A photograph of an astronaut in a white spacesuit standing on the lunar surface. The astronaut is holding a shovel and appears to be working on the ground. The background shows the dark, rocky terrain of the moon with some low hills in the distance. The lighting is bright, creating a long shadow of the astronaut on the ground.

**ECONOMIC AND BUSINESS
PARAMETERS FOR A
RETURN TO THE MOON**

NEEP 533 LECTURE 39

Harrison H. Schmitt

FUNDAMENTAL ASSUMPTIONS

- **\$15 B MAXIMUM CAPITAL AVAILABLE**
- **\$140 M / 100 KG FUTURE VALUE OF HELIUM-3 (D/He-3)**
 - **\$1.27 / MILLION BTUs CURRENT COAL CONTRACT PRICE**
 - **\$2.10 / MILLION BTUs CURRENT FUTURES CONTRACTS**
 - **\$2.50 / MILLION BTUs ASSUMED FOR 2010-2015**
 - **100 KG HELIUM-3 = 5.6×10^7 MILLION BTUs (D/He-3)**
- **\$320 MILLION ANNUAL REVENUES FROM 1000 MWe PLANT**
 - **\$0.04 / KW-HR PRICE “AT THE FENCE”**

ASSUMED USES OF DEVELOPMENT CAPITAL

- **\$5 B FOR NEW SATURN LAUNCH CAPABILITY**
- **\$1.5 B FOR LUNAR HELIUM-3 PRODUCTION**
- **\$6 B FOR FUSION POWER**
 - **\$1 B FOR FUSION TECHNOLOGY**
 - **\$5 B FOR FUSION PLANT**
- **PLUS ~\$1 B BENEFIT FROM BRIDGING
BUSINESSES**

NEW SATURN LAUNCH CAPABILITY

- **\$3000 / KG TO THE MOON IS TARGET**
 - **FACTOR OF 19 LESS THAN SATURN V'S \$57,000 / KG**
 - **\$1000 / KG CURRENT COST OF FUEL**
- **10^5 KG PAYLOAD TO THE MOON**
 - **5×10^4 KG PAYLOAD FOR SATURN V**
- **5 LAUNCHES PER YEAR CAPABILITY**
 - **MAXIMUM FOR APOLLO 1968-69**



NEW SATURN ROCKET

“FACTOR OF 19?”

- 1. DESIGN SPECS ARE CLEAR DUE TO APOLLO SUCCESS**
 - 2. NEW, PROVED TECHNOLOGIES**
 - 3. LONG-TERM PRODUCTION CONTRACTS**
 - 4. COMPUTER-BASED DESIGN, MANUFACTURING, AND MANAGEMENT SYSTEMS**
 - 5. DESIGN TO MINIMUM COST AS WELL AS MAX RELIABILITY AND LONGEVITY**
 - 6. EARTH RETURN CAPABILITY TIED TO TOURISM**
 - 7. DOUBLING OF PAYLOAD OVER APOLLO SATURN V**
- AVERAGE FACTOR OF <1.5 REDUCTION FROM EACH SUFFICIENT TO MEET TARGET OF 19 TOTAL**

LUNAR HELIUM-3 PRODUCTION

- **\$1.5 B INCLUSIVE OF ALL BASIC SUPPORT REQUIREMENTS**
 - **MINER-PROCESSOR**
 - **POWER SYSTEM**
 - **VOLATILES REFINERY**
 - **MOON-EARTH TRANSPORT SYSTEM**
 - **HABITATS, ROVERS, ETC.**
- **ANNUAL, FULLY BURDENED PRODUCTION COSTS**
 - **\$476 M /100 KG FOR FIRST MINER-PROCESSOR**
 - **\$146 M / 100 KG AFTER 5TH MINER-PROCESSOR**
 - **~BREAK EVEN AT \$140 M / 100 KG FOR He-3**
 - **\$101 M / 100 KG AFTER 15TH MINER-PROCESSOR**
- **\$585 M ANNUAL REVENUES AFTER 15TH MINER-PROCESSOR**

