KDI-21

Kamakura Digital Innovation - 21

Overview of the Concept to Hardware Development Process

at

MITSUBISHI ELECTRIC CORPORATION
Kamakura Works
06-26-2001

Presented by Ryusei Matsumoto

Presentation Overview

- Overview of MELCO (Mitsubishi Electric Corporation)
- Overview of Kamakura Works
  - Satellite Heritage
- KDI-21 (Kamakura Digital Innovation-21)
  - Overview of KDI-21
  - Digital Factory
    - KDI-m
    - KDI-e
  - Knowledge Engineering
    - KDI-db
  - Software Development
    - KDI-s
- Future improvement activities

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MELCO & Kamakura Works Overview

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MELCO Operation Groups

PRESIDENT & CEO
I. TANIGUCHI

9 Business Groups

Executive Vice President
Member of the Board
T. Nomakuchi

Corporate Research & Development Group

Communication Systems Group

<< Electronic Systems Group >>

Information Systems & Network Service Group

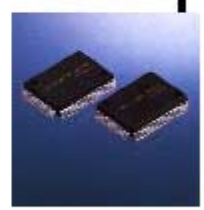
Public Utility systems Group

Building Systems Group

Living Environment & Digital Media Equipment Group

Factory Automation Systems Group

Automotive Equipment Group



Semiconductor Group

MELCO's Heritage Satellite/Component, Integration & Testing Facility

Heritage Satellites/Components

Solar Array

ETS-V, JERS-1, ETS-VI
APSTAR, INSAT-2

INTELSAT-VII, VIIA, VII, IX

Ka-Payload

COMETS
ETS-VI, VII
ICO

Standard Commercial Communication Satellite

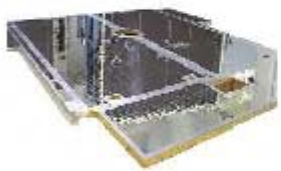
RIM

ETS-VII
SFU
USERS

Satellite Controller

JERS-1
IRIS
ETS-VII
USERS

Heat Pipe Panel



ADEOS
ECHOSTAR
INMARSAT-3
INSAT-2
INTELSAT-VII, VIIA, VII, IX
N-STAR
Space Flyer Unit

Integration & Testing

- 11.5 m diameter thermal vacuum chamber
- 30 ton satellite vibration-test equipment
- Acoustic Chamber for satellite system
- 5 m quiet zone Compact Antenna Test Range

- Prompt delivery,
- Low price,high quality
- Customer support in an integrated production system incorporation all aspects including design, integration and testing.

Thermal Vacuum Chamber

Compact Antenna Test Range

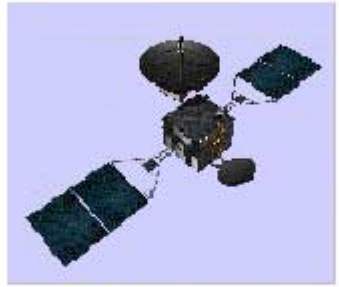
Large Satellite Integration

MITSUBISHI ELECTRIC CORPORATION

MELCO's Satellites Types Overview

OPTUS C1 : GEO
High-Power Communication

ETS-VIII : GEO
Mobile Communication



DRTS : GEO
Inter-Satellite Communication

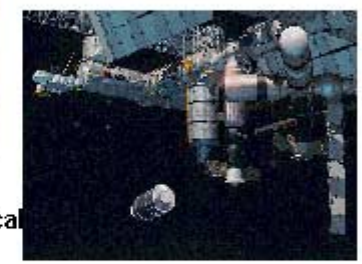
ADEOS-II: Polar Orbit
Environment Observation

MELCO Satellite

Wide Range of Satellite Types

- Ten Satellite Types in Development -

MTSAT-2 : GEO
Aeronautical & Meteorological Mission



HTV : Transfer
Transportation to Space Station

USERS : LEO
Micro-Gravity Experiment
(Super Conductor Material Processing Furnaces)

SERVIS : LEO
Space Environment Experiment
(Verification of COTS parts)

SOLAR-B : Polar
Solar Observation

KDI-21

- Activities to Achieve Short Delivery Time with High-Quality production
- KDI-21 Top-4 Selection
- IT Role in Spacecraft Life Cycle
- Space Life Cycle Database
- Digital Integration/Collaboration

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Activities to Achieve Short Delivery Time with High Quality Production

