TRANSPARENCIES FOR UNIT 12

COOPERATIVE RESEARCH

COOPERATIVE RESEARCH PROMOTES TRANSFER BY...

- PROVIDING MARKET FOCUS
- FACILITATING DESIGN PROCESS
- PROVIDING METHOD TO TRANSFER KNOW-HOW

TYPES OF COOPERATIVE R&D

- CONSORTIA
- SINGLE FIRM
- TECHNICAL ASSISTANCE

gsri

OVERVIEW

COOPERATIVE RESEARCH = POTENTIAL BENEFITS

- — PRIVATE SECTOR
- — UNIVERSITY
- — PUBLIC

MOTIVATIONS FOR COOPERATIVE RESEARCH

- — R & D OBJECTIVES
- — COMMON PROBLEMS
  - SCALE
  - RISK
  - TECHNICAL STAFF DEVELOPMENT
  - HIGH-WIDE TECHNOLOGY BASE

R & D OBJECTIVES, TECHNOLOGY BASE, INDUSTRY STRUCTURE DETERMINE FORM OF COOPERATION

POTENTIAL BENEFITS

POTENTIAL BENEFITS OF COOPERATION	PRIVATE	UNIVERSITY	PUBLIC
◆ BROADER SCOPE OF RESEARCH	✓	✓	✓
◆ REDUCTION IN DUPULICATIVE WORK	✓	✓	✓
◆ LESS CAPITAL INVESTED PER RESULT	✓	✓	✓
◆ BETTER USE OF TECHNICAL PEOPLE	✓	✓	✓
◆ RETAIN SCIENTIFIC LEADERSHIP	✓	✓	✓
◆ MORE RAPID INTEGRATION OF TECHNOLOGIES	✓		✓
◆ RETAIN TECHNOLOGICAL LEADERSHIP	✓		✓
◆ INCREASE PROFITS	✓		
◆ RETURN ON PUBLIC R & D INVESTMENT		✓	✓

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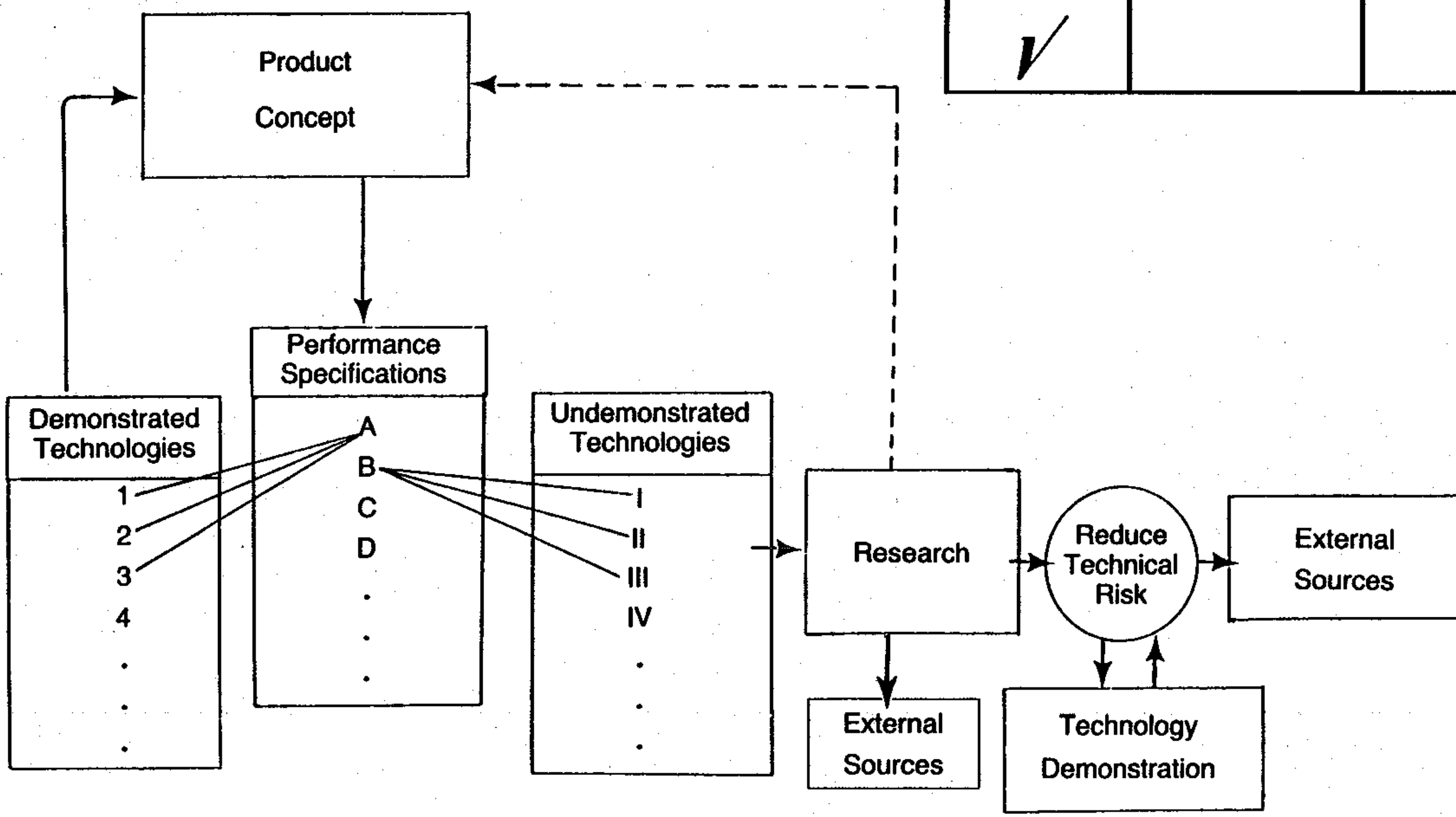
MOTIVATIONS FOR COOPERATIVE RESEARCH