FUSION TECHNOLOGY DEVELOPMENT

- **\$1 B FOR DEVELOPMENT**
 - **ABOUT 5 POTENTIAL APPROACHES**
 - **2-3 TECHNICAL AREAS PER APPROACH**
 - **10-15 RESEARCH PROJECTS AT ~\$10 M EACH**
 - **~\$150 M TOTAL TO SELECT 2-3 BEST APPROACHES**
 - **FLY-OFF OF BEST APPROACHES**
 - **TAKE TO DEMONSTRATION OF $Q \gg 1$**
 - **FUSION TECHNOLOGY SPIN-OFFS WOULD PROVIDE ADDITIONAL FUNDS**
 - **\$1 B NET BENEFIT ASSUMED**

POWER PLANT DEVELOPMENT

- **\$5 B FOR DESIGN AND
CONSTRUCTION OF
DEMONSTRATION PLANT**
 - **POSSIBLE INVESTMENT IN LUNAR
PRODUCTION CAPABILITY**

HELIUM-3 POWER PLANT ECONOMICS

- **\$320 M ANNUAL REVENUES FROM 1000 MWe PLANT**
 - **\$0.04 / KW-HR PRICE “AT THE FENCE”**
- **\$500 M PLANT COST VS. \$1000 M FOR COAL**
 - **\$1000 / YR COST OF CAPITAL FOR DEVELOPMENT**
 - **\$105 M / YR FUEL COSTS VS. \$180 M**
 - **\$22 M / YR NON FUEL COSTS VS. \$44 M**
- **\$1117 M / YR FOR FIRST PLANT**
- **\$377 M / YR FOR 5TH PLANT**
 - **APPROACHING BREAKEVEN**
- **\$244 M / YR FOR 15TH PLANT (~10 YEARS)**

- **\$1.1 B GROSS INCOME AFTER 15TH PLANT**

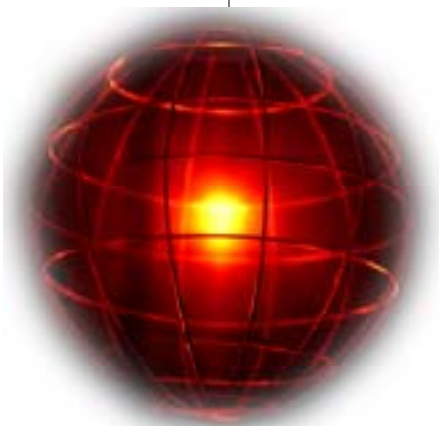
Applications

Near Term

- **Medical Isotope Production**
- **Cancer Therapy**
- **Detection of Explosives**
- **Detection of Chemical Wastes**

Mid-Term

- **Destruction of Fissile Material**
- **Destruction of Radioactive Wastes**



Long Range

- **Small (50-100 MWe) Electrical Power Plants**
- **Use of Advanced Fuels (Helium-3)**
- **Space Propulsion**
- **Base Load Electrical Power Plants**
- **Hydrogen Production**
- **Synthetic Fuel Production**

Availability of a “Mobile” High Energy Proton Source Potentially Very Valuable

Long Term

- **Transmute fission waste products to non-radioactive isotopes**
- **Remotely analyze potentially dangerous materials (neutrons)**
- **Produce radioisotopes for medical treatment**
- **Produce positron emitters for PET diagnostics**

Short Term

DEVELOPMENT PLAN AND MILESTONES

BASED ON **~18*** YEARS FROM
INITIAL FINANCING TO DELIVERY
OF FIRST 100KG HE-3 TO FIRST
OPERATING

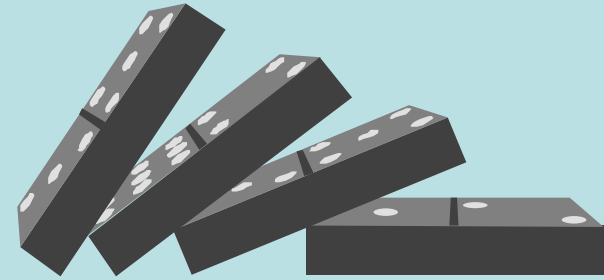
1000 MEGAWATT (e) FUSION PLANT

* INCREASED RATE AND AMOUNT OF FINANCING COULD MAKE
THIS TIME AS SHORT AS **10** YEARS BUT NOT MUCH LESS.

