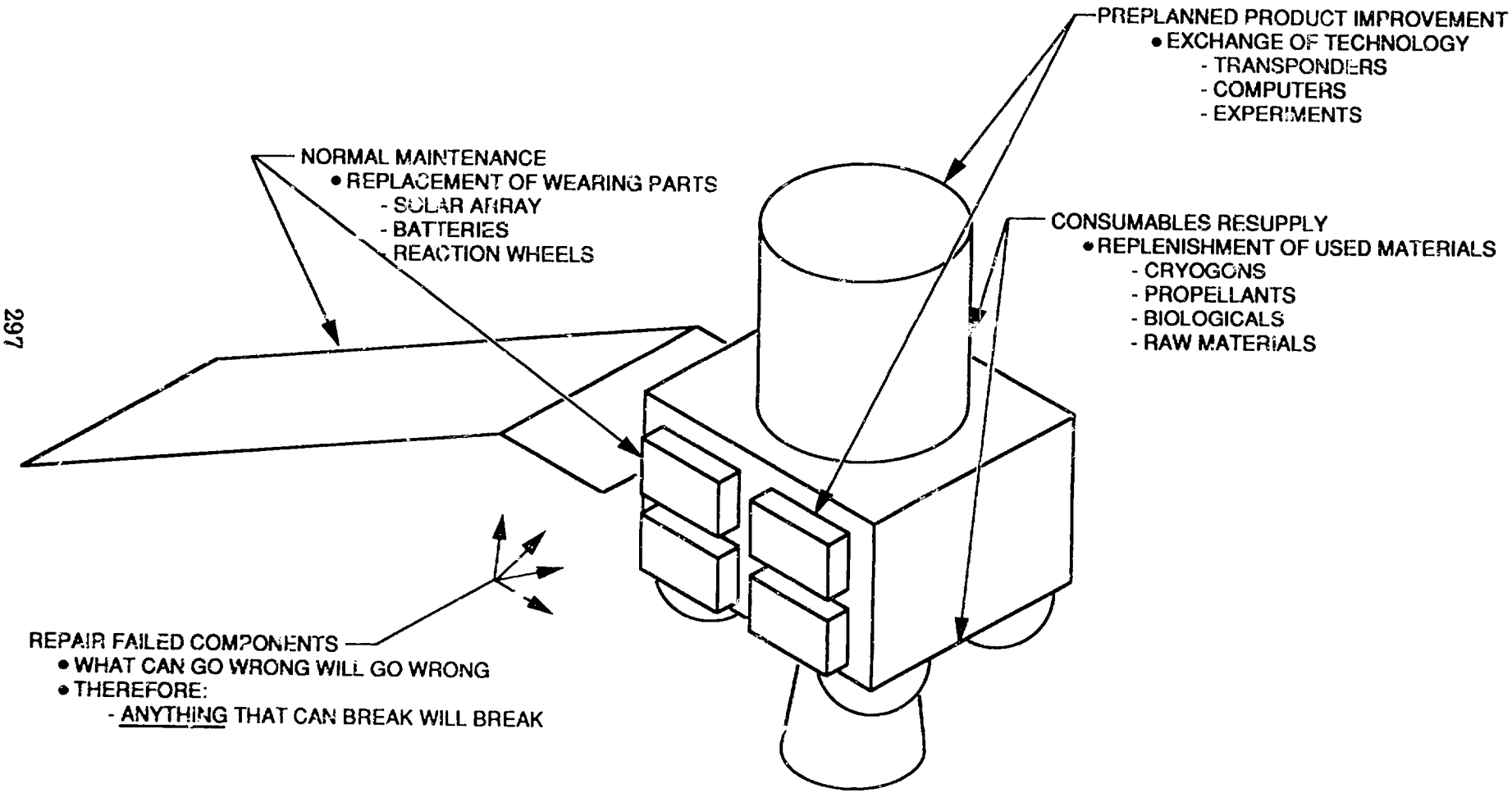
- Murphy lives
- This is why cars come with warranties and we have body shops.

PrePlanned Product Improvement

- The replacement of old technology with new on an existing platform.
- These are most of the year to year car model changes.

SERVICEABLE SPACECRAFT (CONT'D)