Augment Technical Development Capability

- Victory Project
- Strategic Project
- Important Project

Reorganize 3 Main Space Related Areas

- KDI-21
  - Design/Production Reform
- STD2000
  - Space Standardization
- PS2002
  - Space Product Quality Assurance

Improvement of Technology/Production

- Accumulation of Knowledge
  (Institution of Knowledge-Value)
- Reinforcement of Production
- Management Methods of Development

Strengthen Individuals

- Top100 Engineers
- Acknowledge skills
- Skills Inventory

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KDI-21 Top 4 Selection

Knowledge Management
Security Reinforcement

KDI-db

Engineering DB Construction

Development to realize rapid information collection, and reusability by unified maintenance of technical information. Innovation of Design Environment

KDI-m

Mechanical
3D Design
Manufacture・Test
Integration

Design via 3D Model Data
Production Process
Innovation

3D Design/Production System to lead the Satellite Industry

KDI-21 Unified Database

KDI-e

Electrical
Logic Design
Manufacture・Test
Integration

Innovation of Production Process by Digitizing the Development
Production Preparation
Manufacture

Advanced Design Method
FPGA/PCA
Reduction of Design Time by 1/2

KDI-s

Generation S/W Development・Unified Maintenanc

Innovation of S/W Development Process via S/W PDM
S/W Develop/Design Navigation

Challenge to CMM Level 5

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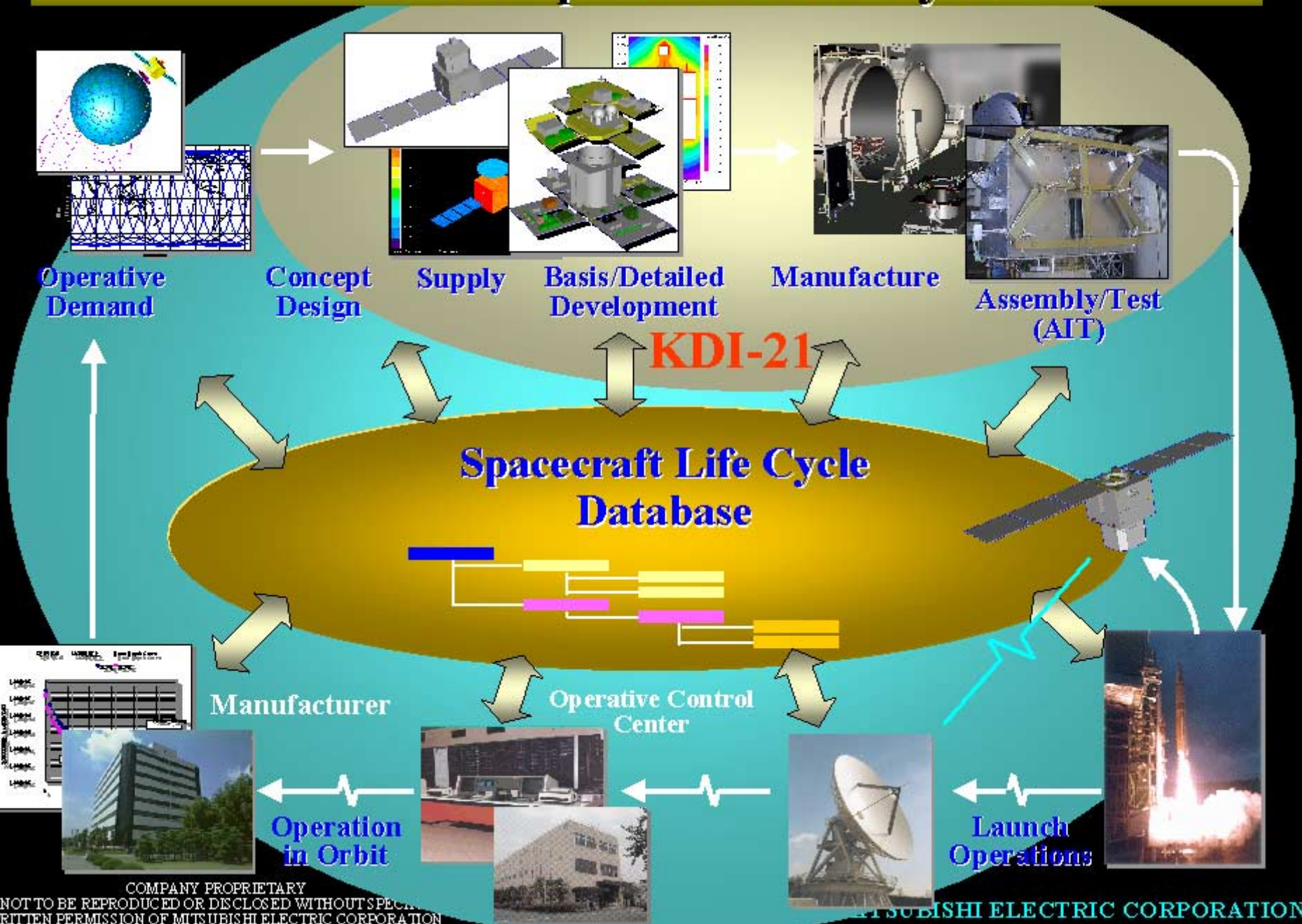
IT Role in Spacecraft Life Cycle



