Tech-89

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SURVEYS ON THE USE OF ADVANCED TECHNOLOGY IN MANUFACTURING

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SURVEYS ON THE USE OF ADVANCED TECHNOLOGY IN MANUFACTURING

Objective

The objective of this paper is to obtain guidance from the members of the American Economic Association Advisory Committee on the development of a survey dealing with the use of advanced technology in manufacturing. This paper provides background information on our efforts to develop technology surveys, the results of our first survey on technology, and a discussion of issues related to the development of a second, more detailed survey. Included are questions we would like the members of the Advisory Committee to address in order to assist us in developing a more useful and comprehensive survey.

Background

Several years ago, we perceived a need for comprehensive data on the pattern of use and diffusion of process technologies across major manufacturing industries. In numerous articles and papers, the point was repeatedly made that the future productivity and competitiveness of American industry will depend, to a large extent, upon regaining our former leadership in the development and use of manufacturing technology. This view was clearly stated in the Report of the President's Commission on Industrial Competitiveness: "Perhaps the most glaring deficiency in America's technological capabilities has been our failure to devote enough attention to manufacturing or 'process' technology." With more and more of our industrial base dependent on new technology, industry not only must increase its efforts to develop new technologies by increasing its research and development investment in innovation, it also must do a better job in adopting and applying technologies in the manufacturing process.

In an effort to address this important issue, a group was formed within the Industry Division of the Bureau of the Census in 1986 to begin developing a survey aimed at measuring the current use and planned use of advanced technology within the manufacturing sector.

As part of the survey development process, copies of the initial questionnaire and technology definitions were sent to a broad cross section of Government, private industry, and academic experts for comment. They were asked to comment on the following aspects of the survey: 1) the need for and usefulness of the data; 2) survey content; 3) survey definitions; 4) planning horizon intervals for acquiring selected technologies; and, 5) suggestions for follow-on surveys. Of those responding, almost 90 percent agreed that there was a need for this type of data. Most indicated that the need was critical and many reported that no other data sources were available.

Based on the feedback we received from these groups, we proceeded with our development of the survey. We decided to collect information about the prevalence of 17 advanced technologies in the areas of design and engineering, fabrication/machining and assembly, automated material handling, automated sensor-based inspection and/or testing equipment, and

communications and control. Since these technologies are used to fabricate solids using discrete manufacturing processes, we chose to limit the survey coverage to five major industrial groups. They are as follows:

Major Group 34 - Fabricated Metal Products
Major Group 35 - Industrial Machinery and Equipment
Major Group 36 - Electronic and Other Electric Equipment
Major Group 37 - Transportation Equipment
Major Group 38 - Instruments and Related Products

Although other industries used these and other technologies to some extent, we felt that including other industries would create problems by introducing complexity. In addition, other major industries were not as homogeneous in their manufacturing processes.

We planned to conduct the survey in two phases. First, questionnaires would be sent to all 40,000 establishments in the major 2-digit industry groups asking whether or not they used one or more of 17 selected technologies and, if not, were there any plans to acquire the technologies. Then, for those plants returning completed questionnaires indicating they either used or were planning to use selected technologies, a second questionnaire would be mailed asking more detailed questions about those technologies.

Then, in 1987, we faced the realities of resource constraints and began to look for less costly ways to collect the information. Rather than canvassing all 40,000 establishments in Major Groups 34-38, and following up with more detailed questionnaires, we chose to select a random sample of about 10,000 establishments classified in these major industry groups. At the same time, we began making inquiries with various government and private trade groups to see if they might be able to assist with funding for the survey. As it turned out, the Defense Logistics Agency, part of the Department of Defense, was very interested in this project and ultimately agreed to help fund the scaled-back sample version of the survey.

The questionnaire was designed to obtain reliable measures of prevalence for 17 advanced technologies, plans to use, reasons for no plans to use, and limited information on plant characteristics. Once this first survey was completed in 1988, our plan was to then use the results to guide us in the selection of the most prevalent technologies and industries for a second, more detailed survey to be conducted independently sometime in 1989 or 1990 depending upon the availability of funding.