"BUSINESS" APPROACH TO LUNAR COMMERCIAL BASE ACTIVATION

- **BUSINESS PLAN DEVELOPMENT**
 - **INITIAL FINANCIAL COMMITMENTS**
 - **COORDINATION WITH AND MARKETING TO RESOURCE USERS**
- **DEVELOPMENT OF FUSION POWER TECHNOLOGY**
 - **SERIES OF BUSINESS BRIDGES TO PROVIDE REQUIRED ROI**
- **DETAILED CHARACTERIZATION OF THE RESOURCE BASE**
 - **GRADE**
 - **GEOTECHNICAL PARAMETERS**
- **DEFINITION OF ENGINEERING DESIGN PARAMETERS**
 - **MINE PLANNING**
 - **DEVELOPMENT OF BASE ARCHITECTURE AND ACTIVATION SEQUENCE**
 - **LAUNCH VEHICLE REQUIREMENTS**
- **FINAL DEFINITION OF LAUNCH AND SUPPORT ECONOMICS**
- **DETAIL DESIGN, MANUFACTURE, AND IMPLEMENTATION**

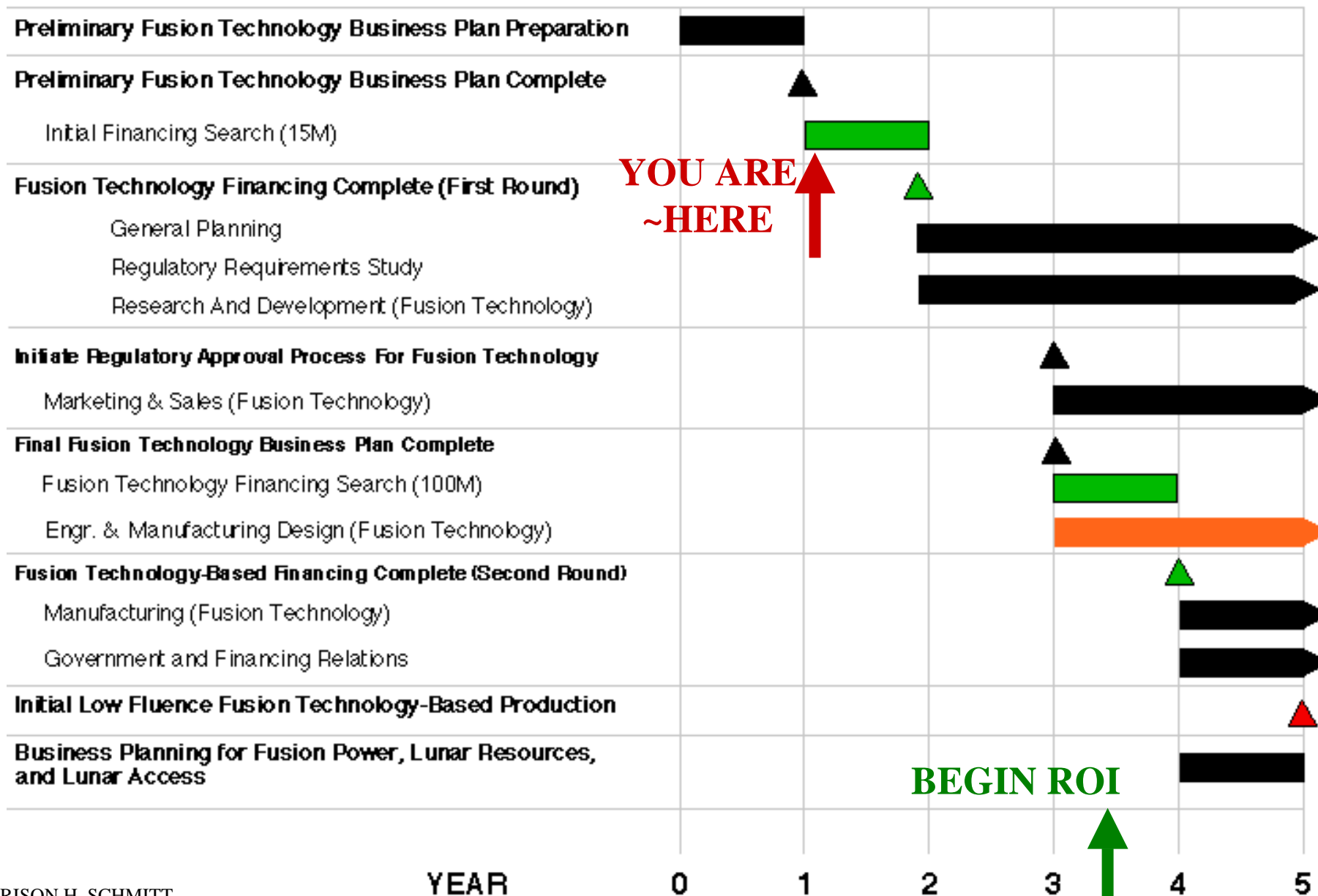
**A COHERENT, LONG TERM
BUSINESS PLAN
CAN BE CREATED
FOR A RETURN TO THE MOON
TO PRODUCE HELIUM-3
AND ITS BY-PRODUCTS**



