

# AD-A197 368

AFWAL-TR-88-4051

AUTOMATED AIRFRAME ASSEMBLY PROGRAM (AAAP - SURVEY  
OF CIM STATUS IN THE AIRCRAFT INDUSTRY)

April 1988

Final Report for Period Nov 86 - Oct 87

Approved for public release; distribution unlimited.



DTIC  
ELECTE  
JUL 19 1988  
S D

MATERIALS LABORATORY  
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES  
AIR FORCE SYSTEMS COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533

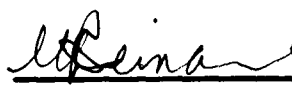
## NOTICE

WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS, OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY GOVERNMENT-RELATED PROCUREMENT, THE UNITED STATES GOVERNMENT INCURS NO RESPONSIBILITY OR ANY OBLIGATION WHATSOEVER. THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA, IS NOT TO BE REGARDED BY IMPLICATION, OR OTHERWISE IN ANY MANNER CONSTRUED, AS LICENSING THE HOLDER, OR ANY OTHER PERSON OR CORPORATION; OR AS CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE, OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION.

  
MICHAEL F. HITCHCOCK  
Program Manager  
Computer Integrated Mfg Branch  
FOR THE COMMANDER

  
DATE

  
WALTER H. REIMANN, Chief  
Computer Integrated Mfg Branch  
Manufacturing Technology Division

IF YOUR ADDRESS HAS CHANGED, IF YOU WISH TO BE REMOVED FROM OUR MAILING LIST, OR IF THE ADDRESSEE IS NO LONGER EMPLOYED BY YOUR ORGANIZATION PLEASE NOTIFY AFWAL/MLTC, WRIGHT-PATTERSON AFB, OH 45433-6533 TO HELP MAINTAIN A CURRENT MAILING LIST.

COPIES OF THIS REPORT SHOULD NOT BE RETURNED UNLESS RETURN IS REQUIRED BY SECURITY CONSIDERATIONS, CONTRACTUAL OBLIGATIONS, OR NOTICE ON A SPECIFIC DOCUMENT.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                              |                                                     |                                                                                                                 |                      |                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|----------------------|----------------------------------|
| 1a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                              |                                                     | 1b. RESTRICTIVE MARKINGS<br>NONE                                                                                |                      |                                  |
| 2a. SECURITY CLASSIFICATION AUTHORITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                              |                                                     | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for public release; distribution is unlimited.               |                      |                                  |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              |                                                     |                                                                                                                 |                      |                                  |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                              |                                                     | 5. MONITORING ORGANIZATION REPORT NUMBER(S)<br>AFWAL-TR-88-4051                                                 |                      |                                  |
| 6a. NAME OF PERFORMING ORGANIZATION<br>NORTHROP AIRCRAFT DIVISION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                              | 6b. OFFICE SYMBOL<br>(if applicable)                | 7a. NAME OF MONITORING ORGANIZATION<br>Materials Laboratory (AFWAL/MLTC)<br>AF Wright Aeronautical Laboratories |                      |                                  |
| 6c. ADDRESS (City, State, and ZIP Code)<br>1 NORTHROP AVE<br>HAWTHORNE, CA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                                     | 7b. ADDRESS (City, State, and ZIP Code)<br>WPAFB, OH 45433-6533                                                 |                      |                                  |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>AIR FORCE WRIGHT AERONAUTICAL LABORATORIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              | 8b. OFFICE SYMBOL<br>(if applicable)<br>AFWAL/MLTC  | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER<br>F33615-87-C-5217                                             |                      |                                  |
| 8c. ADDRESS (City, State, and ZIP Code)<br>MATERIALS LABORATORIES<br>MANTECH DIVISION<br>WPAFB, OH 45433-6533                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |                                                     | 10. SOURCE OF FUNDING NUMBERS                                                                                   |                      |                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                              |                                                     | PROGRAM ELEMENT NO.<br>78011F                                                                                   | PROJECT NO.<br>2865  | TASK NO.<br>1C                   |
| 11. TITLE (Include Security Classification)<br><br>FINAL RESULTS OF THE SURVEY OF THE AIRCRAFT INDUSTRY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |                                                     |                                                                                                                 |                      |                                  |
| 12. PERSONAL AUTHOR(S)<br>PRICE WATERHOUSE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                                     |                                                                                                                 |                      |                                  |
| 13a. TYPE OF REPORT<br>FINAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 13b. TIME COVERED<br>FROM 30NOV86 TO 30OCT87 | 14. DATE OF REPORT (Year, Month, Day)<br>April 1988 |                                                                                                                 | 15. PAGE COUNT<br>42 |                                  |
| 16. SUPPLEMENTARY NOTATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                                     |                                                                                                                 |                      |                                  |
| 17. COSATI CODES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                              |                                                     | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)                               |                      |                                  |
| FIELD<br>13<br>05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | GROUP<br>08<br>03                            | SUB-GROUP                                           | COMPUTER INTEGRATED MANUFACTURING (CIM),<br>AIRCRAFT ASSEMBLY.                                                  |                      |                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                              |                                                     |                                                                                                                 |                      |                                  |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br>The purpose of this survey was to evaluate different airframe manufacturing environments. Price Waterhouse and Northrop Aircraft Division (NAD) personnel developed the survey questions jointly to evaluate the Needs and Requirements definition for the Automated Airframe Assembly Program (AAP). AAP focused on major and minor subassembly operations and related areas. The survey breaks these down into two timeframes: the next 1-5 years (today) and the future (5-10 years).<br><br>The Survey consisted of seven major functional sections including an integration section. The survey sections were completed by those individuals most familiar with the issues being addressed.<br><br>The results respondents to this survey are being kept strictly confidential. Price Waterhouse gathered combined and evaluated survey results. NAD personnel do not have access to an individual company's responses. K... |                                              |                                                     |                                                                                                                 |                      |                                  |
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                              |                                                     | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified                                                            |                      |                                  |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Michael Hitchcock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |                                                     | 22b. TELEPHONE (Include Area Code)<br>(513) 255-7371                                                            |                      | 22c. OFFICE SYMBOL<br>AFWAL/MLTC |

# FINAL RESULTS OF THE SURVEY OF AIRCRAFT ASSEMBLY PRACTICES

## TABLE OF CONTENTS

|                                       | <u>Page</u> |
|---------------------------------------|-------------|
| Scope                                 | 1           |
| Preface                               | 2           |
| Product Design                        | 3           |
| Product Configuration Management      | 10          |
| Product Implementation Planning       | 13          |
| Materials Management                  | 17          |
| Product/Tool Fabrication and Assembly | 23          |
| Product Quality Assurance             | 29          |
| Integration                           | 32          |



|               |                                     |
|---------------|-------------------------------------|
| Accession For |                                     |
| NTIS - CRA&I  | <input checked="" type="checkbox"/> |
| DTIC - TAB    | <input type="checkbox"/>            |
| Unannounced   | <input type="checkbox"/>            |
| Justification |                                     |
| By            |                                     |
| Date          |                                     |
| Approved by   |                                     |
| Date          |                                     |
| A-1           |                                     |

## SCOPE

The purpose of this survey was to evaluate different airframe manufacturing environments. Price Waterhouse and Northrop Aircraft Division (NAD) personnel developed the survey questions jointly to evaluate the Needs and Requirements definition for the Automated Airframe Assembly Program (AAAP). AAAP focuses on major and minor subassembly operations and related areas. The survey breaks these down into two timeframes: the next 1-5 years (today) and the future (5-10 years).