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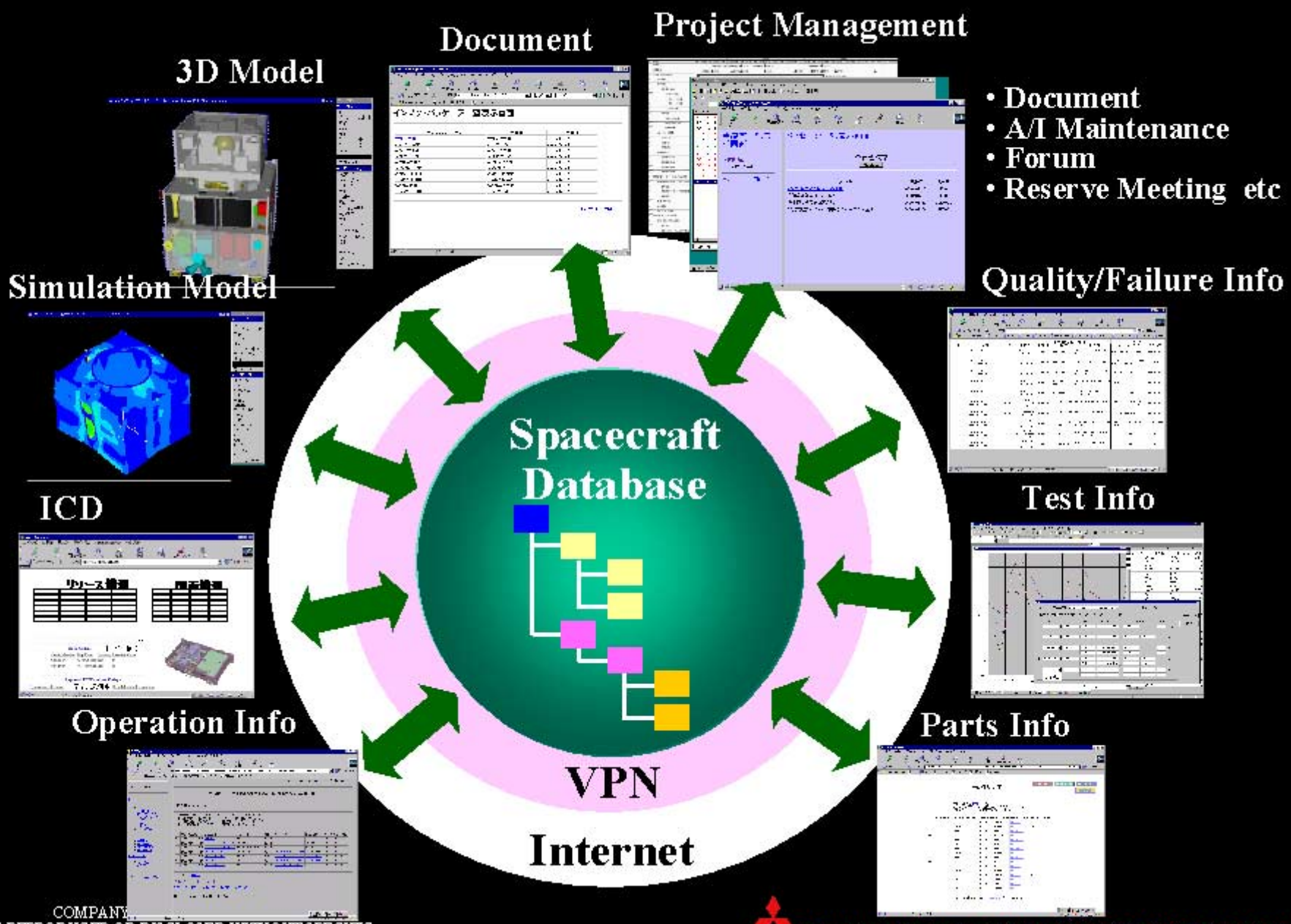
Space Life Cycle Database



