

*A VISION OF WHAT COULD BE*

# TESTING 2000

## WIND TUNNEL TESTING IN THE 21st CENTURY

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# PREAMBLE

The following set of charts are a companion set to the TESTING 2000 Text. They were developed with the intent of applying the concept to wind tunnels at Ames Research Center, thus Ames tunnels are used in the typical scenarios. The ideas and concepts are equally applicable to production, or for that matter, research wind tunnels at any testing site.

# GENERAL NOTION

- TESTING 2000 is a wind tunnel testing concept that is believed to be responsive to the needs of industry to reduce the time required to “lines freeze” by about two-thirds.
- The general idea is to implement processes, procedures, and equipment that will enable high-productivity, high-frequency testing.
- High quality wind tunnel flow and high data quality are assumed to be embedded in the TESTING 2000 concept, and along with speed of testing will enable US wind tunnels to achieve and retain world preeminence
- Maximum use of Information Technology will be made to support the real-time conversion of wind tunnel data to design knowledge , and to enable every possible phase of a wind tunnel test to be conducted remotely.

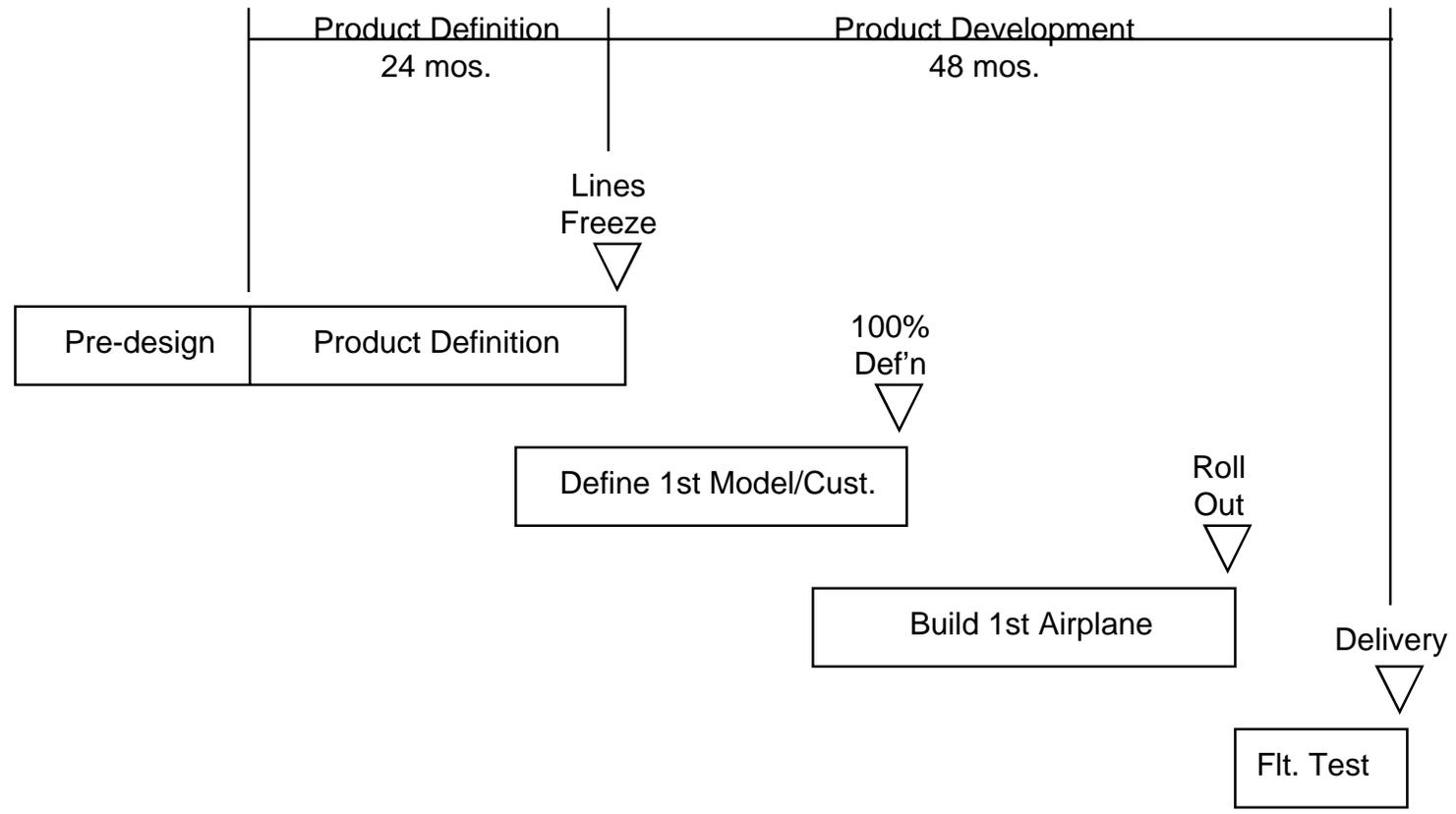
# TESTING 2000

## A NEW PARADIGM FOR THE FUTURE

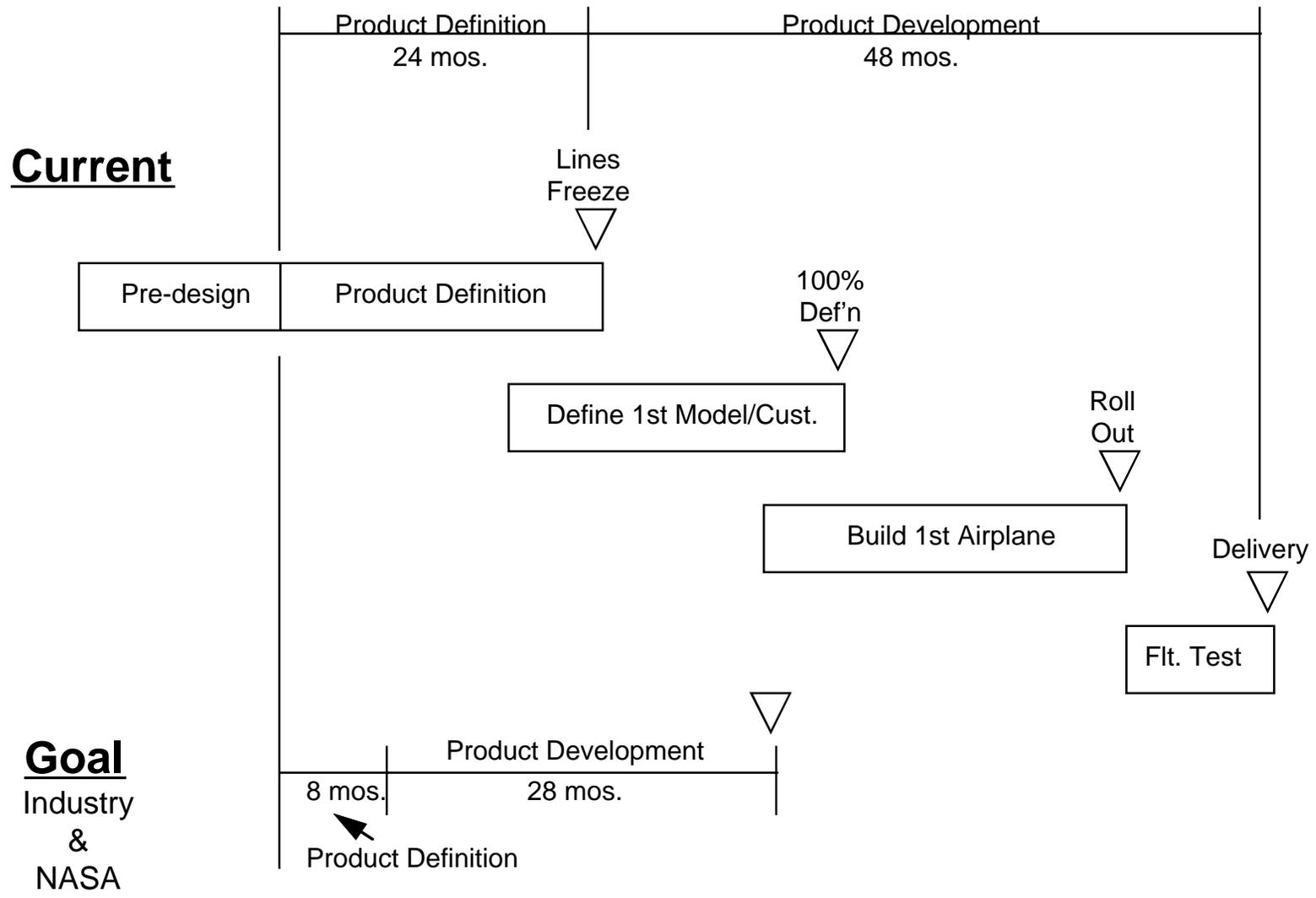
### GOAL

- Provide the wind tunnel testing and information systems technology that will enable the time required for Product Definition phase to be reduced by about two thirds
  - Develop and implement an integrated package of services and technology that will enable a wind tunnel test cycle, from the time that the configuration to be tested is defined until the knowledge from the test is acquired and assimilated, to be completed in one month, with no customer personnel required to be present at the testing site, or
  - Alternatively conduct a series of 2-3 day tests on two week intervals until the design is completed.