The survey consisted of seven major functional sections including an integration section. The survey sections were completed by those individuals most familiar with the issues being addressed.

The results of this survey are strictly confidential. Price Waterhouse gathered and evaluated survey results. NAD personnel do not have access to an individual company's responses.

## FINAL REPORT

The purpose of this final report is to present the composite responses of 16 surveyees (twenty companies and two universities were requested to participate in the survey). The following points should be considered when interpreting the report:

- Although most of the surveyees answered all of the questions, some surveyees did not.
- These results contain responses from two universities.
- Some surveyees did not respond to the 5-10 years column for certain questions. An obvious explanation for this is that the long-range plans are sensitive and/or sufficiently vague to present a specific response to the question. Another interpretation is that if the "Today" response is highly desirable, the surveyee would have the same 5-10 years response.

# **INTERIM RESULTS OF THE SURVEY OF AIRCRAFT ASSEMBLY PRACTICES**

## **PREFACE**

What aircraft program (commercial and military) does your facility help to produce?

|                |             |                      |                         |
|----------------|-------------|----------------------|-------------------------|
| A-6, A-7, A-10 | CL601       | Firebe Target Drones | SSVT                    |
| ADP's          | CD10        | EA-6B                | T-45                    |
| AH Helicopter  | F-4         | E2C                  | T-46A                   |
| AV8B Harrier   | F-5E/F      | KC-10                | V-22                    |
| B-1B           | F-14        | KC-135               | YF23                    |
| B-52           | F-15 Eagle  | MD-80                | 340                     |
| C-5B           | F-18 Hornet | N-14                 | 707, 737, 747, 757, 767 |
| C-17           | FA-18A      | RPVS                 |                         |

How many employees do you have?

|   |                  |
|---|------------------|
| 0 | Less than 1000   |
| 3 | 1001 - 5000      |
| 4 | 5001 - 10,000    |
| 2 | 10,001 - 15,000  |
| 3 | More than 15,000 |

What percent of your business is commercial (versus government-funded)?

The following numbers were given by respondents:

|   |        |
|---|--------|
| 2 | 0%     |
| 1 | 2%     |
| 1 | 10%    |
| 1 | 15%    |
| 1 | 19%    |
| 1 | 20%    |
| 1 | 25-30% |
| 1 | 35%    |
| 1 | 50%    |
| 1 | 60%    |
| 1 | 64%    |

What Air Force programs is your university currently involved with?

|       |                                                          |
|-------|----------------------------------------------------------|
| AFOSR | (Surveyee not personally involved in it though)          |
| IISS  | with Boeing (surveyee involved in program)               |
| ICC   | with McAir (surveyee involved in program)                |
| AAAP  | with Northrop and Douglas (surveyee involved in program) |
| IDS   | with Rockwell (surveyee involved in program)             |

## PRODUCT DESIGN

### ENGINEERING DESIGN:

For all sections, please check all answers which apply:

1. Are your engineering design systems that are used to design fab components also used to design assemblies?

14 Yes  
0 No

### PLEASE ANSWER ALL REMAINING QUESTIONS FOR ASSEMBLY-RELATED PROCEDURES ONLY

2. Identify your stage in the development of a fully computerized design engineering environment.

Today    5-10 years

|   |    |                      |
|---|----|----------------------|
| 4 | 0  | Under consideration  |
| 4 | 1  | In development       |
| 7 | 1  | Started to implement |
| 4 | 12 | Fully implemented    |

3. Does your design team consisting of people from Engineering, Manufacturing, Planning, Quality Assurance, Production Control, etc., work on design concurrently (as opposed to sequentially)?

Today    5-10 years

|   |    |                     |
|---|----|---------------------|
| 4 | 14 | Yes                 |
| 6 | 1  | No                  |
| 7 | 0  | Under consideration |

4. Are group technology concepts utilized during the design process?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 6  | 13 | Yes |
| 10 | 2  | No  |

5. Are separate drawings created for detail component parts (mono detail) or are they included in a subassembly drawing?

Today 5-10 years

|    |   |                                   |
|----|---|-----------------------------------|
| 8  | 7 | Separate drawings                 |
| 13 | 7 | Included in a subassembly drawing |

Comments: One respondent wrote "would only produce separate drawings if complexity requires" next to "Separate drawings."

Another respondent wrote "mixed scenario today ... totally monodetail in future" next to this question.

Another respondent wrote "both by class project" next to this question.

6. What is the mechanism used for tracking engineering documents?

|   |                                                                                 |
|---|---------------------------------------------------------------------------------|
| 5 | Stand-alone automated document tracking system                                  |
| 3 | Automated document tracking system directly linked to computer-aided design     |
| 2 | Automated document tracking system directly linked to other technical databases |
| 7 | Manual document tracking system                                                 |
| 0 | Other                                                                           |

7. Is a central database utilized for both drawing and supporting technical data?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 2 | 15 | Yes |
| 4 | 0  | No  |

8. What percentage of your engineering drawings are created utilizing computer-aided design?

Today 5-10 years

|   |    |               |
|---|----|---------------|
| 6 | 0  | Less than 25% |
| 1 | 0  | 25-50%        |
| 4 | 1  | 50-75%        |
| 4 | 13 | 75-100%       |

Comments: One respondent noted that the choice for this question was "program dependent."

9. What percentage of your engineering drawings are designed using two-dimensional computer graphics?

**Today      5-10 years**

|   |   |               |
|---|---|---------------|
| 6 | 7 | Less than 25% |
| 1 | 3 | 25-50%        |
| 5 | 2 | 50-75%        |
| 3 | 2 | 75-100%       |

10. What percentage of your engineering drawings are designed using three-dimensional computer graphics?

**Today      5-10 years**

|    |   |               |
|----|---|---------------|
| 11 | 1 | Less than 25% |
| 4  | 4 | 25-50%        |
| 1  | 5 | 50-75%        |
| 0  | 6 | 75-100%       |

11. Which of the following apply to the use of three-dimensional computer graphics?

**Today      5-10 years**

|    |    |                                        |
|----|----|----------------------------------------|
| 3  | 14 | Modeling with solids                   |
| 12 | 6  | Modeling with wire frames and surfaces |
| 4  | 1  | Wire frames only                       |

12. For your conceptual, preliminary and detail design do you use:

**Today      5-10 years**

|    |   |                                                         |
|----|---|---------------------------------------------------------|
| 1  | 4 | One computer-aided design system                        |
| 4  | 6 | Different computer-aided design systems                 |
| 14 | 7 | Combination of computer-aided design and drawing boards |

Comments: One respondent noted that the choice for this question was "program dependent."

13. Are your computer-aided design systems used for assembly tool design the same as those used for assembly part design?