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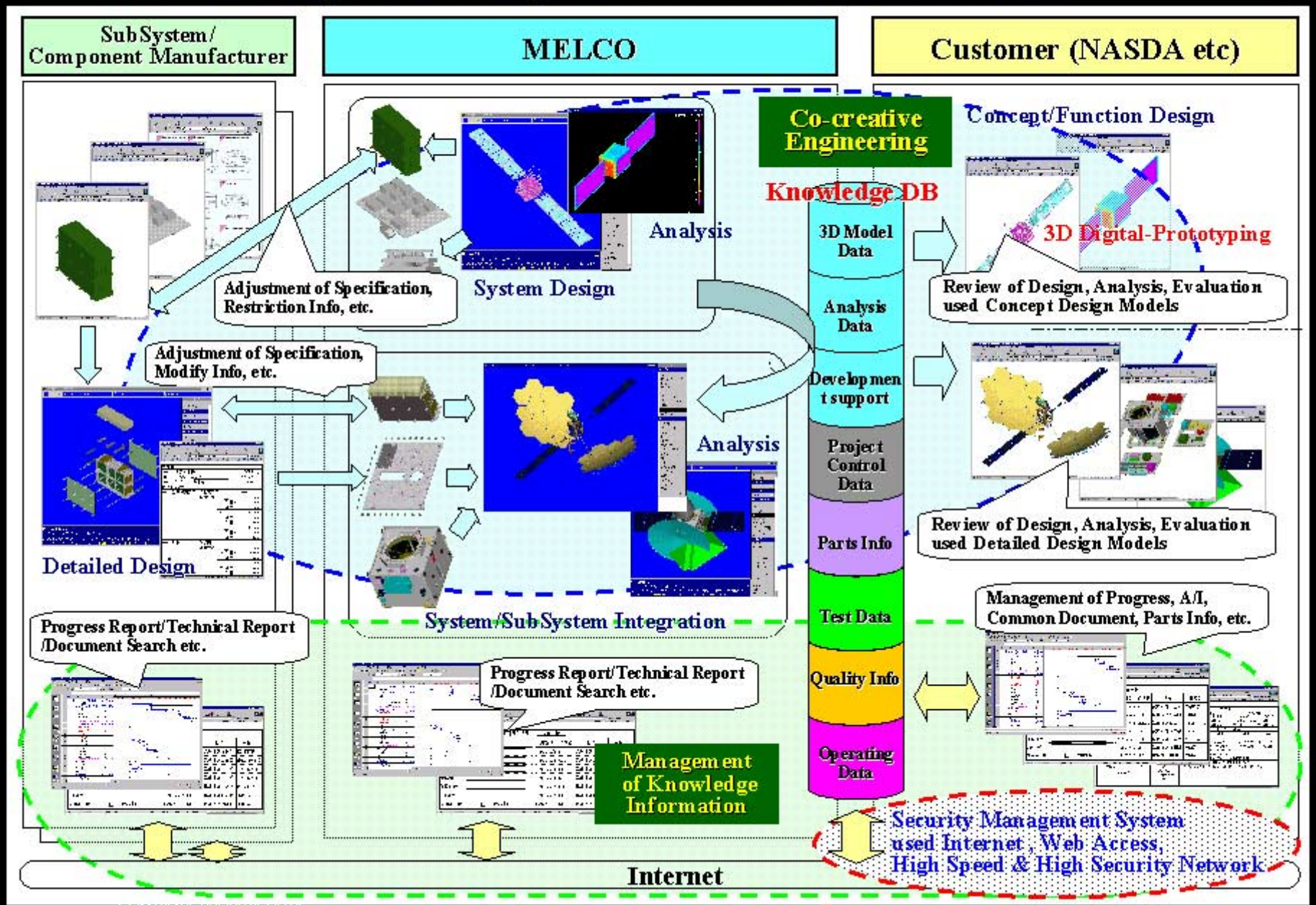
Digital Integration / Collaboration



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KDI-m Digital Factory

- 3D Satellite Development
- 3D Top-Down Design
- 3D Virtual Integration
- System Design/Simulation
- Design Review (Built-in Quality)
- Collaboration
- 3D Consistent Production (Manufacturing/Assembly/Testing)