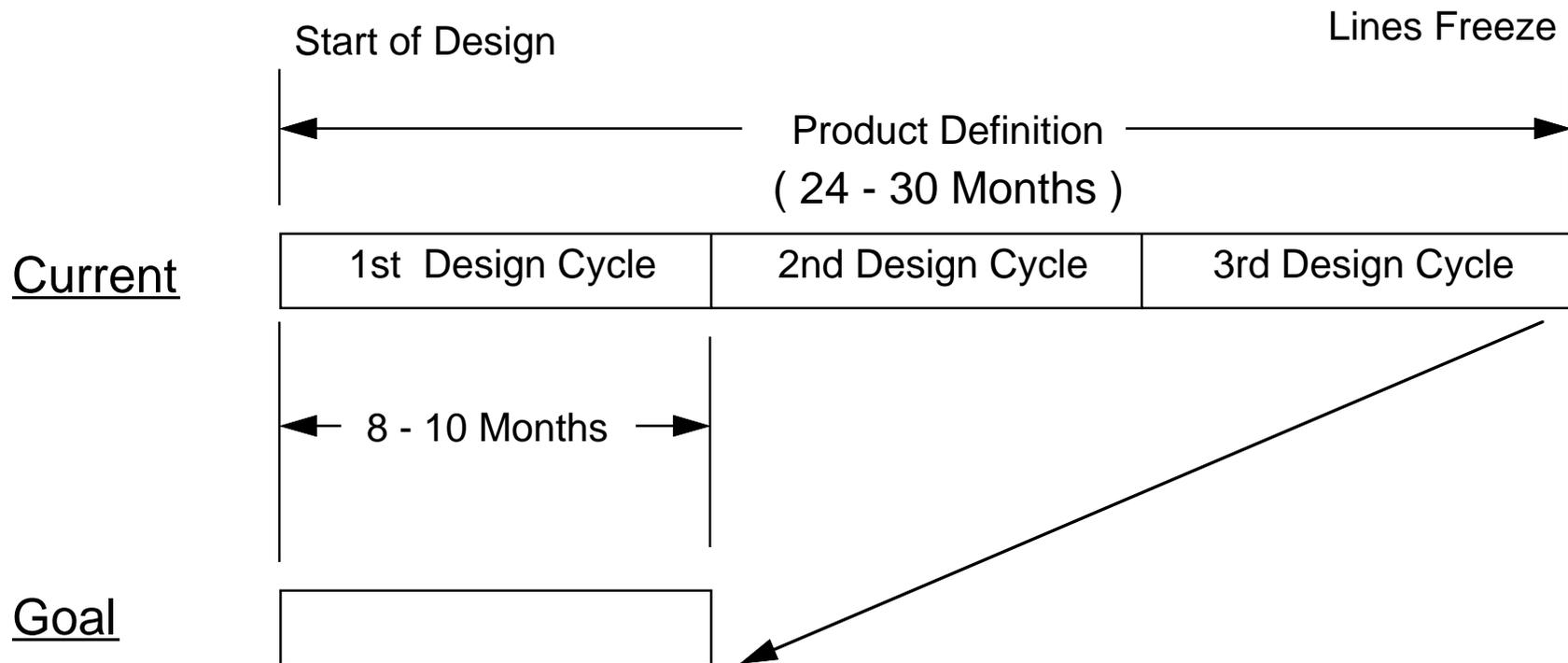
# TYPICAL AIRCRAFT DEVELOPMENT CYCLE