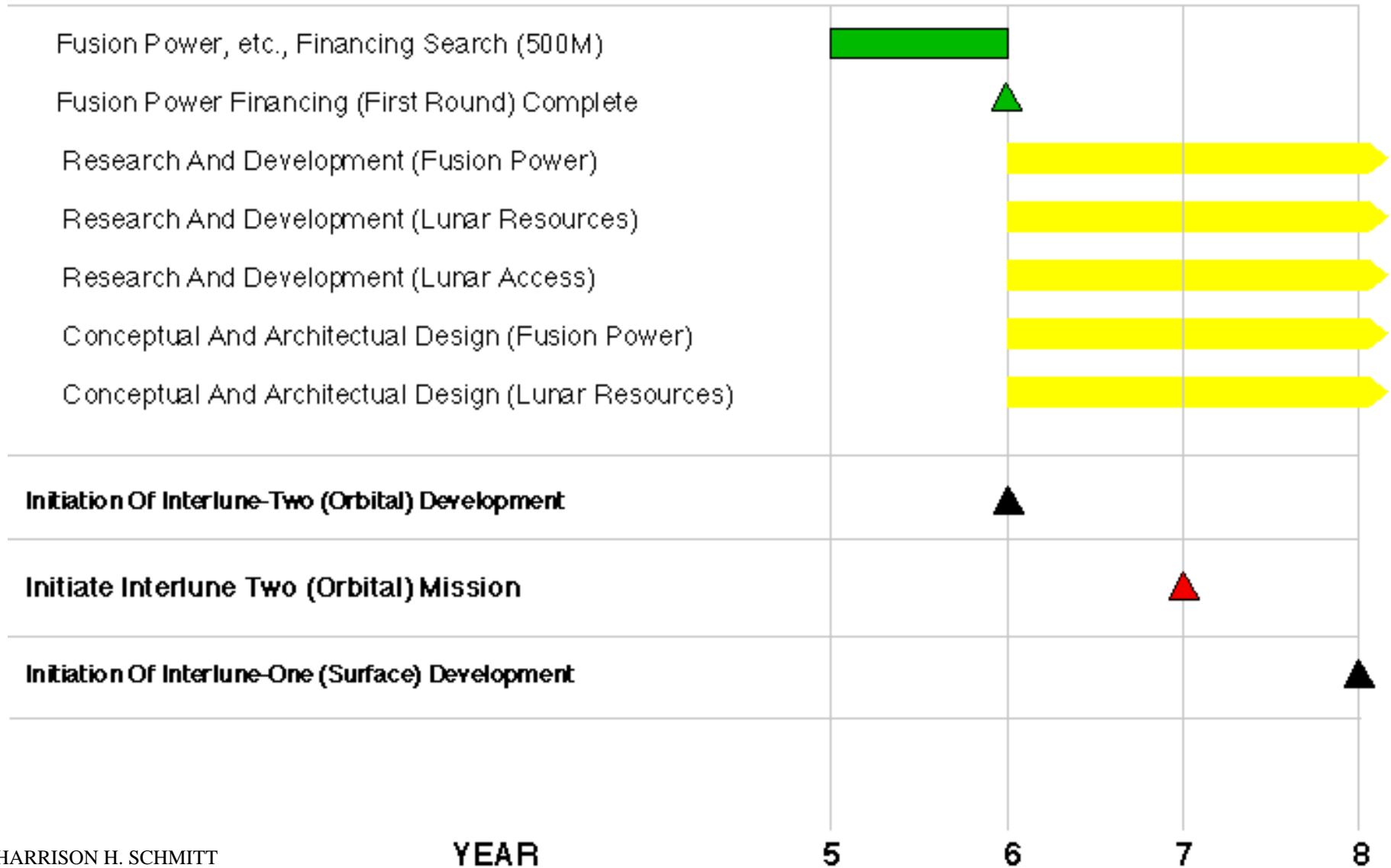
**FOLLOWING CHARTS ILLUSTRATE
THAT A RATIONAL BUSINESS
PLANNING PROCESS IS FEASIBLE.**