Because a survey of this kind had not been conducted before, we decided to pretest the questionnaire and survey procedures using a sample of 300 manufacturing plants. The pretest was successfully carried out during August-October 1987. The full survey was carried out during the period of August-November 1988. (Copies of the cover letter, survey definitions, and questionnaire are attached for your information).

Results From 1988 Technology Survey

The preliminary results were tabulated and are scheduled for release in March 1989. Copies of the preliminary report will be made available at the meeting of the Advisory Committee in April.

A final report is scheduled for release in late 1989. For this report, we are considering matching the response cases from the technology survey to the 1987 Census of Manufactures file in an effort to obtain more detailed information about the plants than was collected in the initial survey. Using the information from the census, we are considering developing various ratios for comparison with technology use. These could include: 1) value added per employee; 2) value added per production worker hour; 3) average hourly earnings of production workers; 4) payroll per employee; and 5) production workers as a percentage of total employment.

It should also be pointed out that, during the past two years, we worked closely with the Canadian and Australian statistical agencies to help them to develop similar technology surveys. The Canadian survey was carried out by Statistics Canada and the final report was released in June 1987. (Copies of several selected tables are attached). We are currently discussing with them the possibility of preparing a joint report comparing the results of their survey with those from our survey. The Australian survey was conducted in 1988 and we are awaiting the results.

Plans for Future Technology Surveys

Now that our work on the first survey is nearing completion, we are turning our attention to planning for the second, more detailed survey dealing with advanced technology. As a part of this process, we are soliciting comments and guidance from a variety of groups, such as the AEA, to ensure that the data we collect are relevant to the needs of data users.

As a first step, we met recently with representatives from various government and industry organizations with an interest in technology and its use in the manufacturing sector. At this meeting, we presented a tentative survey plan. The plan called for using the results of the first technology survey to guide us in the development of the second survey that would focus on a smaller number of technologies (2 or 3 technologies) and to limit coverage to a smaller number of major industries (1 or 2 industries) where the technologies were most prevalent. The survey would be based on a random sample of manufacturing establishments drawn from the 1987 Census of Manufactures frame. A questionnaire would be mailed to the plant manager or engineer of each sampled establishment asking whether or not they currently used or planned to use the selected technologies in the production process.

For technology currently in use, a series of specific questions would be asked. Suggested possible major areas of inquiry were as follows:

- number of (selected technology) units in place and for how long
- number of (selected technology) units plan to acquire and time frame
- specific uses in the production process
- assessment of utility
- factors influencing decision to acquire technology
- degree of satisfaction with technology

- effect on work force
- problems encountered during acquisition/implementation

For technology not currently in use, but which the plant plans to acquire, the following areas of inquiry were suggested:

- number of (selected technology) units plan to acquire
- time frame
- factors influencing decision to acquire technology
- anticipated problems with acquisition/implementation

For each technology that is not currently in use with no plans to acquire, the following topic of inquiry was suggested:

- factors influencing decision not to acquire the technology

From this meeting, five major objectives for the second survey emerged. What follows is a priority ranking of these objectives, including a brief discussion of each:

Objective 1: Quantifiable Measures of Technology Use

The survey must provide some quantifiable measure(s) of the use of selected technologies. From the first survey, all we know is whether or not a particular plant uses the technology in operations. We cannot differentiate between those plants using only one unit versus those with hundreds of units in place. The group agreed that quantification was extremely important. Possible alternatives include attempting to find out what proportion of the production process is affected by the technology or measuring technology use as a function of plant capacity.

Objective 2: Decision Making Process to Invest in Technology

There is a need for information concerning the process by which decisions to acquire or not to acquire technology get made. The survey should attempt to describe the process of justification companies go through in deciding to purchase advanced technology. The survey should illuminate primary economic factors and organizational, size, and structural elements as they relate to the decision-making process.

Objective 3: Anticipated/Unanticipated Problems

Information should be collected concerning anticipated and unanticipated problems encountered in the acquisition and implementation of advanced technologies. These would include such things as long lead times, problems with availability, high cost, lack of engineering/technical resources, training problems, problems with installation and testing, software problems, lack of standards/compatibility, and opposition from management/labor.

Objective 4: Effect on Workforce

There is a need to obtain more detailed information on the effect of the technology on the workforce. Included here are such things as additional training requirements, skill requirements, layoffs, re-assignments, literacy and specialization requirements, and sources of new labor.