PRIVATE:	RESEARCH OBJECTIVES SPEED TO MARKET APPROPRIABILITY
UNIVERSITY:	RESEARCH OBJECTIVES
PUBLIC LAB:	RESEARCH OBJECTIVES

PRIVATE FIRM

PRODUCT CONCEPTS AND R & D ACTIVITIES

PRIVATE	UNIVERSITY	PUBLIC
✓		



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DURATION BETWEEN CONCEPTION AND COMMERCIAL INTRODUCTION FOR SELECTED INNOVATIONS

	Year of First Conception	Year Of First Realization	Duration Time
Heart Pacemaker	1928	1960	32
Hybrid Corn	1908	1933	25
Hybrid Small Grains	1937	1955	19
Green Revolution Wheat	1950	1966	16
Electrophotography	1937	1959	22
Input-Output Economic Analysis	1936	1964	28
Organophosophorus Insecticides	1934	1947	13
Oral Contraceptive	1951	1960	9
Magnetic Ferrites	1933	1955	22
Video Tape Recorder	1950	1956	6
Average Duration			19.2

Source: Robert C. Dean, Jr., "The Temporal Mismatch - Innovation's Pace vs. Management's Time Horizon", *Research Management,* May, 1974, p. 4 (from Battelle Memorial Institute Study, 1973).