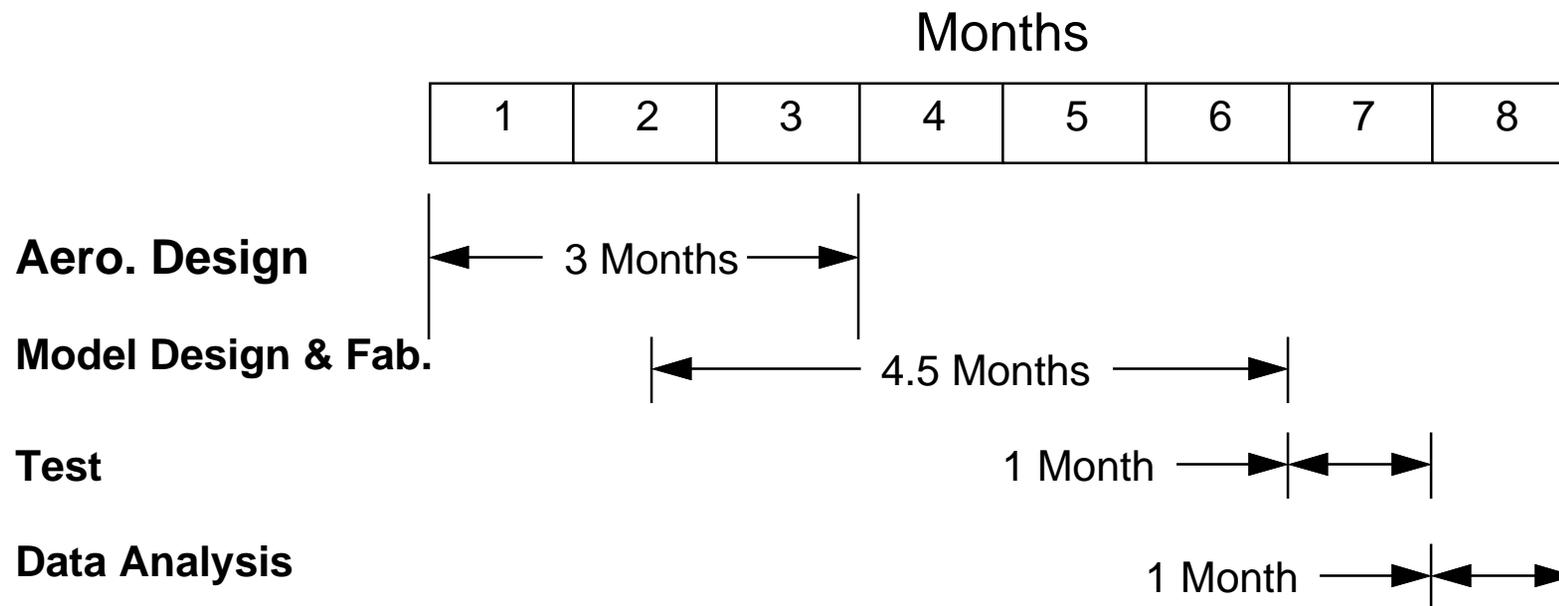
# TYPICAL AIRCRAFT DEVELOPMENT CYCLE



# TYPICAL AIRPLANE DESIGN