Objective 5: Sources of Technology

It is important to find out more about the sources of various technologies. Included here is information concerning the extent to which technologies are developed within the company, obtained from outside sources, or obtained through a combination of the two. For those technologies obtained from

outside sources, it is important to know to what extent those sources are foreign or domestic.

Questions To Be Addressed

In our effort to develop the final report based on a match to the 1987 Census of Manufactures file and to further refine the scope and content of the second technology survey, we need the AEA Advisory Committee's help. There are several major questions we would like you to consider. They are as follows:

1. Are the items we are planning to use from the match to the census file for the final report useful in comparing to technology usage? If not, why not? Are there any additional items from the census that you think should be considered?

2. Are the objectives outlined for the second survey sufficiently comprehensive or are there others that should be considered? If yes, what are they and why?

3. Do you agree or disagree with the ranking of the objectives? If you disagree, why, and what ranking would you like to see? If we had to cut back the number of objectives due to resource constraints, which objectives should be cut?

4. With regard to the first objective dealing with the need for quantification, what measures would be most meaningful? Number of units in place? Value of technology as a percentage of total value of equipment? Total investment? What, if any, problems do you see in collecting this type of information?

5. With respect to the second objective pertaining to the decision-making process, what do you think are the principal economic factors that are taken into account? Return on investment? Cost of investment? Increased productivity? Meeting competition? Increased efficiency? Higher quality? Which of these are most important? How would you suggest we go about measuring these factors?

6. Are there any other comments or suggestions you have concerning the scope and content of the proposed survey?

SMT-L1
(8-88)

UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

OFFICE OF THE DIRECTOR

TO PLANT MANAGER OR ENGINEER

The health of the U.S. economy depends, to a large degree, on the productivity and competitiveness of American industry. To remain strong in the face of world competitive pressures, American industry must remain a leader in the development and use of advanced manufacturing technologies. Policymakers in Government and leaders in industry have expressed an increased need for information to assess patterns of use and diffusion of advanced manufacturing technologies across major manufacturing industries. In the absence of comprehensive and consistent information on this topic, the Bureau of the Census is conducting the enclosed Survey of Manufacturing Technology as a supplement to the 1987 Economic Censuses.

We selected the establishment shown on the enclosed report form as part of a larger sample of establishments that represent U.S. manufacturers. It is important that we receive a response from each of these selected establishments, including yours, and that the department or authority most familiar with this plant's operations respond frankly to this survey.

The law (Title 13, United States Code, Sections 193 and 224) requires your response to this survey, and by Section 9 of the same law your report to the Census Bureau is confidential. Only sworn Census Bureau employees will see the information you report and they will use it only for statistical purposes. Please return the completed report within 30 days. If you have any questions regarding this survey, please call Mr. Ken McBeth on (301) 763—7535.

Thank you for your cooperation in this important survey. The Census Bureau appreciates your help.

Sincerely,

John G. Keane

JOHN G. KEANE

Enclosure

DEFINITION OF TERMS FOR SECTION A

COMPUTER-AIDED DESIGN (CAD) AND/OR COMPUTER-AIDED ENGINEERING — Use of computers for drawing and designing parts or products and for analysis and testing of designed parts or products.

COMPUTER-AIDED DESIGN (CAD)/ COMPUTER-AIDED MANUFACTURING (CAM) — Use of CAD output for controlling machines used to manufacture the part or product.

DIGITAL DATA REPRESENTATION — Use of digital representation of CAD output for controlling machines used to manufacture the part or product.

NC/CNC MACHINE — A single machine either numerically controlled (NC) or computer numerically controlled (CNC) with or without automated material handling capabilities. NC machines are controlled by numerical commands, punched on paper or plastic mylar tape while CNC machines are controlled electronically through a computer residing in the machine.

FLEXIBLE MANUFACTURING CELL (FMC) — Two or more machines with automated material handling capabilities controlled by computer(s) or programmable controller(s), capable of single path acceptance of raw material and single path delivery of finished product.

FLEXIBLE MANUFACTURING SYSTEM (FMS) — Two or more machines with automated material handling capabilities controlled by computer(s) or programmable controller(s), capable of multiple path acceptance of raw material and multiple path delivery of finished product. A FMS may also be comprised of two or more FMC's linked in series or parallel.