**Today      5-10 years**

|    |    |     |
|----|----|-----|
| 12 | 15 | Yes |
| 4  | 1  | No  |

14. What percentage of tool designs are hand-drawn vs. computer-aided designed?

| Today | 5-10 years |                |
|-------|------------|----------------|
| 11    | 8          | Less than half |
| 1     | 8          | More than half |

**ENGINEERING ANALYSIS:**

1. How does modeling for your engineering analysis programs use design geometry?

| Today | 5-10 years |                                  |
|-------|------------|----------------------------------|
| 5     | 1          | Human interpretation only        |
| 11    | 4          | Computer-assisted interpretation |
| 2     | 12         | Automated modeling               |

2. Where in your analysis are computer graphics programs used?

| Today | 5-10 years |                                                              |
|-------|------------|--------------------------------------------------------------|
| 14    | 10         | Finite element analysis                                      |
| 6     | 11         | Avionics analysis                                            |
| 11    | 11         | Static and dynamic structural analysis                       |
| 9     | 11         | Aerodynamic analysis                                         |
| 7     | 11         | Propulsion analysis                                          |
| 7     | 11         | Thermal analysis                                             |
| 2     | 11         | Logistics support (reliability and maintainability) analysis |
| 3     | 10         | Vulnerability analysis                                       |
| 10    | 11         | Radar cross section analysis                                 |

3. In which of the following ways do you use your engineering analysis systems?

| Today | 5-10 years |                                                                                                                                  |
|-------|------------|----------------------------------------------------------------------------------------------------------------------------------|
| 13    | 7          | You create assembly designs through computer-aided design and then download them to engineering analysis software for validation |
| 1     | 8          | You feed information into the engineering analysis software and the system returns with a suggested assembly design              |

4. What capabilities do your computer graphics finite element mesh and design programs provide?

Today 5-10 years

|    |   |                                                                                                           |
|----|---|-----------------------------------------------------------------------------------------------------------|
| 14 | 6 | Lofting/geometric surface definition                                                                      |
| 11 | 6 | Creation of grid points and elements individually                                                         |
| 10 | 8 | Creation of grid points and elements by mesh generation techniques                                        |
| 9  | 8 | Definition of element and material properties                                                             |
| 9  | 7 | Creation of boundary conditions, constraints, externally applied loads and predefined nodal displacements |
| 10 | 6 | Display of model geometry from any angle with grid ID, element ID, and other similar data superimposed    |
| 5  | 8 | Display of constraints, applied load, and temperature data superimposed                                   |
| 6  | 9 | Automated mesh refinement                                                                                 |
| 8  | 5 | Free-body analysis option                                                                                 |
| 8  | 7 | Dividing a full model into partitions and merging of partitions into a full model                         |
| 11 | 4 | Windowing and zooming of a portion of the structure                                                       |
| 10 | 3 | Capability to obtain X-Y plots of any user-defined data                                                   |
| 12 | 4 | Generation of graphical display for visual evaluation                                                     |
| 7  | 6 | Minimum/maximum search capability                                                                         |

5. What mechanisms are used in your environment to feedback analysis and testing results to the computer-aided design system?

Today 5-10 years

|    |    |                                                                      |
|----|----|----------------------------------------------------------------------|
| 13 | 2  | Manual process                                                       |
| 6  | 6  | Results are maintained in a technical database                       |
| 2  | 13 | The technical database is linked to the computer-aided design system |

6. What kind of workstations are you using?

Today 5-10 years

|    |    |                                                                  |
|----|----|------------------------------------------------------------------|
| 8  | 3  | Stand-alone                                                      |
| 13 | 7  | Terminals linked to a central technical database                 |
| 3  | 13 | Intelligent workstations linked to a central technical data base |

## PRODUCIBILITY:

1. Are Design, Manufacturing Engineering, and Quality Assurance people co-located (or have joint meetings on a regular basis) during the design effort to ensure producibility?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 11 | 14 | Yes |
| 6  | 0  | No  |

2. At what point in the design process do your producibility (design and cost) personnel get involved?

Today    5-10 years

|   |    |                            |
|---|----|----------------------------|
| 9 | 12 | Preliminary design         |
| 7 | 3  | After engineering analysis |
| 7 | 1  | Initial drawing check      |
| 3 | 1  | After approval             |

Comments: One respondent added the following choice:

|     |     |            |
|-----|-----|------------|
| [x] | [x] | Conceptual |
|-----|-----|------------|

3. How are producibility analysis results transferred from conceptual design to detail design?

Today    5-10 years

|    |    |                           |
|----|----|---------------------------|
| 14 | 7  | Meetings/discussions      |
| 1  | 11 | Automated process/systems |
| 7  | 3  | Reports                   |

4. When reviewing drawings, are they on:

Today    5-10 years

|    |    |             |
|----|----|-------------|
| 5  | 14 | CRT         |
| 15 | 4  | Paper/MYLAR |

5. How is assembly modeling that checks for mating, tolerances, etc., performed?

Today    5-10 years

|    |    |                                                          |
|----|----|----------------------------------------------------------|
| 2  | 13 | Using simulation software                                |
| 13 | 4  | Physically building a prototype                          |
| 10 | 4  | Calculations are performed by looking at data from a CRT |

6. When do you make your make/buy decision?

Today    5-10 years

|    |    |                                       |
|----|----|---------------------------------------|
| 6  | 10 | During design process                 |
| 10 | 4  | During manufacturing planning process |

Comments: One respondent wrote "we don't" next to this question.

**INTEGRATED-LOGISTICS SUPPORT:**

1. How are reliability and maintainability issues involving assemblies fed into the design process?

|   |                                                                                  |
|---|----------------------------------------------------------------------------------|
| 3 | The information is captured from the field but does not link to design systems   |
| 2 | The information is captured in the field and immediately links to design systems |
| 4 | This is done informally                                                          |
| 4 | Through manual review of reports from a stand-alone system                       |

Comments: One respondent added the following choice:

[x] During the design process

2. Is the assembly design group currently involved in any computer-aided logistics-related initiatives or government-funded projects?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 4  | 13 | Yes |
| 11 | 1  | No  |

3. How do you interface with the customer in the logistics support area?

Today    5-10 years

|   |   |                                                     |
|---|---|-----------------------------------------------------|
| 2 | 5 | Totally computerized interface to the customer      |
| 9 | 1 | Provide customers with computer-generated drawings  |
| 8 | 4 | Illustrate part breakdown in computerized form      |
| 3 | 2 | Provide customers with computerized inspection data |

## PRODUCT CONFIGURATION MANAGEMENT

1. What portions of tracking the engineering release cycle are automated?

**Today    5-10 years**

|   |    |                                                                       |
|---|----|-----------------------------------------------------------------------|
| 7 | 7  | Tracking the transfer of the drawing from pre-release to release      |
| 6 | 6  | Controls ensuring that the correct version of the drawing is released |
| 6 | 11 | Tracking throughout the cycle                                         |

2. Are drawings automatically transferred from the working version to pre-release through the computer-aided design program or through a configuration management system which interfaces with the computer-aided design system?