PRIVATE	UNIVERSITY	PUBLIC
✓		

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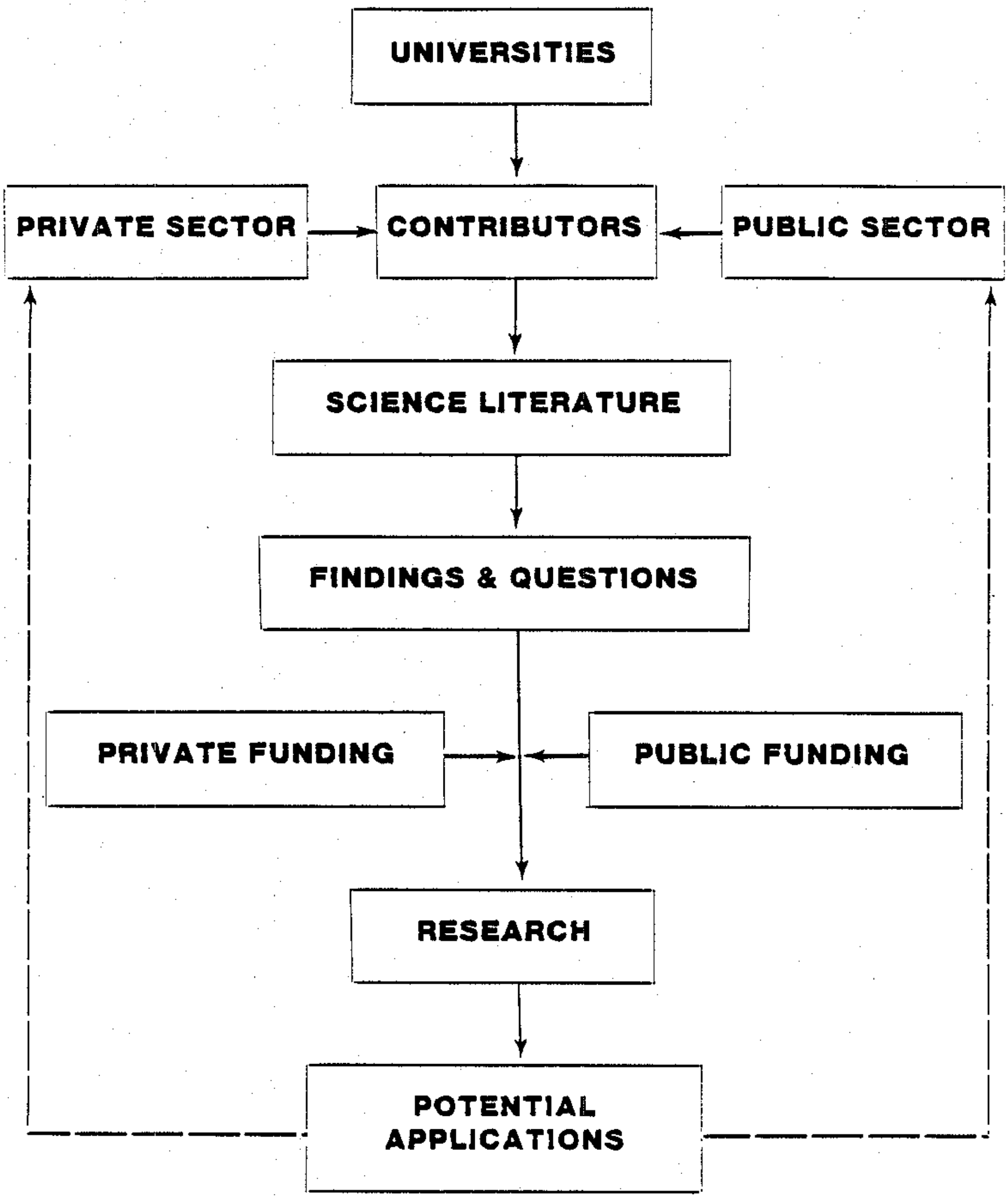
EXAMPLES OF IMITATION BY INDUSTRY RIVALS: MAJOR INVENTIONS

Invention		Inventors	First Successful Commercial Application	Succeeding Applications
Aerodynamic knowledge permitting designs of well-streamlined airplanes	1906-08	Lanchester, working privately. Prandtl, at University of Gottingen, and others mostly at universities. Glider designers, working privately, Northrop while working for Lockheed	Lockheed Vega (1927)	DC-3
Cantilever monoplane	1910-15	Junkers, at Aachen Technische Hochschule, Levavasseur of Antoinette	Junkers F-19 (1919)	Fokker Monoplanes
Slotted Wing	1917-19	Lachmann, working privately, Handley Page Ltd.	Albatross C-72 (1926)	Junkers JU-52
Slotted flap	1920	Handley Page Ltd., O. Mader of Junkers	Albatross C-72 (1926)	Northrup Gamma Lockheed Orion
Cowls for radial engines	1921-28	V. Clark of Dayton-Wright, Townend of the National Physical Laboratory, Weick of NACA	Lockheed Vega (1927)	Northrup Alpha Boeing Monomail
Variable-pitch propeller	1923-29	Hele-Shaw and Beacham, working privately, but with some government funds. Turnbull, again working privately but receving government funds. Caldwell working for the Army, then privately, then for Hamilton-Standard	Boeing 247 (1933)	DC-3
Stressed-skin metal construction	1914-29	Junkers, at Aachen, then forms company, Dornier, working for Zeppelin company. Rohrbach also working for Zeppelin. Wagner, working for Rohrbach's company. Northrop, head of his own company	Northrop Alpha Boeing Monomail (1930)	DC-3
Jet engine	1929-36	Whittle, working privately, von Ohain, working privately. Wagner and Mueller, at Junkers	Boeing 707 (1958)	DC-8
Swept-back wing for transonic and supersonic flight	1935-39	Busemann and Betz at University of Gottingen	Boeing 707 (1958)	DC-8
Variable sweepback for supersonic airplanes	1941-58	Lippisch at Messerchmitt, Stack et al. at NACA, Wallis et al. at Vickers		