MATERIALS WORKING LASER — Laser technology used for welding, cutting, treating, scribing, and marking.

ROBOT — A reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

PICK AND PLACE ROBOT — A simple robot, with one, two, or three degrees of freedom, which transfers items from place to place by means of point-to-point moves. Little or no trajectory control is available.

AUTOMATIC STORAGE AND RETRIEVAL SYSTEM (AS/RS) — Computer controlled equipment providing for the automatic handling and storage of materials, parts, subassemblies, or finished products.

AUTOMATIC GUIDED VEHICLE SYSTEM (AGVS) — Vehicles equipped with automatic guidance devices programmed to follow a path that interfaces with work stations for automated or manual loading and unloading of materials, tools, parts, or products.

TECHNICAL DATA NETWORK — Use of local area network (LAN) technology to exchange technical data within design and engineering departments.

FACTORY NETWORK — Use of local area network (LAN) technology to exchange information between different points on the factory floor.

PROGRAMMABLE CONTROLLER — A solid state industrial control device that has programmable memory for storage of instructions, which performs functions equivalent to a relay panel or wired solid state logic control system.

COMPUTERS USED FOR CONTROL ON THE FACTORY FLOOR — Exclude computers imbedded within machines, or computers used solely for data acquisition or monitoring. Include computers that may be dedicated to control, but which are capable of being reprogrammed for other functions.

FORM **SMT-1**
(7-18-88)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

SURVEY OF MANUFACTURING TECHNOLOGY

Please complete this form and RETURN TO

BUREAU OF THE CENSUS
1201 East Tenth Street
Jeffersonville, IN 47133

Please refer to Definition of Terms on the reverse side of the transmittal letter.

NOTICE — Response to this inquiry is required by law (title 13, U.S. code). By the same law, your report to the Census Bureau is confidential. It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

In correspondence pertaining to this report, please refer to this Census File Number (CFN)

Section A — TECHNOLOGY USE

INSTRUCTIONS

For EACH of the technologies listed below, mark (X) in the column that best reflects this plant's use of or plans for that technology. Report each technology separately even though it may be used within a "cell" or "system". Be sure to mark the appropriate column 4—6 if there are no plans to use the technology.

		Used in operations	Not currently used in operations				
			Plan to use within:		No plans to use because:		
			The next 2 years	2 – 5 years	Does not apply to operations	Not cost effective	Other
		(1)	(2)	(3)	(4)	(5)	(6)
1. DESIGN AND ENGINEERING							
a. Computer aided design (CAD) and/or computer aided engineering (CAE)	11						
b. CAD output used to control manufacturing machines (CAD/CAM)	12						
c. Digital representation of CAD output used in procurement activities	13						
2. FABRICATION/MACHINING, AND ASSEMBLY							
a. Flexible manufacturing cell(s) (FMC) or system(s) (FMS)	21						
b. NC/CNC machine(s)	22						
c. Materials working laser(s)	23						
d. Pick and place robot(s)	24						
e. Other robots	25						
3. AUTOMATED MATERIAL HANDLING							
a. Automatic storage and retrieval system (AS/RS)	31						
b. Automatic guided vehicle systems (AGVS)	32						
4. AUTOMATED SENSOR BASED INSPECTION AND/OR TESTING EQUIPMENT							
a. Performed on incoming or in process materials	41						
b. Performed on final product	42						
5. COMMUNICATIONS AND CONTROL							
a. Local area network for technical data	51						
b. Local area network for factory use	52						
c. Intercompany computer network linking plant to subcontractors, suppliers, and/or customers	53						
d. Programmable controller(s)	54						
e. Computer(s) used for control on the factory floor	55						

PLEASE CONTINUE ON REVERSE SIDE →

Section B — CHARACTERISTICS OF THIS ESTABLISHMENT

1. How many years has this establishment manufactured products at this location? — 01

- 1 ☐ Less than 5 years
- 2 ☐ 5 to 15 years
- 3 ☐ 16 to 30 years
- 4 ☐ Over 30 years

2. How would you characterize the nature of manufacturing at this plant? — 02

- 1 ☐ Fabrication/Machining
- 2 ☐ Assembly
- 3 ☐ Fabrication/Machining and assembly
- 4 ☐ Neither fabrication/machining nor assembly