**Today    5-10 years**

|   |    |     |
|---|----|-----|
| 7 | 11 | Yes |
| 9 | 1  | No  |

3. How are the various departments informed that a drawing is to be reviewed (drawing check)?

**Today    5-10 years**

|    |    |                                                                                                     |
|----|----|-----------------------------------------------------------------------------------------------------|
| 15 | 1  | They receive the paper drawing                                                                      |
| 1  | 11 | They receive a message on their CRT notifying them that the drawing is available for them to review |

4. Is your approval or sign-off required on paper documents due to contractual requirements?

**Today    5-10 years**

|    |   |     |
|----|---|-----|
| 10 | 2 | Yes |
| 6  | 9 | No  |

5. Are there automated mechanisms ensuring that only one release version of the drawing revision exists and that the version to be released is the correct version?

**Today    5-10 years**

|   |    |     |
|---|----|-----|
| 8 | 10 | Yes |
| 7 | 1  | No  |

6. What portions of change control are automated?

Today 5-10 years

|   |    |                                                                                                                    |
|---|----|--------------------------------------------------------------------------------------------------------------------|
| 0 | 9  | The creation of an engineering change order is automatically triggered by a change to the parts list               |
| 7 | 7  | The parts list is updated as part of the release process when an engineering order is released                     |
| 3 | 10 | Engineering change orders are linked to the computer-aided design system                                           |
| 4 | 7  | Controls ensuring that no further changes are made to the engineering change order in the middle of a review cycle |

7. What is your primary cause of changes?

Today 5-10 years

|    |   |                                      |
|----|---|--------------------------------------|
| 14 | 7 | Product hardware change requirements |
| 0  | 4 | Product software change requirements |

8. When changes are made on the shop floor, how is design engineering informed of the change?

Today 5-10 years

|    |    |                                                |
|----|----|------------------------------------------------|
| 14 | 2  | Manual procedure                               |
| 0  | 10 | Automated procedure                            |
| 1  | 4  | Combination of manual and automated procedures |

9. Do you automatically interface the configurations?

Today 5-10 years

|   |   |                                           |
|---|---|-------------------------------------------|
| 5 | 0 | As designed/as planned                    |
| 5 | 0 | As planned/as built                       |
| 4 | 2 | As designed/as planned/as built           |
| 1 | 8 | As designed/as planned/as built/as spared |

10. How is the engineering parts list maintained?

Today 5-10 years

|   |    |                                                                                     |
|---|----|-------------------------------------------------------------------------------------|
| 6 | 1  | Manually created and maintained                                                     |
| 9 | 1  | Maintained on a stand-alone system                                                  |
| 3 | 5  | Automated and interfaces with the computer-aided design system                      |
| 1 | 12 | Integrated and maintained with the drawing through the computer-aided design system |

11. Does the engineering parts list system automatically identify changes to the lower assembly based on changes to the higher assembly?

Today      5-10 years

|    |    |     |
|----|----|-----|
| 4  | 11 | Yes |
| 10 | 2  | No  |

## PRODUCT IMPLEMENTATION PLANNING

1. For manufacturing purposes, can your manufacturing assembly Bill of Material deviate from your engineering Bill of Material?

Today    5-10 years

|    |   |     |
|----|---|-----|
| 14 | 9 | Yes |
| 1  | 2 | No  |

2. To what extent is process planning automated?

Today    5-10 years

|    |    |                                                                                          |
|----|----|------------------------------------------------------------------------------------------|
| 10 | 3  | Work instructions are created manually                                                   |
| 10 | 5  | Subsets of planning papers are generated automatically for standard processes            |
| 6  | 4  | Work instructions are created through a stand-alone automated process                    |
| 3  | 11 | Artificial intelligence systems are utilized to aid in the planning of work instructions |
| 2  | 11 | Work instructions are created through a direct link to the computer-aided design system  |
| 3  | 13 | Group technology concepts are applied                                                    |

3. What systems interface with your process planning system?

Today    5-10 years

|    |    |                                                    |
|----|----|----------------------------------------------------|
| 5  | 11 | Producibility analysis                             |
| 11 | 9  | Inspection instructions                            |
| 5  | 12 | Computer-aided design                              |
| 2  | 12 | Computer-aided design/computer-aided manufacturing |
| 10 | 10 | Scheduling                                         |
| 3  | 9  | Capacity planning                                  |

4. Are your computerized drawings and work instructions transmitted to the floor for use by shop floor operators?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 8 | 11 | Yes |
| 7 | 2  | No  |

Comments: One respondent put the word "LIMITED" next to the Today/Yes response.

5. Is the planning of your electrical wire system automated?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 7 | 11 | Yes |
| 9 | 3  | No  |

6. Indicate which of the following are included in work instructions through an automated process:

Today    5-10 years

|    |    |                                                                                                         |
|----|----|---------------------------------------------------------------------------------------------------------|
| 12 | 9  | Parts list                                                                                              |
| 4  | 12 | Pictorial aids as a supplement                                                                          |
| 8  | 10 | Engineering drawing reference                                                                           |
| 9  | 8  | Configuration information                                                                               |
| 10 | 8  | Outstanding revision identification                                                                     |
| 7  | 6  | Engineering next assembly identification                                                                |
| 9  | 8  | Manufacturing next assembly identification                                                              |
| 8  | 8  | Reference to drawing notes                                                                              |
| 10 | 12 | Sequence of operations, parts, and tools                                                                |
| 9  | 8  | Identification of parts temporarily located or installed on one job and completely installed on another |
| 9  | 9  | Specific locations (station, water lines, etc.)                                                         |
| 10 | 11 | Identification of tools and jigs                                                                        |
| 7  | 9  | Instructions on how to load/unload tools and jigs                                                       |
| 5  | 9  | Specification of substitute parts                                                                       |
| 10 | 12 | Manufacturing specifications                                                                            |
| 8  | 10 | Types of sealants, lubricants, primer, etc.                                                             |
| 10 | 12 | Cure times and conditions                                                                               |
| 9  | 10 | Torque specification where applicable                                                                   |
| 9  | 11 | Tolerances to be held                                                                                   |
| 9  | 11 | Process specification identification                                                                    |

Comments: One respondent wrote "for composites" next to "Cure items and conditions."

7. Are systems and procedures utilized in assembly process planning different than those utilized for tool process planning?

Today    5-10 years

|    |   |     |
|----|---|-----|
| 15 | 6 | Yes |
| 1  | 7 | No  |

8. To what extent is the tool planning process automated?

Today 5-10 years

|    |    |                                                                                          |
|----|----|------------------------------------------------------------------------------------------|
| 11 | 4  | Work instructions are created manually                                                   |
| 7  | 7  | Subsets of planning papers are generated automatically for standard processes            |
| 4  | 4  | Work instructions are generated through a stand-alone automated process                  |
| 0  | 10 | Artificial intelligence systems are utilized to aid in the planning of work instructions |
| 1  | 8  | Work instructions are created through a direct link to the computer-aided design system  |

Comments: For the first choice, one respondent put "Limited Automation" next to the Today/Yes response and "Increased automation but not total" next to the 5-10 years response.

9. What systems interface with your tool planning system?

Today 5-10 years

|   |   |                                                    |
|---|---|----------------------------------------------------|
| 4 | 7 | Inspection instructions                            |
| 4 | 8 | Computer-aided design                              |
| 4 | 9 | Computer-aided design/computer-aided manufacturing |
| 6 | 9 | Master schedule                                    |

Comments: One respondent did not answer this question because Question 8's response was that work instructions are created manually.