FAIRCHILD
SPACE COMPANY



NON- SERVICEABLE SPACECRAFT

FAIRCHILD
SPACE COMPANY

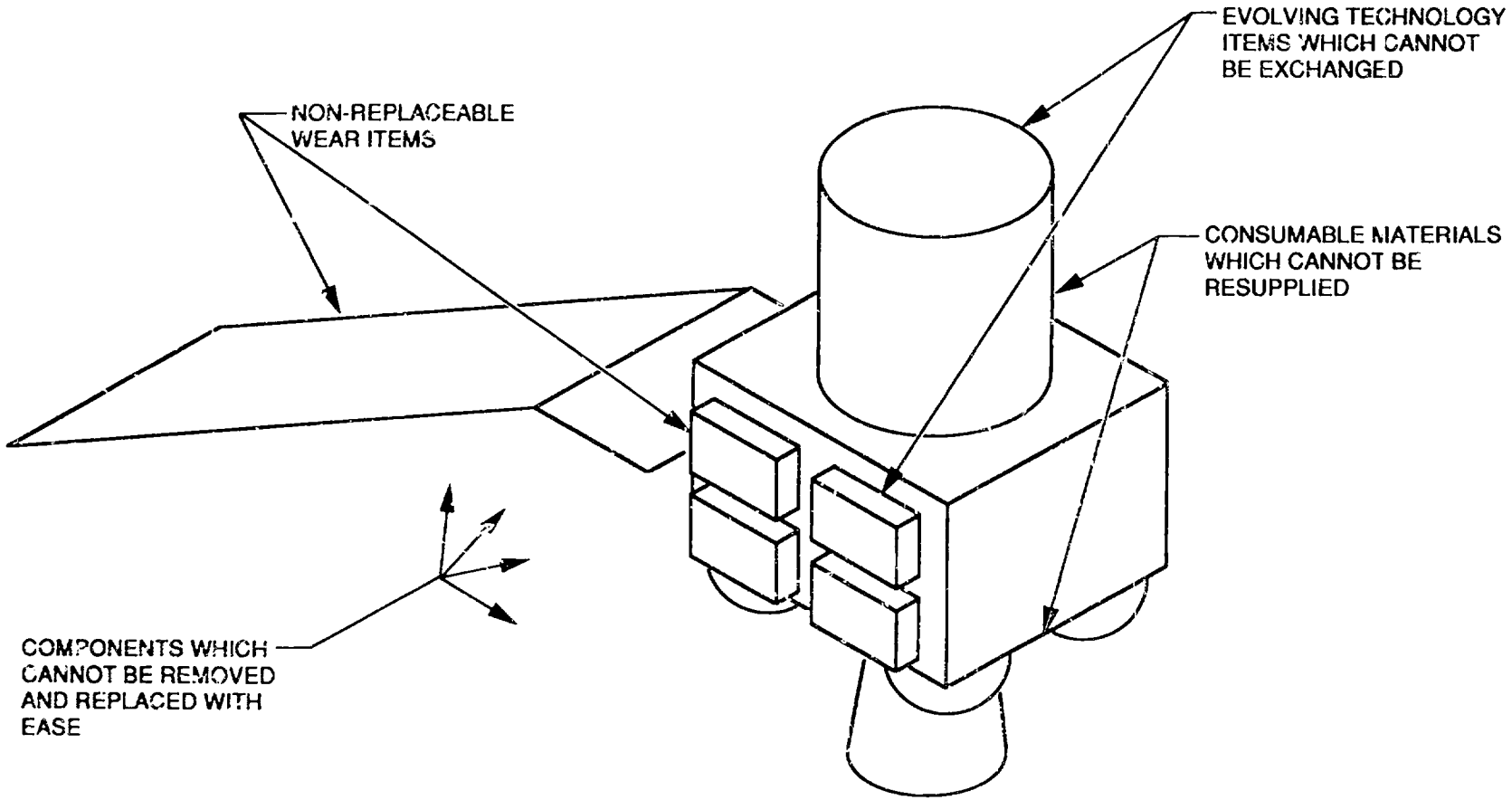
What is the major servicing issue?

What came first? The chicken or the egg?

Spacecraft developers don't want to design servicable spacecraft unless a servicer is available. The potential servicer developers don't want to build servicing equipment for which there are no users.