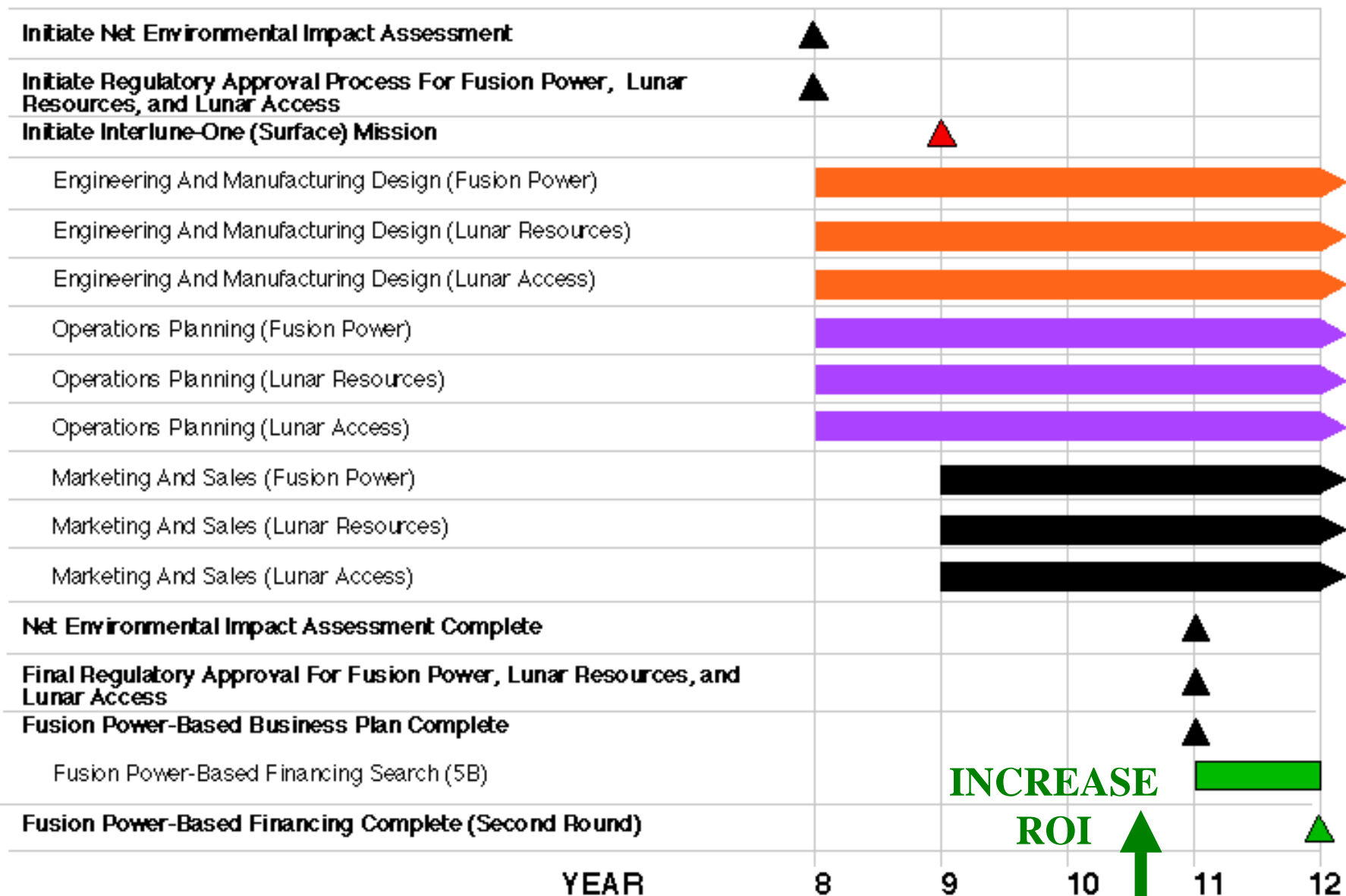
Phase I: Fusion Technology Startup (Venture Financing) – Years 0-5