3. What is the average market price for most products of this plant? — 03

- 1 ☐ Less than $5
- 2 ☐ $5 to $100
- 3 ☐ $101 to $1000
- 4 ☐ $1001 to $2000
- 5 ☐ $2001 to $10,000
- 6 ☐ Over $10,000

4. What is the market for most products of this plant? — 04

- 1 ☐ Consumer (personal use by household)
- 2 ☐ Commercial (e.g. offices, hospitals, services, etc.)
- 3 ☐ Industrial (manufacturing, mining, construction, and utilities)
- 4 ☐ Transportation
- 5 ☐ Government
- 6 ☐ Other
- 7 ☐ Can't specify

5. Are any of the products produced in this plant manufactured to military specifications? — 05

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Don't know

6. Are any of the products manufactured at this plant shipped directly to Federal defense agencies (such as the Department of Defense, Departments of the Army, Navy, Air Force, Marine Corps, the Defense Logistics Agency, etc.)? — 06

- ☐ Yes — What percentage (based on value of goods and services) of all products manufactured at this plant are shipped to Federal defense agencies on an annual basis?
  - 1 ☐ 1–25%
  - 2 ☐ 26–75%
  - 3 ☐ Over 75%
  - 4 ☐ Don't know
- 5 ☐ No
- 6 ☐ Don't know

7. Are any of the products manufactured at this plant shipped to other companies that are prime contractors to Federal defense agencies. — 07

- ☐ Yes — What percentage (based on value of goods and services) of all products manufactured at this plant are shipped to prime contractors on an annual basis?
  - 1 ☐ 1–25%
  - 2 ☐ 26–75%
  - 3 ☐ Over 75%
  - 4 ☐ Don't know
- 5 ☐ No
- 6 ☐ Don't know

Section C — VERIFICATION

Please check to make certain that one column is marked for EACH of the technologies listed in section A and one box is marked for EACH of the characteristics in section B. This is very important since it affects our ability to process the survey results.

THANK YOU FOR YOUR COOPERATION

Remarks

Section D — CONTACT

Name of person to contact regarding this report		Telephone		
		Area code	Number	Extension
Title of contact	Date			

SURVEY OF MANUFACTURING TECHNOLOGY
JUNE 1987

FINAL REPORT

Classification Systems Branch
Statistics Canada

Table 1 The technologies

Technology group	Technology
1 Design and Engineering	
	1.1 Computer-aided design (CAD) and/or computer-aided engineering (CAE)
	1.2 CAD output to control manufacturing machines (CAD/CAM)
	1.3 Digital data representation of CAD output used in procurement activities
2 Fabrication and Assembly	
	2.1 Standalone NC/CNC machines
	2.2 Flexible manufacturing cells (FMC)
	2.3 Flexible manufacturing systems (FMS)
	2.4 Laser-based fabrication equipment
	2.5 Simple pick and place robots
	2.6 Other more complex robots
3 Automated Material Handling	
	3.1 Automated storage and retrieval system (AS/RS)
	3.2 Automated guided vehicle systems (AGVS)
4 Computer-based Inspection, Sensor and Testing Equipment	
	4.1 Performed in process
	4.2 Performed on the final product
5 Communications and Control	
	5.1 Local area network for technical data
	5.2 Local area network for factory use
	5.3 Intercompany computer network linking plant to suppliers and/or customers
	5.4 Programmable controllers
	5.5 Industrial computers used for control on the factory floor

Table 7 Percentage of responding establishments in the industry which used the technology

Industry	Technology group: 1 Design and engineering			2 Fabrication and assembly					
	Technology: 1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6
Food, beverages, tobacco	9	7	7	10	9	8	2	4	3
Rubber and plastics	22	10	9	17	13	7	3	11	7
Leather, textiles, clothing	15	9	6	13	5	4	1	3	1
Wood	13	12	8	14	9	9	6	4	2
Furniture and fixture	8	3	4	12	5	3	2	6	2
Paper and allied products	14	9	11	19	7	4	3	6	3
Printing, publishing and allied	16	10	6	15	5	5	7	2	--
Primary metal	32	18	10	24	12	9	4	15	8
Fabricated metal products	20	11	6	29	7	6	3	5	3
Machinery	38	20	12	49	11	9	5	4	7
Transportation equipment	35	22	13	35	18	15	7	23	17
Electrical and electronic products	43	19	19	34	14	11	6	13	6
Non-metallic mineral products	14	10	6	21	15	12	2	11	3
Petroleum and chemicals	18	5	7	12	8	6	1	7	2
Other manufacturing	13	6	4	13	4	3	2	4	1
All manufacturing	18	10	8	19	9	7	3	6	3