10. Do any of the following apply to your tool orders?

Today 5-10 years

|   |   |                                                                                               |
|---|---|-----------------------------------------------------------------------------------------------|
| 3 | 8 | Automatically create a tool order triggered by a transaction in computer-aided design systems |
| 9 | 9 | Tracked and maintained by an automated process                                                |
| 6 | 2 | Tracked and maintained by a manual process                                                    |

11. Which of the following apply to tool order schedules?

Today 5-10 years

|   |   |                                                                  |
|---|---|------------------------------------------------------------------|
| 7 | 2 | Manually maintained                                              |
| 7 | 6 | Automatically maintained                                         |
| 3 | 8 | Interfaced with the master schedule through an automated process |

12. How are your part protection specifications created?

Today 5-10 years

|    |    |                                                         |
|----|----|---------------------------------------------------------|
| 0  | 11 | Interfacing to the computer-aided design system         |
| 15 | 3  | Without interfacing to the computer-aided design system |

13. What methods are you using to research the required product material?

Today 5-10 years

|    |    |                                                                                               |
|----|----|-----------------------------------------------------------------------------------------------|
| 1  | 8  | On-line catalogs are used to identify which materials are available on the market             |
| 1  | 10 | On-line systems with various search capabilities aid in the decision on which material to use |
| 11 | 3  | Manual process                                                                                |

14. How are your material specifications created?

Today 5-10 years

|    |    |                                                         |
|----|----|---------------------------------------------------------|
| 2  | 10 | Interfacing with the computer-aided design system       |
| 13 | 3  | Without interfacing to the computer-aided design system |

15. Do you have an automated system which allows for the comparison of actual material statistics with requirements, specifications, or test results when performing trend analysis?

Today 5-10 years

|    |   |     |
|----|---|-----|
| 0  | 9 | Yes |
| 13 | 4 | No  |

## MATERIALS MANAGEMENT

### PRODUCTION PLANNING:

1. Is your assembly schedule developed using an automated system?

Today    5-10 years

|    |   |     |
|----|---|-----|
| 12 | 9 | Yes |
| 3  | 1 | No  |

2. Which of the following describes schedule turnaround time from receipt of contract delivery dates to release of detailed requirement schedules?

Today    5-10 years

|    |   |       |
|----|---|-------|
| 4  | 9 | Days  |
| 11 | 3 | Weeks |

3. Is production progress automatically compared to the schedule in a computer system?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 9 | 10 | Yes |
| 6 | 1  | No  |

Comments: One respondent put "Fab & Minor Assy." next to the Today/Yes response.

4. Does your system:

|    |                                                     |
|----|-----------------------------------------------------|
| 11 | Flag exceptions and reprioritize                    |
| 4  | Report the need for a work-around plan if necessary |

5. Do you use a common bill of material for your manufacturing and material planning?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 11 | 10 | Yes |
| 5  | 1  | No  |

6. Are tooling requirements included in the bill-of-material?

Today    5-10 years

|   |   |     |
|---|---|-----|
| 6 | 8 | Yes |
| 9 | 1 | No  |

**INVENTORY MANAGEMENT:**

1. Is a computer-based system utilized for controlling material?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 13 | 10 | Yes |
| 2  | 0  | No  |

2. Are you considering "Just-In-Time" concepts for implementation in your factory?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 7 | 11 | Yes |
| 7 | 2  | No  |

Comments: One respondent noted that for "Just-In-Time" the "goal is to reduce flow times, but not a true JIT discipline."

3. Is real-time access to part status (location, quantity, etc.) available when items are in transit (both inter- and intra-plant transit)?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 7 | 11 | Yes |
| 8 | 2  | No  |

4. Which of the following best describes your method for tracking material shortages on the shop floor?

Today    5-10 years

|   |    |                       |
|---|----|-----------------------|
| 7 | 1  | Manual                |
| 9 | 10 | Computer-based system |

5. Which of the following best describes your requisition process?

Today 5-10 years

|    |    |                                       |
|----|----|---------------------------------------|
| 2  | 0  | Manual, paper media                   |
| 12 | 2  | Computer-assisted, paper media        |
| 1  | 12 | Computer-based, paperless requisition |

6. Does an automated system support the tracking of non-conforming material?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 8 | 11 | Yes |
| 6 | 0  | No  |

**WAREHOUSING:**

1. Do you utilize an Automated Storage/Retrieval System (AS/RS) for storing material?

Today 5-10 years

|    |    |     |
|----|----|-----|
| 12 | 10 | Yes |
| 4  | 1  | No  |

Comments: One respondent put the word "Limited" next to the Today/Yes response and "Not Total" next to the 5-10 years/Yes response.

If you use an AS/RS, is it integrated with cycle counting?

Today 5-10 years

|   |   |     |
|---|---|-----|
| 9 | 9 | Yes |
| 4 | 1 | No  |

2. Which of the following best describes your warehousing for purchased parts?

Today 5-10 years

|   |   |                                     |
|---|---|-------------------------------------|
| 7 | 4 | Centralized (one warehouse)         |
| 8 | 7 | Decentralized (multiple warehouses) |

# RECEIVING/INSPECTION:

1. How would you describe your receiving function?

Today 5-10 years

|    |   |                                           |
|----|---|-------------------------------------------|
| 5  | 5 | Decentralized (multiple receiving points) |
| 11 | 6 | Centralized (one receiving point)         |

Comments: One respondent put "Docks" next to the Decentralized choices and "Paper" next to the Centralized choices.

2. How do you capture receiving/inspection data for purchased parts?

Today 5-10 years

|    |    |                                       |
|----|----|---------------------------------------|
| 13 | 3  | Manual                                |
| 6  | 12 | Bar coding                            |
| 1  | 4  | Voice recognition                     |
| 1  | 2  | Optical character readers             |
| 1  | 1  | Radio frequency surface acoustic wave |
| 1  | 2  | Magnetic strip                        |

3. Does purchasing have on-line, real-time access to receiving data?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 9 | 12 | Yes |
| 6 | 0  | No  |

4. How are your shop floor priorities passed to receiving?

Today 5-10 years

|   |    |                        |
|---|----|------------------------|
| 5 | 2  | Manually               |
| 4 | 11 | Computerized interface |

5. In your environment, is the following data available on the computer?

Today 5-10 years

|    |   |                              |
|----|---|------------------------------|
| 14 | 7 | Receiving                    |
| 12 | 7 | In-transit to inspection     |
| 14 | 7 | Inspection                   |
| 12 | 8 | In-transit to stockroom      |
| 12 | 6 | Discrepant material handling |

**MATERIAL REQUIREMENTS  
PLANNING FOR PURCHASED ITEMS:**

1. Does your material function utilize the same schedule information as the production function?

**Today    5-10 years**

|    |    |     |
|----|----|-----|
| 12 | 11 | Yes |
| 3  | 1  | No  |

2. Do you perform simulation as part of the material planning function?

**Today    5-10 years**

|    |   |     |
|----|---|-----|
| 3  | 9 | Yes |
| 12 | 2 | No  |

3. Do you utilize a Manufacturing Resource Planning (MRP II) system for material planning?

**Today    5-10 years**

|    |    |     |
|----|----|-----|
| 4  | 10 | Yes |
| 10 | 0  | No  |

4. Do you have a single system that generates requirements for material and for production (including tooling and spares)?