Source: R. Miller and D. Savers, *The Technical Development of Modern Aviation*, Rutledge and Kegan Paul, London (1968)

PRIVATE	UNIVERSITY	PUBLIC
✓		

UNIVERSITY & SCIENCE-ORIENTED PUBLIC LAB RESEARCH ACTIVITIES



PRIVATE	UNIVERSITY	PUBLIC
	✓	✓

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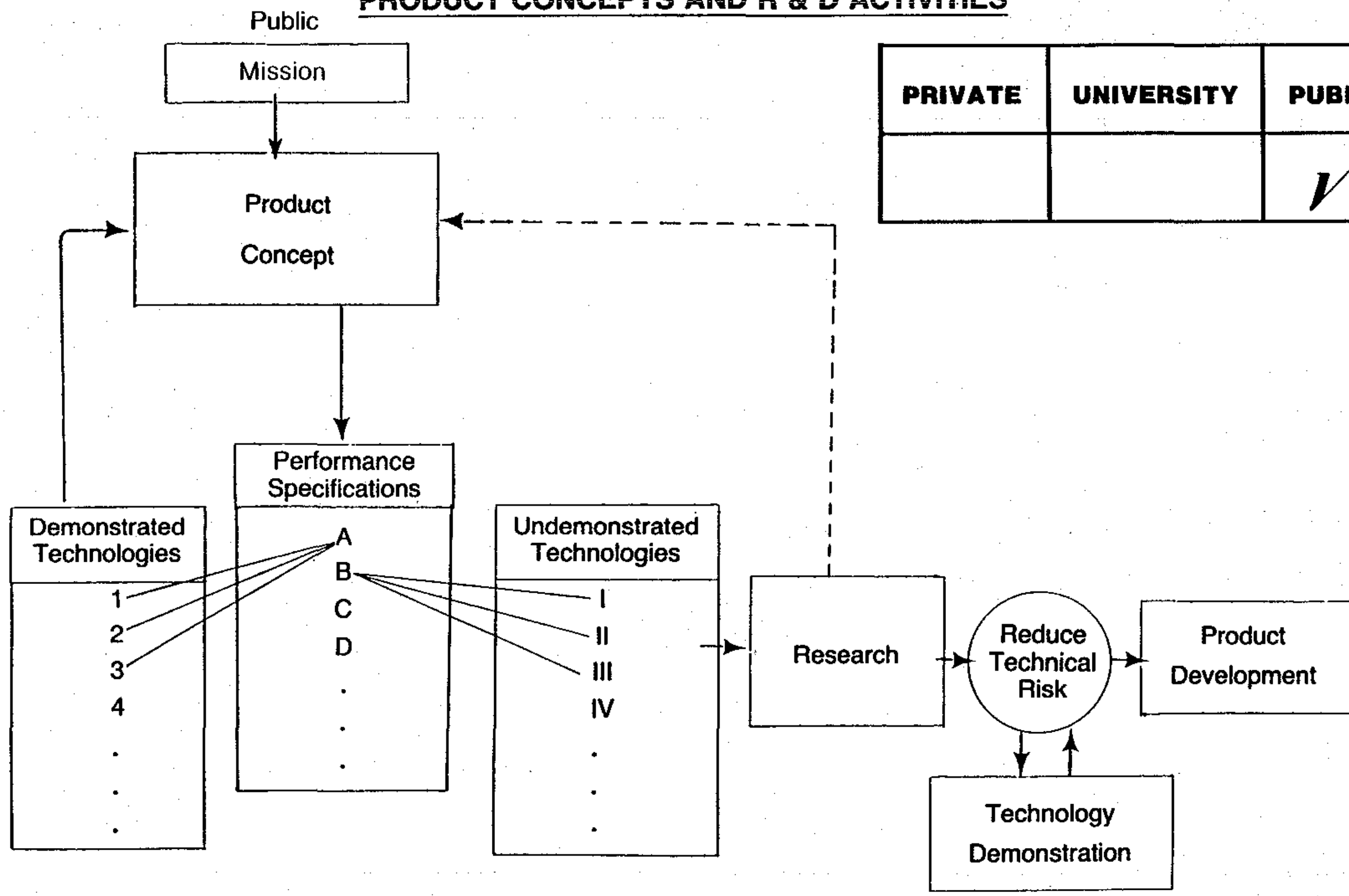
LAB DEVELOPING PRODUCTS