NON-SERVICEABLE SPACECRAFT

FAIRCHILD
SPACE COMPANY



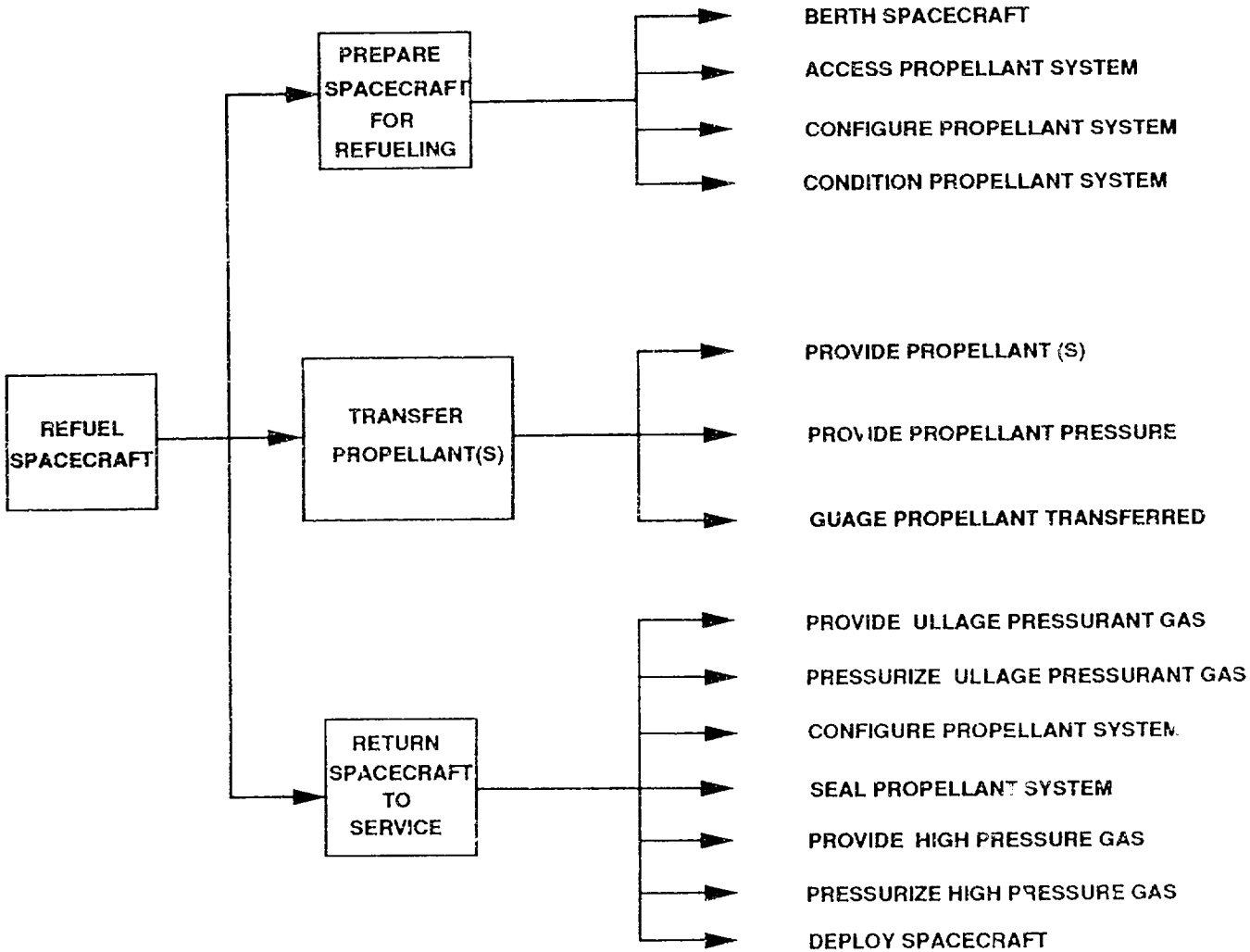
FAIRCHILD
SPACE COMPANY

Let's look at one particular issue: Propellant Resupply. We can design this to be easy or difficult. Consider a few of these steps:

- Acess propellant system - if we can simply agree on a simple, mechanized system to do this - eliminating complex operations and EVA - this step becomes trivial. Agreement, however, is difficult and the mechanism development must be funded.
- Condition Propellant System - This usually means venting of ullage gas to clear pressurant bubbles from screens. Venting is a problem as is ullage gas replacement. Thus if spacecraft tanks are selected which minimize the problem, its a big step forward.
- Provide ullage pressurant gas - If this can be avoided, the operation becomes simpler.
- Pressurize ullage pressurant gas - As above, if this can be avoided, the operation becomes simpler.
- Provide high pressure gas - and . . . .
- Pressurize high pressure gas - These steps refer to the resupply of cold gas propulsion systems and the high pressure gas feed for propulsion systems which utilize pressure regulation to maintain a constant propellant feed pressure. This is a very difficult step which should be "designed around" if possible.

EXAMPLE (CONT'D)

FAIRCHILD
SPACE COMPANY



SERVICING CONCERNS

FAIRCHILD
SPACE COMPANY

Spacecraft propulsion system resupply then, can be divided into these major issues:

- Design for Servicing
- Servicing Technology
- Mechanization

These issues are, however, interrelated such that a choice in one area drives a a selection in another.

In general, resupply will be aided by automation of the fluid transfer control system. This will probably include development of an expert system.

SERVICING CONCERN (CONT'D)

FAIRCHILD
SPACE COMPANY

SERVICING TECHNOLOGY / DESIGN FOR SERVICING	INTERFACE			VENTING TECHNOLOGY			COMPRESSOR FOR ON-ORBIT OPERATION
		MECHANIZATION					
	EVA	GENERAL PURPOSE ROBOT	SPECIAL PURPOSE MECHANISM	LIQUID VAPOR SEPARATOR	VENT PRODUCT SCRUBBER	PROPELLANT PUMP	
USE OF CONSENSUS INTERFACE	X	X	X				
MINIMIZE VENTING				X	X	X	
MINIMIZE GAS RESUPPLY							X
"EASY VENT" PROPELLANT TANK				X	X		

So Where Does Space Station Freedom Come Into Play?

- First, the Servicing Bay - which has been deferred - can help to break the "chicken or egg" logjam. If this bay is well equipped with berthing facilities, consumables resupply tankers and mechanized servicing systems it will allow the spacecraft developers to plan for specific servicing activities.
- Second, as a major, high cost, long term asset, the space station itself will require servicing. This will help to encourage development of the technologies and creation of the hardware needed for servicing operations.
- Third, as a transportation node for the Moon or Mars missions, Space Station Freedom will be a test bed for advanced resupply issues relating to cryogonic resupply.

SPACE STATION FREEDOM

FAIRCHILD
SPACE COMPANY