-- = amount too small to be expressed

Table 7 (continued)

Industry	Technology group: 3 Automated material handling		4 Inspection, sensor and testing equipment		5 Communications and control				
	Technology: 3.1	3.2	4.1	4.2	5.1	5.2	5.3	5.4	5.5
Food,beverages,tobacco	7	2	16	13	11	11	12	32	15
Rubber and plastics	7	6	23	17	22	22	19	39	20
Leather,textiles,clothing	3	2	5	4	9	9	6	11	10
Wood	9	3	15	10	9	8	10	27	19
Furniture and fixture	--	--	2	1	8	7	9	8	9
Paper and allied products	9	8	35	25	19	20	20	43	36
Printing, publishing and allied	4	2	11	6	10	6	9	13	10
Primary metal	8	3	35	30	31	30	31	56	40
Fabricated metal products	3	2	10	10	11	11	10	21	11
Machinery	3	2	15	18	15	12	14	26	15
Transportation equipment	4	5	31	31	21	21	34	42	29
Electrical and electronic products	7	6	30	30	29	26	17	38	22
Non-metallic mineral products	15	5	18	10	13	14	10	33	18
Petroleum and chemicals	9	2	24	24	19	18	14	35	25
Other manufacturing	2	--	8	7	7	9	6	12	6
All manufacturing	6	3	15	13	13	13	12	25	16

-- = amount too small to be expressed

Table 8 Percentage of responding establishments in the industry which used at least one of the technologies in a technology group

Industry	Technology groups				
	1 Design and engineering	2 Fabrication and assembly	3 Automated material handling	4 Inspection, sensor and testing equipment	5 Communications and control
Food,beverages,tobacco	14	19	7	17	38
Rubber and plastics	24	32	10	26	47
Leather,textiles,clothing	17	18	4	5	20
Wood	21	22	9	16	33
Furniture and fixture	9	19	--	2	20
Paper and allied products	23	24	13	36	53
Printing, publishing and allied	21	22	5	11	24
Primary metal	35	34	9	39	68
Fabricated metal products	24	33	3	13	31
Machinery	41	52	4	20	41
Transportation equipment	39	50	6	36	54
Electrical and electronic products	40	44	10	33	57
Non-metallic mineral products	19	36	17	19	40
Petroleum and chemicals	21	20	9	29	45
Other manufacturing	15	18	2	9	20
All manufacturing	22	27	7	17	35

-- = amount too small to be expressed

Table 9 Percentage of establishments in the industry, using or planning to use at least one of the technologies

Industry	All technologies			
	Use of at least one technology		Planned use of at least one technology	
	for production and evaluation	for evaluation only	in two years	in five years
Food,beverages,tobacco	46	1	6	5
Rubber and plastics	60	2	7	3
Leather,textiles,clothing	37	1	8	5
Wood	45	1	9	3
Furniture and fixture	32	2	13	6
Paper and allied products	64	1	6	1
Printing, publishing and allied	47	1	4	2
Primary metal	75	--	3	4
Fabricated metal products	51	2	8	7
Machinery	66	2	9	4
Transportation equipment	64	--	6	5
Electrical and electronic products	73	--	8	2
Non-metallic mineral products	61	2	5	4
Petroleum and chemicals	57	3	8	3
Other manufacturing	37	2	10	5
All manufacturing	50	1	7	4

-- = amount too small to be expressed

Galta

Do we lag?

Effect – jobs, skill req, does it improve productivity

Who introduces? New type of firm?

items to limit – all on a per worker basis –

are there minimum scales for these technologies?

no questions re effects on capital

what costs have been caused by this technology:

obj. #2 not big priority – create others an effect

Loden

objective #2 should be low priority

add: reasons for introducing this technology

obj #5 should be higher