PRODUCT CONCEPTS AND R & D ACTIVITIES

PRIVATE	UNIVERSITY	PUBLIC
		✓



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MOTIVATIONS FOR COOPERATIVE RESEARCH

COMMON PROBLEMS

- SCALE
- RISK
- TECHNICAL DEVELOPMENT OF STAFF
- HIGH-WIDE TECHNOLOGY BASE

PRIVATE	UNIVERSITY	PUBLIC
✓	✓	✓

HIGH TECHNOLOGY BASE

U.S. MANUFACTURERS RANKED BY TOTAL EMBODIED R&D[1]
THE DOC3 DEFINITION OF HIGH-TECHNOLOGY PRODUCTS[2]

SIC CLASS	DESCRIPTION	TOTAL INTENSITY[3] (PERCENT)
376	Guided Missiles and spacecraft	63.86
365,366, 367	Communications equipment and electronic components	16.04
372,[4]	Aircraft and parts	15.40
357	Office, computing, and accounting machines	13.65
348	Ordnance and accessories	13.64
283	Drugs and Medicines	8.37
281	Industrial inorganic chemicals	8.23
38 (excluding) 3825	Professional and scientific instruments	5.70
351	Engines, turbines and parts	5.49
282	Plastic and synthetic materials	5.42
	Weighted average all manufacturers	3.30

[1] The total of direct and indirect R&D expenditures.

[2] High-technology products are defined as those having significantly higher R&D embodies in them. Plastic and synthetic materials have 30 percent more R&D embodies in them than agricultural chemicals (the next group of products in the ranking).

[3] Total R&D expenditures, both direct and indirect, as a percentage of product shipments.

[4] Aircraft and parts includes aircraft engines.

SOURCE: Davis, L.A. "Technology Intensity of U.S. Output and Trade," Office of Trade and Investment Analysis, U.S. Department of Commerce, February 1982.

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HIGH-WIDE TECHNOLOGY BASE

Value of Inputs from High Technology Industries Per Dollar of Total Output of High Technology Industries (1)

SIC Codes	I/O Industry Number	Guided Missiles & Space Vehicles 13.01	Ordnance & Accessories 13.02-13.07	Industrial Chemicals 27.01	Plastics & Synthetic Materials 28	Drugs & Medicines 29.01	Engines, Turbines & Parts 43	Office Computing Accounting Machines 51	Communications & Electronics 56-57	Aircraft & Parts 60	Professional & Scientific Instruments 62-63
376	13.01	.01362	-	-	-	-	-	-	-	.00011	-
348	13.02-13.07	.00065	.08089	.00002	.00001	.00003	-	-	.00002	.00008	-
281	27.01	.00002	.00001	.19229	.28952	.02604	.00005	.00018	.00482	.00082	.00444
282	28	.00110	.00029	.00332	.02075	-		.00146	.01015	.00239	.00696
283	29.01	-	-	-	-	.06151	-	-	-	-	-
351	43	-	.00290	-	-	-	.10745	-	-	.00076	-
357	51	-	-	-	-	-	-	.06476	.00039	.00205	-
365-7	56-57	.05447	.00888	.00007	.00004	.00020	.00004	.05815	.18528	.05789	.01930
372	60	.09302	.00497	.00002	.00001	-	-	.00001	.00001	.15955	.00001
38 exc 3285	62-63	.00746	.00021	.00152	.00159	.00207	.00042	.00326	.00129	.00943	.05482
	High Technology Inputs Excluding Own-Industry Inputs	.15672	.01726	.00495	.29117	.03834	.00051	.06306	.01668	.07353	.03090
	Number of Supplying Industries	6	6	6	5	4	3	5	6	8	5
	Ranking (Based on No. of Supplying Industries)	(2)	(2)	(2)	(3)	(4)	(5)	(3)	(2)	(1)	(3)