PROCESS

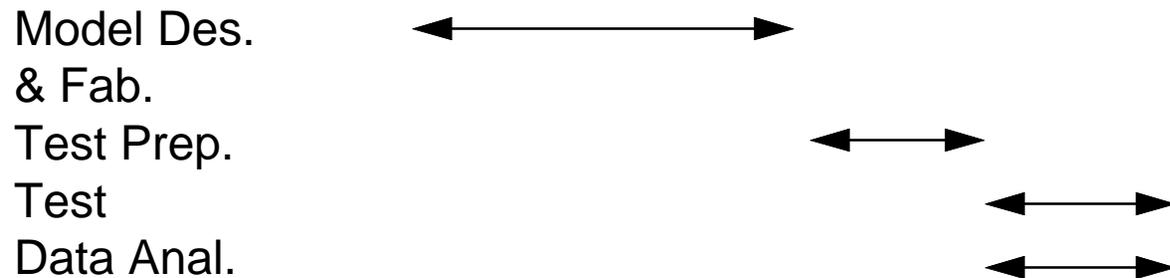
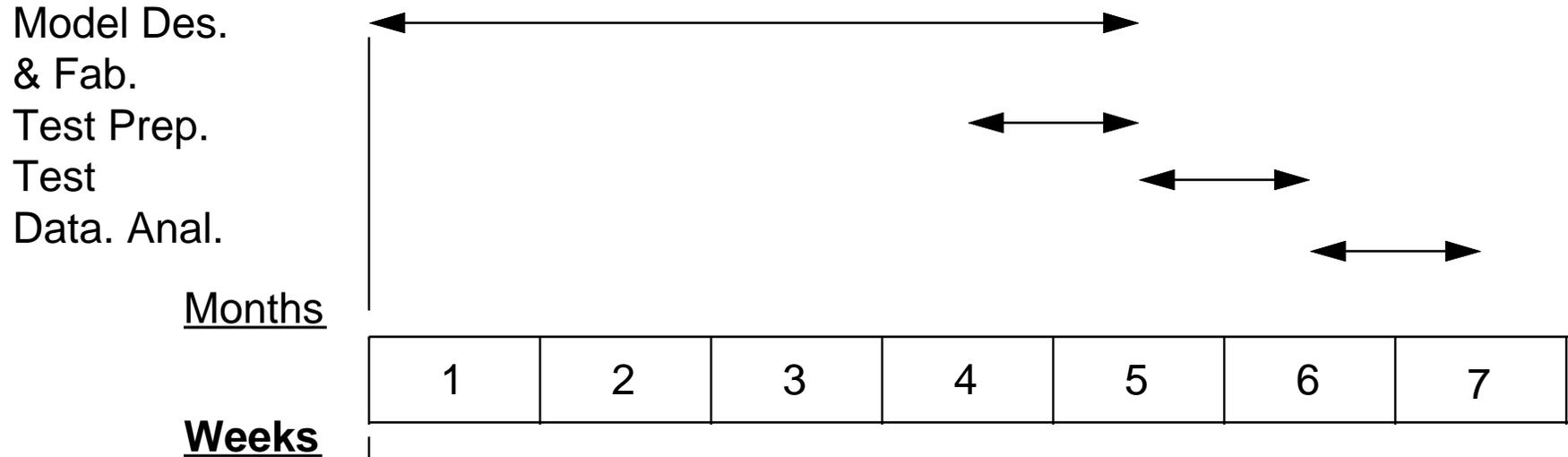