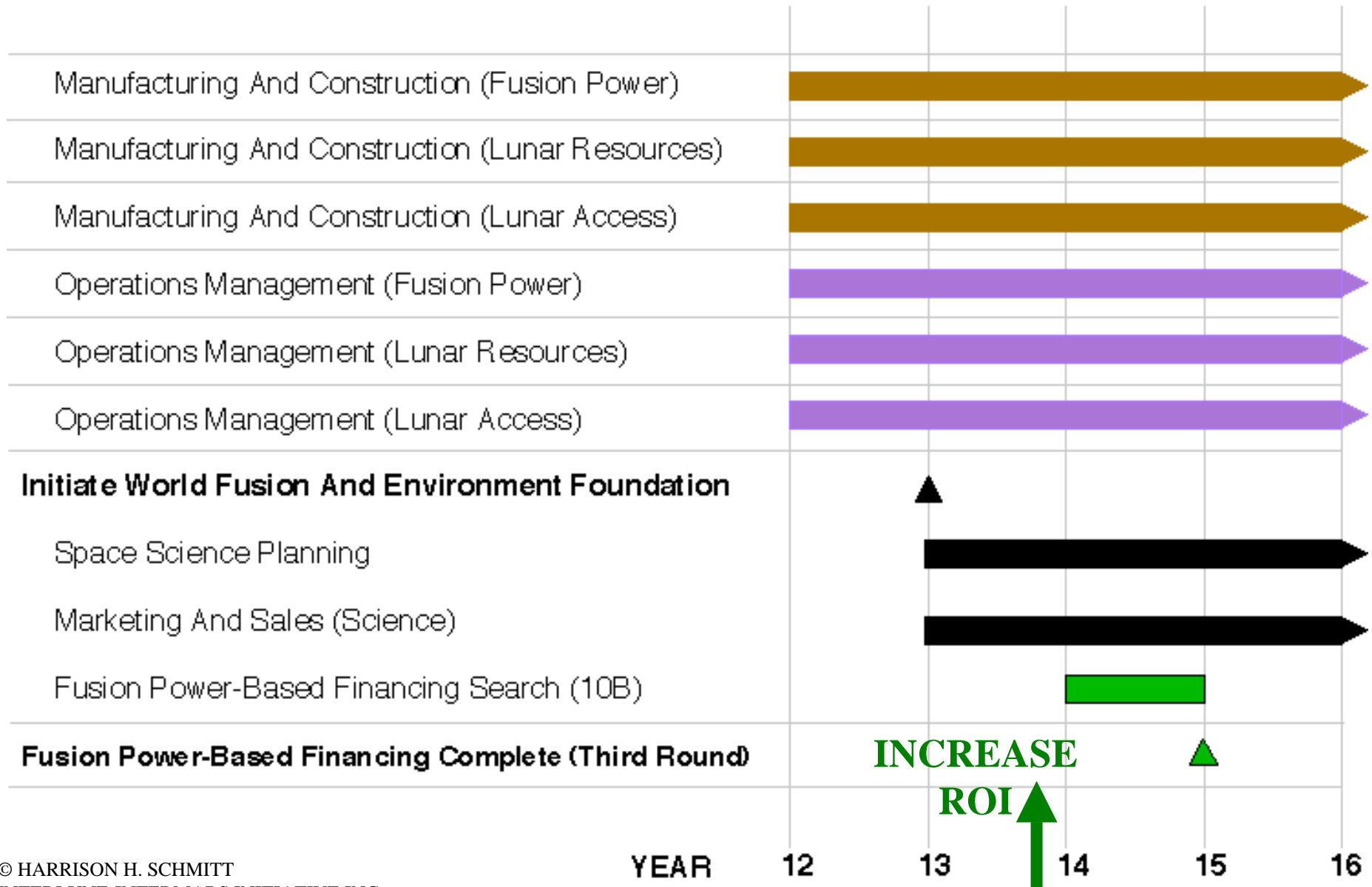
Phase II: Fusion Technology Business (Internal/Debt/Private Equity Financing) – Years 5-8