(1) Inputs for an industry are read down the column. All numbers are in dollar per dollar of final output.
Source: "The Detailed Input Output Structure of the U.S. Economy, 1972" (Volume 1) (1979)

(2) Aircraft and part includes aircraft engine.

SCALE

LARGER EFFORT IS MORE EFFICIENT:

- COMPUTATIONAL COSTS
- FIXED FACILITIES REQUIRED
- SIZE OF EFFORT REQUIRED

PRIVATE	UNIVERSITY	PUBLIC
✓	✓	✓

RISK

	ENTITY A	ENTITY B
BUDGET	$10	$10
NO. OF PROJECTS	1	4
PROBABILITY OF SUCCESS — EACH PROJECT	0.5	0.5
TOTAL EXPECTED PAYOFF	20	20
STD. DEV.	31.6	10.7

PRIVATE	UNIVERSITY	PUBLIC
✓	✓	✓

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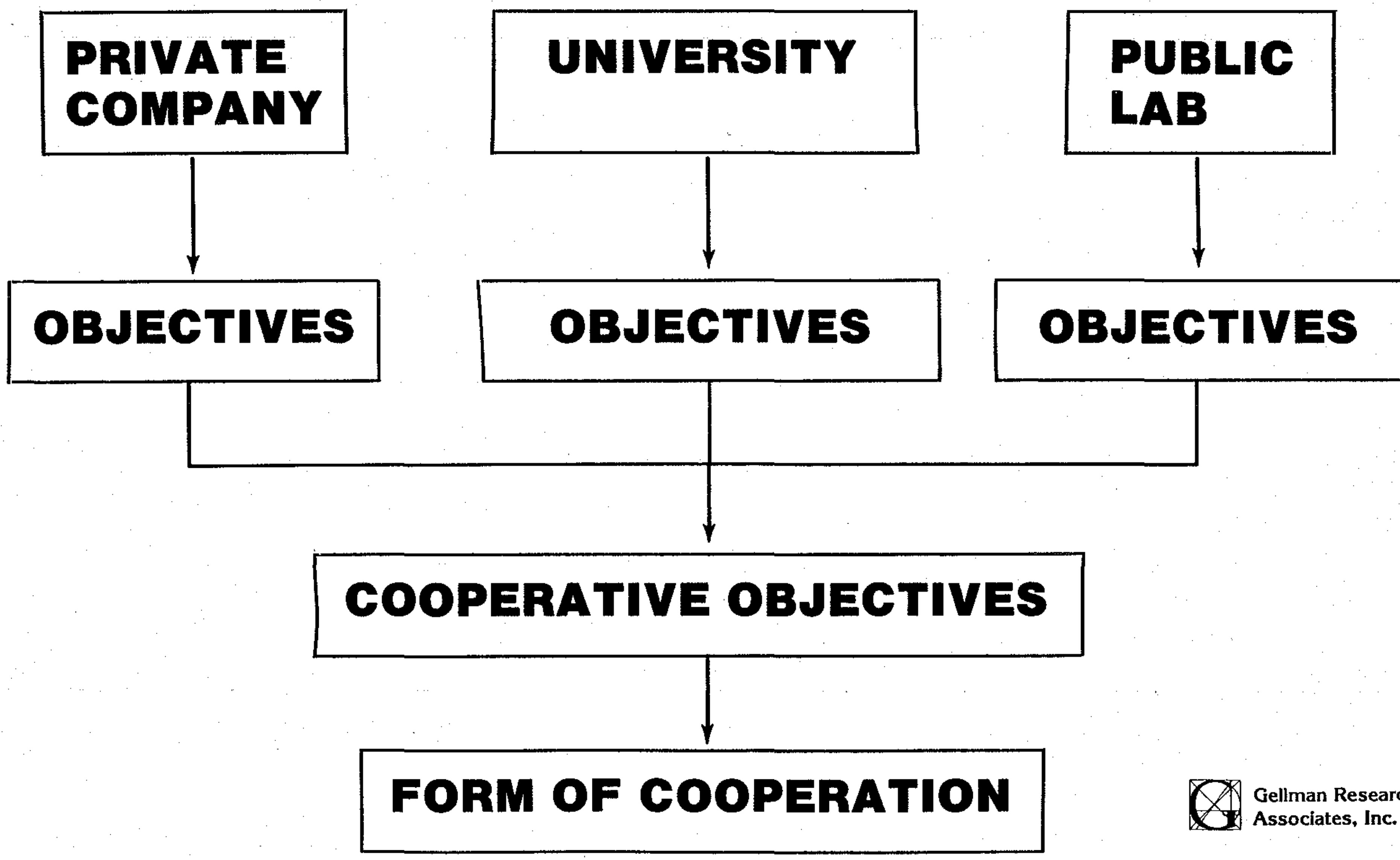
FORM OF COOPERATION