# A TYPICAL CURRENT AIRPLANE DESIGN CYCLE



# CONTINUOUS WIND TUNNEL TEST

## CURRENT



## TESTING 2000

# HIGH-FREQUENCY WIND TUNNEL TESTING TESTING 2000

Weeks:

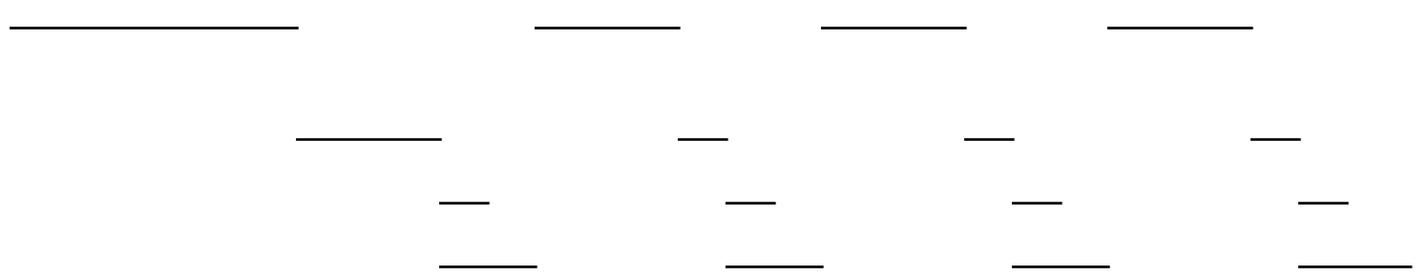
1	2	3	4	5	6	7	8	9	...
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Model Des.  
& Fab.

Test Prep.

Test

Data Anal.



# TESTING 2000

OBJECTIVE: On the first day of business in the next century, operate the Ames 12-Ft. Pressure Wind Tunnel and the 11-Ft. Transonic Wind Tunnel with a revolutionary new paradigm.

This new paradigm will encompass the ability to conduct a typical, continuous, developmental wind tunnel test in thirty days from the time of initial contact by the user to the completion of the test, including fabrication of the wind tunnel model. Alternatively, the capability to conduct a high-frequency series of two to three day tests on about two week intervals will be available. Further, the entire test will be conducted using extensive networking capability such that users are never required to be at the test site. Information technology processes will be implemented to ensure that all knowledge to be gained from testing will be acquired by the end of the test.

PAYOFF: New paradigm will enable users to achieve required testing in a shorter time, essentially on demand, with no staffing required at the test site. The testing process will be an interactive, real-time part of the design process.

# TYPICAL SCENARIOS

## A CONTINUOUS TEST

– 1/3/00:

- User logs onto Ames Wind Tunnel Web page to request a typical development wind tunnel test to be conducted in either the 12-Ft. PWT or the 11-Ft. TWT and completed by 2/1/00
- Ames responds that we have a lower priority test that can be interrupted for a one week period of testing starting 1/24/00
- User responds with details of test and requests Ames use Remote Model Design and Manufacturing (RMDM) to construct the model
- Ames agrees that the test can be conducted within the required schedule
- Master contract agreement is activated with the user and a line of credit established at Ames to support the test

– 1/4/00

- User transmits model coordinates, data reduction program requirements, instrumentation requirements and test matrix to Ames over a secure network
- Dedicated test team formed at Ames

# SCENARIO, cont'd

- 1/5/00
  - Ames activates RMDM network for model construction
- 1/6/00 to 1/17/00
  - All details of test planning completed interactively between users and Ames test team using a secure network. Extensive use of intelligent agents in test planning.
- 1/19/00
  - Model components arrive at Ames. Model assembly, checkout and instrumenting begin
- 1/22/00
  - Model assembly, checkout, and data reduction system verification complete
- 1/24/00
  - Model installation begins. Completed in 4 hours and first data run initiated