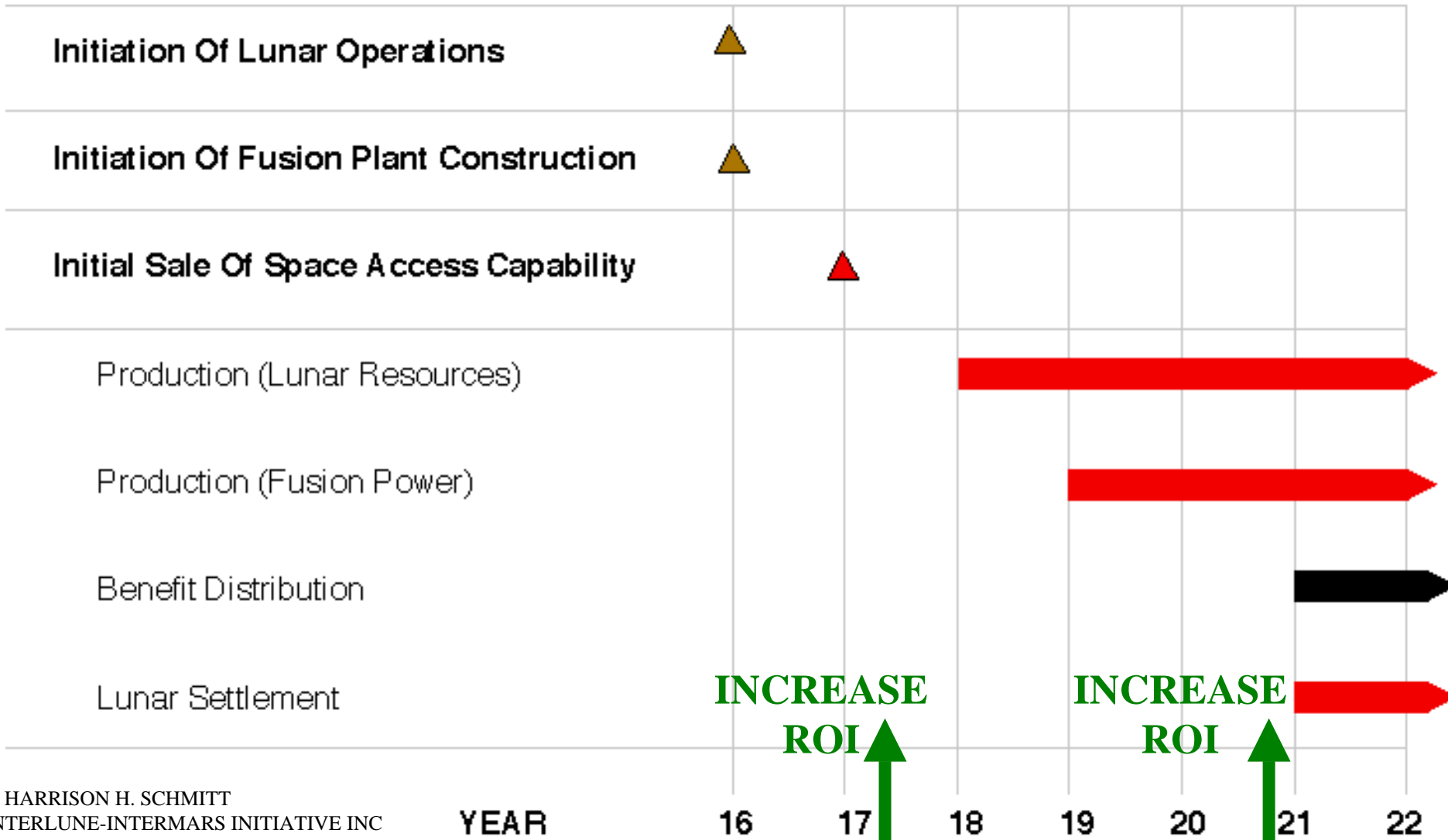
Phase III: Fusion Power/Lunar Resources Startup - Stage One (Internal/Private Equity Financing) - Years 8-12



Phase IV: Stage Two - Fusion Power/Lunar Resources Startup - Stage Two (Internal/Private Or Public Equity Financing) - Years 12-16



Phase V: Fusion Power, Lunar Resources, And Space Access Business (Internal/Public Equity Financing) - Years 16 - Subsequent



MAJOR ISSUES

**FUSION
TECHNOLGY**

**LAUNCH
COSTS**