**Today    5-10 years**

|   |   |     |
|---|---|-----|
| 8 | 8 | Yes |
| 6 | 3 | No  |

Comments: One respondent added the phrase "(Except Tooling)" after "Yes".

5. Do you utilize order-point or economic order quantity techniques (versus time-phased netting) for some of the parts?

**Today    5-10 years**

|    |   |     |
|----|---|-----|
| 12 | 7 | Yes |
| 3  | 3 | No  |

6. Do you plan material requirements separately for major aircraft programs?

Today 5-10 years

|    |   |     |
|----|---|-----|
| 11 | 7 | Yes |
| 4  | 4 | No  |

#### CAPACITY PLANNING:

1. Do you utilize rate tool analysis for capacity planning purposes?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 9 | 11 | Yes |
| 6 | 0  | No  |

2. If you utilize rate tool analysis, which of the following is it based on?

Today 5-10 years

|   |   |                |
|---|---|----------------|
| 7 | 4 | Target hours   |
| 4 | 4 | Manhours       |
| 9 | 8 | Schedule rates |

3. Is a computer-based system utilized for capacity planning purposes?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 9 | 13 | Yes |
| 6 | 0  | No  |

Comments: One respondent added the word "somewhat" to the Today/No response.

#### PURCHASING:

1. Which of the following functions are supported by an automated system?

Today 5-10 years

|    |   |                               |
|----|---|-------------------------------|
| 9  | 7 | Price quotation activity      |
| 13 | 7 | Purchase order preparation    |
| 12 | 9 | Order follow-up               |
| 9  | 7 | Price performance analysis    |
| 10 | 6 | Delivery performance analysis |
| 11 | 8 | Cash commitment analysis      |
| 9  | 8 | Contract administration       |

## PRODUCT/TOOL FABRICATION AND ASSEMBLY

### ENGINEERING CHANGES:

1. If there is a problem with the manufacturability or inspectability of a product, how is engineering notified?

Today 5-10 years

|    |    |             |
|----|----|-------------|
| 0  | 12 | By computer |
| 15 | 2  | Manually    |

### SHOP ORDER CONTROL:

1. Is a system in place that assures the availability of all requirements (material, tool, details) prior to release of a production order to the floor?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 8 | 12 | Yes |
| 7 | 0  | No  |

2. Which of the following describe the media used for communicating shop orders?

Today 5-10 years

|    |    |                |
|----|----|----------------|
| 3  | 0  | Manual         |
| 13 | 12 | Computer-based |

### TOOLING:

1. Do you use tools for more than one configuration?

Today 5-10 years

|    |    |     |
|----|----|-----|
| 12 | 10 | Yes |
| 2  | 1  | No  |

2. How do you initiate the actual building of a tool?

Today 5-10 years

|    |   |                 |
|----|---|-----------------|
| 7  | 1 | Manually        |
| 10 | 5 | Computer-aided  |
| 1  | 8 | Computer-driven |

3. How do you monitor the progress of tool construction?

| Today | 5-10 years |                          |
|-------|------------|--------------------------|
| 8     | 1          | Manually                 |
| 9     | 8          | Computer-aided           |
| 1     | 6          | Fully computer-automated |

**SHOP FLOOR SCHEDULE:**

1. How is your shop schedule developed for assembly?

| Today | 5-10 years |                                  |
|-------|------------|----------------------------------|
| 1     | 0          | Manually                         |
| 10    | 0          | Computer-aided                   |
| 5     | 9          | Computer-driven                  |
| 0     | 8          | Using AI/knowledge-based systems |

Comments: One respondent wrote "computer-generated bar charts" next to "Computer-aided."

2. Reschedules which affect work-in-process are:

| Today | 5-10 years |                           |
|-------|------------|---------------------------|
| 6     | 12         | Automatically rescheduled |
| 11    | 0          | Manually rescheduled      |

Comments: One respondent wrote "hi-level input to automated system" next to this question.

3. How is shop floor information provided to the shop floor scheduler?

| Today | 5-10 years |                    |
|-------|------------|--------------------|
| 2     | 1          | Manually           |
| 14    | 2          | Computer printouts |
| 7     | 11         | Display terminals  |

# **SUBASSEMBLY:**

1. How do you handle the following subassembly processes:

| <u>Process</u> | <u>Today</u>  |                  | <u>5-10 years</u> |                  |
|----------------|---------------|------------------|-------------------|------------------|
|                | <u>Manual</u> | <u>Automated</u> | <u>Manual</u>     | <u>Automated</u> |
| Deburring      | 15            | 5                | 7                 | 10               |
| Drilling       | 14            | 12               | 7                 | 12               |
| Fastening      | 12            | 11               | 8                 | 11               |
| Grinding       | 13            | 3                | 8                 | 7                |
| Laminating     | 13            | 7                | 5                 | 10               |
| Painting       | 13            | 7                | 9                 | 12               |
| Riveting       | 13            | 12               | 9                 | 11               |
| Routing        | 12            | 14               | 6                 | 11               |
| Sealing        | 15            | 3                | 9                 | 8                |
| Welding        | 15            | 4                | 9                 | 8                |

# **PARTS MOVEMENT/MATERIAL HANDLING:**

1. How do you move assemblies? (check all that apply)

Today    5-10 years

|    |    | <u>Method</u>                   |
|----|----|---------------------------------|
| 5  | 12 | Automated Guided Vehicles (AGV) |
| 5  | 7  | Carousels                       |
| 14 | 7  | Carts                           |
| 8  | 7  | Conveyors                       |
| 14 | 9  | Forklifts                       |
| 14 | 8  | Manually                        |
| 7  | 6  | Mobile fixture transport system |
| 10 | 14 | Overhead track                  |

# **PRODUCTION PERFORMANCE:**

1. Are your mechanical or machine resource allocations controlled by a central source?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 9 | 11 | Yes |
| 6 | 2  | No  |

**WORK-IN-PROCESS (WIP):**

1. How do you collect shop floor subassembly data? (check all that apply):

**Today    5-10 years**

|    |    |                          |
|----|----|--------------------------|
| 12 | 5  | Manually                 |
| 12 | 13 | Bar code                 |
| 11 | 10 | Badge reader             |
| 6  | 6  | Magnetic stripe          |
| 0  | 0  | Radio frequency code     |
| 0  | 0  | Stencils                 |
| 0  | 6  | Voice recognition        |
| 0  | 5  | Optical character reader |

2. How do you store assemblies? (check all that apply):

**Today    5-10 years**

|    |    | <u>Method</u>                       |
|----|----|-------------------------------------|
| 6  | 12 | AS/RS (Automated Storage/Retrieval) |
| 14 | 11 | Bins                                |
| 6  | 7  | Carousels                           |
| 6  | 5  | Drawers                             |
| 14 | 10 | Pallets                             |
| 15 | 12 | Racks                               |
| 15 | 11 | Shelves                             |

3. How do you track your work-in-process?

**Today    5-10 years**

|    |    |                       |
|----|----|-----------------------|
| 5  | 1  | Manual                |
| 13 | 12 | Computer-based system |

**SPARES AND SPARES REPLENISHMENT:**

1. Is your spares scheduling system:

**Today    5-10 years**

|    |    |                |
|----|----|----------------|
| 5  | 0  | Manual         |
| 10 | 11 | Computer-based |

**LABOR:**

1. Does your work-in-process system automatically collect labor attendance?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 6 | 11 | Yes |
| 9 | 3  | No  |

**MANUFACTURING CENTERS/CELLS:**

1. Do you have manufacturing cells?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 13 | 13 | Yes |
| 1  | 0  | No  |

Comments: One respondent put "Limited" next to the Today/Yes response.