# SCENARIO, cont'd

- 1/24/00 to 1/28/00
  - Wind tunnel test conducted. All data transmitted to user's remote Virtual, Interactive Control Room site
  - Users modifies run matrix and downloads run conditions to wind tunnel control system
  - DARWIN on line
  - Small model components manufactured to enable changes in configuration resulting from real-time analysis of test results
  - All data transmitted to user is final data with real-time updates reflecting changing test parameters.
- 1/28/00
  - Wind tunnel test complete, and model removed at end of shift
- 1/29/00
  - Final billing transmitted to user and payment transmitted to Ames electronically

# HIGH-FREQUENCY TEST SERIES

- 1/3/00:

- User logs ont Ames Wind Tunnel Web Page to request a series of 2-3 day wind tunnel tests to be conducted in either the 12-Ft. PWT or the 11-Ft. TWT beginning around 1/24/00 and continueing for about 6 months.
- Ames resonponds that the test request can be accomodated by scheduling for planned tests to be interrupted.
- *Remainder of scenario is identical with Continuous Test Scenario until model installation on 1/24/00 is complete*

- 1/24/00 - 1/26/00

- Wind tunnel test conducted. All data transmitted to User's remote, Interactive Control Room site.
- DARWIN on line
- Model removed at end of shift on 1/26/00

# HIGH-FREQUENCY TEST SERIES, cont'd

- 1/24/00 to 1/28/00

- Data analysis conducted concurrent with wind tunnel test to define results and to determine next step in design process
- New model contours developed and forwarded to Remote Model Design and Manufacturing Network

- 1/31/00 to 2/8/00

- Machining of new model contours initiated, e.g. a new wing
- New parts complete by 2./8/00 and assemble begins at Ames

- 2/9/00 to 2/11/00

- Model assemble and checkout completed

-2/14/00 to 2/16/00

- Model installed and test conducted
- *Sequence continues on 2 week intervals until design complete. Final billing at completion of wind tunnel test series.*

# APPROACH

To bring about a revolutionary change in wind tunnel testing, many of the current processes will have to be changed. Many of these changes will be critical to the success of the new paradigm. Other changes will add value to the new testing paradigm as it contributes to reducing the time to develop a new aircraft configuration, but are not critical to the goal to reducing the time to conduct a wind tunnel test to 30 days.

# CRITICAL ELEMENTS

- Improved business practices
- Just-in-time testing processes
- Dedicated test teams with customer oriented attitudes
- Intelligent agents for test planning
- Remote access model design and manufacturing system
- Rapid data reduction program development
- One day balance calibration capability
- Rapid installation - deinstallation of models
- Virtual, interactive control rooms at user site
- High-speed, near real time data acquisition systems
- Institutionalized advanced instrumentation and test techniques
  - PSP, DGV, IR Thermography, model deformation, optical angle of attack, wall corrections, support interference corrections, etc..
- Overall high facility productivity

# GENERIC SUSTAINING ELEMENTS

- On-line, real-time data uncertainty analysis tools
- Thorough, detailed facility calibrations
- Flow quality consistent with customer requirements
- Quick installation, calibration/facility flow quality continuity models and test procedures to check, on a regular basis, for facility flow quality degradation.
- Customer oriented metri capability and testing processes

# ADDED VALUE ELEMENTS

- Current-aircraft data bases
  - Will provide users with confidence in wind tunnel results as they relate to their current aircraft.
- Information systems for aerodynamic knowledge
  - Knowledge based software tools that will enable users to convert data to knowledge in real time during a wind tunnel test
- Real-time aircraft design tools
  - Tools will enable configuration modifications to be developed during a wind tunnel test
- Information Management System
  - A DARWIN or DARWIN like information management system that integrates all of the elements of the integrated design process together