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INDUSTRY STRUCTURE

CONDITION	CAUSE	RESULT
FEW COMPETITORS	SUNK COSTS LICENSE TO OPERATE TECHNOLOGY PATENTS	NO COOPERATION —INDUSTRY EVOLVING TOWARD SINGLE FIRM
DIFFERENTIATED PRODUCTS	CONSUMER DEMAND	COOPERATION —COMPETITION IS INDIRECT
INTERNATIONAL BARRIERS OR SUBSIDY	PUBLIC POLICY	COOPERATION TO MEET A COMMON THREAT

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TECHNOLOGY CHARACTERISTICS

WIDE TECHNOLOGY BASE

MULTIPLE APPLICATIONS

HIGH COST TO NEXT TECHNOLOGICAL STEP

MULTIPLE DIRECTIONS POSSIBLE TO REACH NEXT TECHNOLOGICAL STEP

MULTIPLE DISCIPLINES TO BE INTEGRATED TO REACH NEXT TECHNOLOGICAL STEP

BASIC RESEARCH REQUIRED TO REACH NEXT TECHNOLOGICAL STEP

SCIENCE LEADERSHIP IN UNIVERSITIES OR PUBLIC LAB

EXAMPLES

COOPERATIVE CONSORTIUM	CHARACTERISTICS
MCC	COMMON THREAT HIGH COST TO NEXT STEP MULTIPLE DISCIPLINES MULTIPLE APPLICATIONS DIRECT COMPETITORS INVOLVED RISK BASIC RESEARCH
NASA	HIGH COST TO NEXT STEP RISK DIRECT COMPETITORS INVOLVED APPROACHABILITY PUBLIC MISSION BASIC & APPLIED RESEARCH
SEMI CONDUCTOR	COMMON THREAT SCIENCE LEADERSHIP IN UNIVERSITIES HIGH COST TO NEXT STEP RISK DIRECT COMPETITORS INVOLVED BASIC RESEARCH

HOW TO MAKE IT HAPPEN . . .

NO COOKBOOK

DIRECT METHODS

- ANALYZE RESEARCH PROGRAMS FOR POTENTIAL COMMERCIAL APPLICATIONS
  - ON-GOING WORK
  - NEW PROJECTS
- RELY PRIMARILY ON PERSONAL CONTACTS WITH INDUSTRY TO IDENTIFY POTENTIAL COOPERATIVE PROJECTS
- DISCUSS INDUSTRIAL INTEREST WITH INDUSTRY CONTACTS
- FIND COMMON RESEARCH OBJECTIVES
- STRUCTURE AGREEMENTS

INDIRECT METHODS

- ATTEND INDUSTRY MEETINGS
- SPONSOR LABORATORY MEETINGS WITH INDUSTRY
- PUBLIC INFORMATION