2. Are any of your cells fully automated and controlled by a computer?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 6 | 13 | Yes |
| 8 | 1  | No  |

Comments: One respondent put "Limited" next to the Today/Yes response and "More but not totally" next to the 5-10 years/Yes response.

Another respondent put "In Test" next to the Today/No response.

3. Do any of your cells interface with other computer systems?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 9 | 12 | Yes |
| 5 | 0  | No  |

4. Do your cells utilize mostly dedicated fixtures/tools?

Today    5-10 years

|   |   |     |
|---|---|-----|
| 9 | 8 | Yes |
| 5 | 5 | No  |

5. Do your cells have these types of automated capabilities? (check all that apply)

| Today | 5-10 years |                       |
|-------|------------|-----------------------|
| 2     | 11         | Simulation            |
| 8     | 11         | Work-in-process       |
| 5     | 10         | Center cell interface |
| 6     | 9          | Safety and collision  |
| 7     | 11         | In-process inspection |
| 10    | 12         | Material handling     |
| 7     | 11         | NC robot              |
| 8     | 10         | Cell level management |
| 5     | 7          | Historic files        |
| 8     | 10         | Active files          |
| 9     | 10         | In queue files        |
| 3     | 7          | Maintenance           |
| 6     | 9          | Quality assurance     |
| 6     | 9          | Tooling               |
| 5     | 9          | Man/machine function  |

**DATABASES:**

1. In your database design:

| Today | 5-10 years |                                                                     |
|-------|------------|---------------------------------------------------------------------|
| 6     | 0          | The data base supports one specific computer application program    |
| 10    | 13         | The data base supports multiple applications and shares common data |

## PRODUCT QUALITY ASSURANCE

### DETAIL PARTS:

### COORDINATE MEASURING MACHINE:

1. Do you use coordinate measuring machines to:

- 15 Inspect detail parts
- 14 Inspect tools
- 10 Measure composites
- 0 Don't use a coordinate measuring machine

2. Does your coordinate measuring machine generate points/vector data?

|                                                                     | <u>Today</u> |    | <u>5-10 years</u> |    |
|---------------------------------------------------------------------|--------------|----|-------------------|----|
|                                                                     | Yes          | No | Yes               | No |
| In a modular system                                                 | 3            | 8  | 9                 | 2  |
| In a point to point system                                          | 13           | 0  | 10                | 0  |
| It only generates pure probe inspection data                        | 7            | 6  | 6                 | 4  |
| Output is formatted for any inspection device                       | 6            | 7  | 10                | 2  |
| Data is edited on this system                                       | 11           | 2  | 9                 | 2  |
| The model is the Master Inspection File                             | 7            | 6  | 10                | 1  |
| Models must be fully surfaced with full probe simulation capability | 5            | 7  | 6                 | 4  |
| It is feature-driven                                                | 4            | 9  | 9                 | 2  |

Comments: One respondent wrote "Uses probe only" next to the third choice and "Math" next to the seventh choice.

Another respondent wrote "It can be (Direct Computer Control)" next to "It is feature-driven."

Another respondent did not answer this question and wrote "Note: we utilize DEA equipment" next to it."

### COMPOSITES:

1. How are composites inspected? (please check all that apply):

| Today | 5-10 years |                              |
|-------|------------|------------------------------|
| 13    | 13         | X-Ray                        |
| 15    | 14         | Ultrasonics                  |
| 7     | 12         | Coordinate measuring machine |

# INSPECTION TECHNOLOGIES:

1. Which of the following do you use for inspection purposes, and where do you use them? (check all that apply)

|                                    | <u>Today</u>    |                | <u>5-10 years</u> |                |
|------------------------------------|-----------------|----------------|-------------------|----------------|
|                                    | <u>Area</u>     |                | <u>Area</u>       |                |
|                                    | <u>Assembly</u> | <u>Tooling</u> | <u>Assembly</u>   | <u>Tooling</u> |
| Air Gages                          | 12              | 8              | 10                | 7              |
| Artificial Intelligence (AI)       | 2               | 1              | 13                | 9              |
| Automated hole gauging             | 6               | 2              | 12                | 6              |
| Automated penetrant                | 5               | 1              | 7                 | 2              |
| Automated theolodite measurement   | 8               | 10             | 12                | 10             |
| Coordinated measuring machine      | 12              | 12             | 12                | 12             |
| Computerized pattern recognition   | 2               | 2              | 10                | 5              |
| Computerized torque wrench         | 1               | 0              | 6                 | 1              |
| Eddy current                       | 11              | 5              | 10                | 5              |
| 5Electro-optical                   | 7               | 7              | 8                 | 6              |
| Flouriscopic                       | 6               | 1              | 9                 | 2              |
| Lasers                             | 6               | 7              | 12                | 13             |
| Manual                             | 12              | 12             | 11                | 10             |
| Manual-check fixture               | 13              | 10             | 9                 | 8              |
| Metrology (calibration) automation | 7               | 6              | 8                 | 7              |
| Photogrammetric                    | 4               | 2              | 6                 | 5              |
| Plug gages                         | 14              | 13             | 11                | 11             |
| Robots                             | 8               | 1              | 12                | 7              |
| Rotary gage                        | 6               | 5              | 8                 | 4              |
| Topology confirmation              | 7               | 4              | 8                 | 4              |
| Ultrasonic                         | 14              | 6              | 14                | 6              |
| Video probe liquid light optics    | 1               | 0              | 4                 | 0              |
| Voice data                         | 2               | 1              | 7                 | 2              |
| X-Ray                              | 5               | 4              | 14                | 5              |

Comments: One respondent wrote "(surface waviness)" next to Topology confirmation.

**OTHER:**

1. How are inspection results usually communicated?

**Today    5-10 years**

|    |    |                          |
|----|----|--------------------------|
| 13 | 7  | Memos                    |
| 10 | 7  | Person-to-person contact |
| 9  | 14 | Computers                |

Comments: One respondent added the following choice:

☒      ☒      Work orders

Another respondent underlined the word "usually."

## INTEGRATION

### FACTORY-WIDE INTEGRATION:

1. Has a formal long-range Computer Integrated Manufacturing plan been established in your company?

5 Yes  
10 No

2. Does a formal plan exist for migrating to a computer integrated manufacturing environment?

4 Yes  
11 No

3. Is there a plan or commitment in your company to develop a common data model for shared data?

Today 5-10 years

|   |    |     |
|---|----|-----|
| 5 | 13 | Yes |
| 9 | 0  | No  |

4. Is there a plan or commitment in your company to follow industry or government standards in the data exchange between:

Today 5-10 years

|    |   |                                |
|----|---|--------------------------------|
| 8  | 9 | Your company and vendors?      |
| 10 | 9 | Your company and the customer? |

Comments: One respondent put the word "within" before "Your company and the customer?".

5. Has a generic center/cell architecture been established for use throughout the factory?

7 Yes  
8 No

6. What major computer hardware systems are you currently using?

| <u>System</u> |           |
|---------------|-----------|
| 2             | NCR       |
| 15            | IBM       |
| 4             | Sperry    |
| 1             | Honeywell |
| 11            | DEC       |
| 9             | HP        |
| 1             | Tandem    |

Comments: Respondents noted that they also use the following systems: Amdahl, Amdahl (Mainframes), Concurrent Computers.

7. What data base management systems are utilized by your company?

| <u>DBMS</u> |            |
|-------------|------------|
| 1           | ADABAS     |
| 2           | IDMS       |
| 12          | IMS        |
| 1           | DataCom/DB |
| 7           | DB2        |
| 4           | Oracle     |
| 1           | Total      |

Comments: Respondents noted that they also use the following systems: Ultra, MIMS.

**HARDWARE - TERMINALS:**

1. In work areas where multi-system access is required, which of the following best describes how terminals are used in your company?

| <u>Today</u> |    | <u>5-10 years</u> |                                                            |
|--------------|----|-------------------|------------------------------------------------------------|
| 8            | 3  |                   | Terminals dedicated solely to a particular system          |
| 2            | 1  |                   | Single terminal with manual switching between mainframes   |
| 5            | 4  |                   | Single terminal access via controller to mainframe systems |
| 6            | 14 |                   | Single terminal access via network to mainframe system     |

Comments: One respondent rephrased the second response to be "Single terminal with manual log-off/log-on switching between mainframe software."

2. Are personal computers linked to each other and to larger computers using local area networks (LAN)?

Today    5-10 years

|   |    |     |
|---|----|-----|
| 9 | 13 | Yes |
| 6 | 0  | No  |

Comments: One respondent crossed-out "to each other and."

Another respondent wrote "Depending on security regulations by the customer" next to "Yes."

Another respondent wrote "But not all" next to "Yes."

#### **HARDWARE - CONTROLLERS:**

1. How would the integration between work cell controllers and equipment (robotics, automated guided vehicles, shop floor equipment) best be described in your environment?

Today    5-10 years

|    |   |                   |
|----|---|-------------------|
| 3  | 0 | No integration    |
| 12 | 7 | Some integration  |
| 0  | 7 | Total integration |

2. How would the integration between workcenter controllers and central processors best be described?

Today    5-10 years

|    |   |                   |
|----|---|-------------------|
| 5  | 0 | No integration    |
| 10 | 7 | Some integration  |
| 0  | 7 | Total integration |

3. How would the integration between cell controllers and data collection devices best be described?

Today    5-10 years

|    |   |                   |
|----|---|-------------------|
| 4  | 0 | No integration    |
| 10 | 6 | Some integration  |
| 0  | 8 | Total integration |

4. How would the integration between different vendor cell controllers and systems best be described?

Today    5-10 years

|   |   |                   |
|---|---|-------------------|
| 6 | 1 | No integration    |
| 8 | 6 | Some integration  |
| 0 | 7 | Total integration |

#### GRAPHICS AND TECHNICAL DATA:

1. Which of the following best describes the interaction between engineering and manufacturing?

Today    5-10 years

|    |    |                                                                               |
|----|----|-------------------------------------------------------------------------------|
| 12 | 0  | Interfaced (data is passed between manufacturing and engineering)             |
| 4  | 12 | Integrated (same data base is utilized by both manufacturing and engineering) |

2. How is company-specific design knowledge captured?

Today    5-10 years

|   |    |                                                 |
|---|----|-------------------------------------------------|
| 6 | 1  | No formal mechanism exists to capture knowledge |
| 8 | 5  | Manual procedures                               |
| 1 | 11 | Artificial intelligence                         |

3. How is company-specific process planning knowledge captured?

Today    5-10 years

|   |    |                                                 |
|---|----|-------------------------------------------------|
| 2 | 0  | No formal mechanism exists to capture knowledge |
| 9 | 5  | Manual procedures                               |
| 2 | 11 | Artificial intelligence                         |

4. Which of the following applications does group technology support?

Today    5-10 years

|   |    |                                                                                                 |
|---|----|-------------------------------------------------------------------------------------------------|
| 2 | 11 | Design engineering (part family development, storage and retrieval of similar part information) |
| 2 | 9  | Assembly planning                                                                               |
| 7 | 10 | Process planning                                                                                |
| 1 | 8  | NC programming                                                                                  |
| 1 | 8  | Cost estimating                                                                                 |

4. (Continued)

Comments: One respondent added another column:

1-4 years

[x]  
[x]  
[ ]  
[x]  
[x]

5. Is your company actively participating in the Product Data Exchange Standard (PDES) organization?

10 Yes  
4 No

6. Is your company actively participating in the Integrated Information Support System (IISS) program?

6 Yes  
7 No

Comments: One respondent added that they were "Tracking IISS."

**NETWORKING:**

1. Does your company have a long-range networking plan?

12 Yes  
2 No

2. Which standards are you using regarding protocols?

Today 5-10 years

|    |    |          |
|----|----|----------|
| 10 | 1  | Ethernet |
| 5  | 1  | TCP/IP   |
| 6  | 12 | MAP/TOP  |

3. With regard to your factory network, which of the following technologies will be utilized?

Today    5-10 years

|   |   |              |
|---|---|--------------|
| 8 | 7 | Broadband    |
| 6 | 9 | Fiber optics |

4. If there are plans to transmit data long distance, what form of transmission will be used?

Today    5-10 years

|    |   |                      |
|----|---|----------------------|
| 10 | 7 | Modem via phone line |
| 3  | 3 | Microwave            |
| 5  | 6 | Satellite            |

Comments: One respondent wrote "Security restrictions limit long distance transmissions" next to the first choice.

Another respondent added ", T-1" to the first choice.

5. To what extent is technical data transferred via the National Bureau of Standards, IGES (Initial Graphics Exchange Specification) standard in your company?

Today    5-10 years

|    |   |                                                 |
|----|---|-------------------------------------------------|
| 11 | 4 | Internally among different CAD/CAM systems      |
| 4  | 7 | Externally to/from suppliers and subcontractors |
| 2  | 0 | Not used at all                                 |

Comments: One respondent added a new column to the choices:

1-4 years

☐  
☒  
☐

One respondent added the following choice:

☐      ☒      PDES (Product Data Exchange Standard)

6. Is MAP/TOP being used to support any applications in a production mode?

Today    5-10 years

|    |    |     |
|----|----|-----|
| 1  | 10 | Yes |
| 12 | 1  | No  |

Comments: One respondent added a new column to the choices:

1-4 years

|                                     |
|-------------------------------------|
| <input checked="" type="checkbox"/> |
| <input type="checkbox"/>            |