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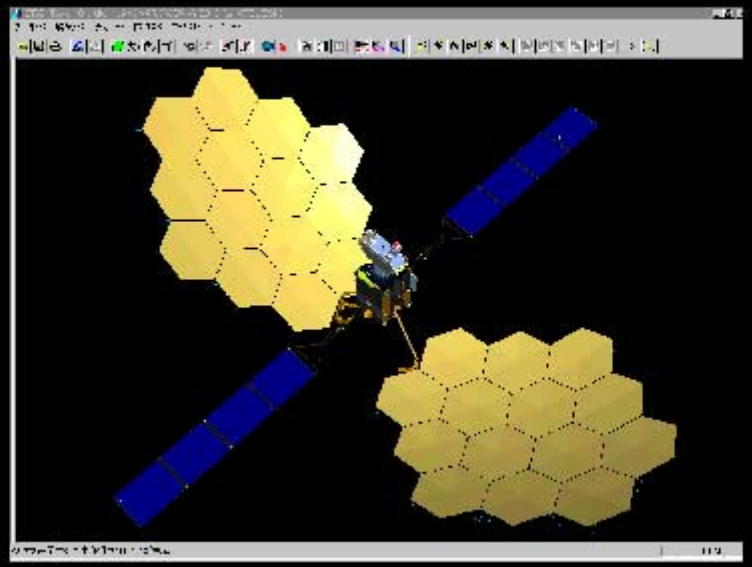
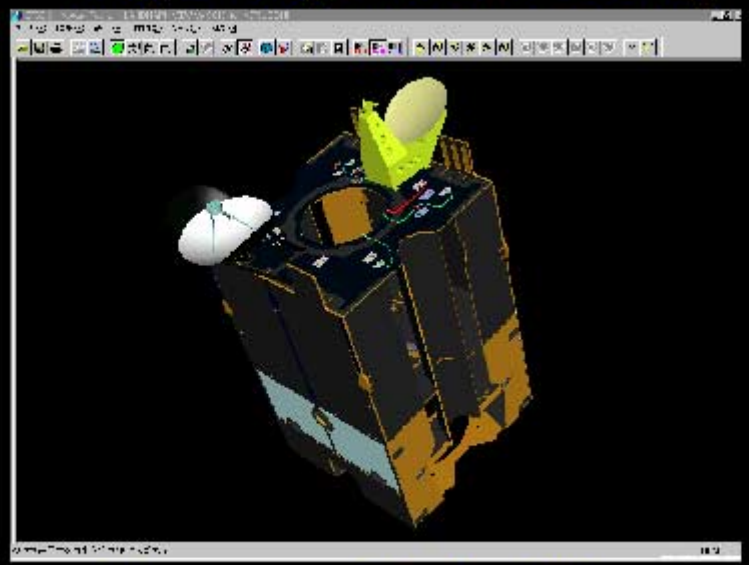
3D Satellite Development

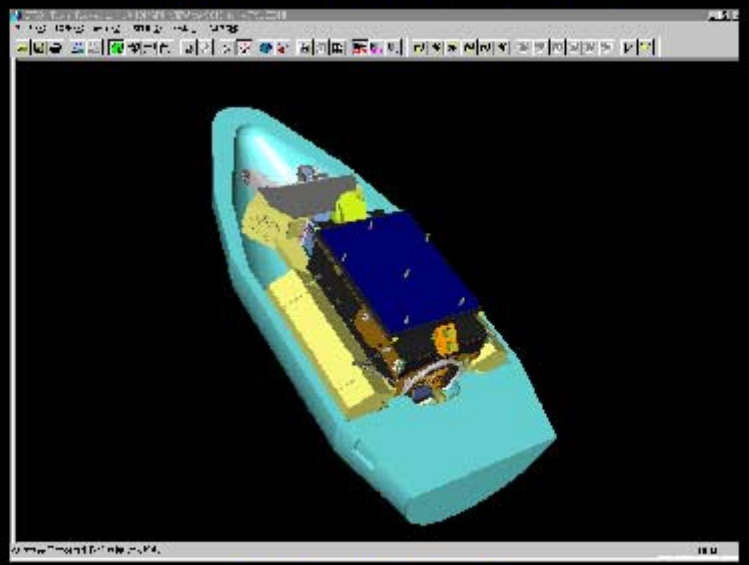
Design, Integration and Testing



System Model in Orbit



Structure of Payload/Bus



Rocket Interface

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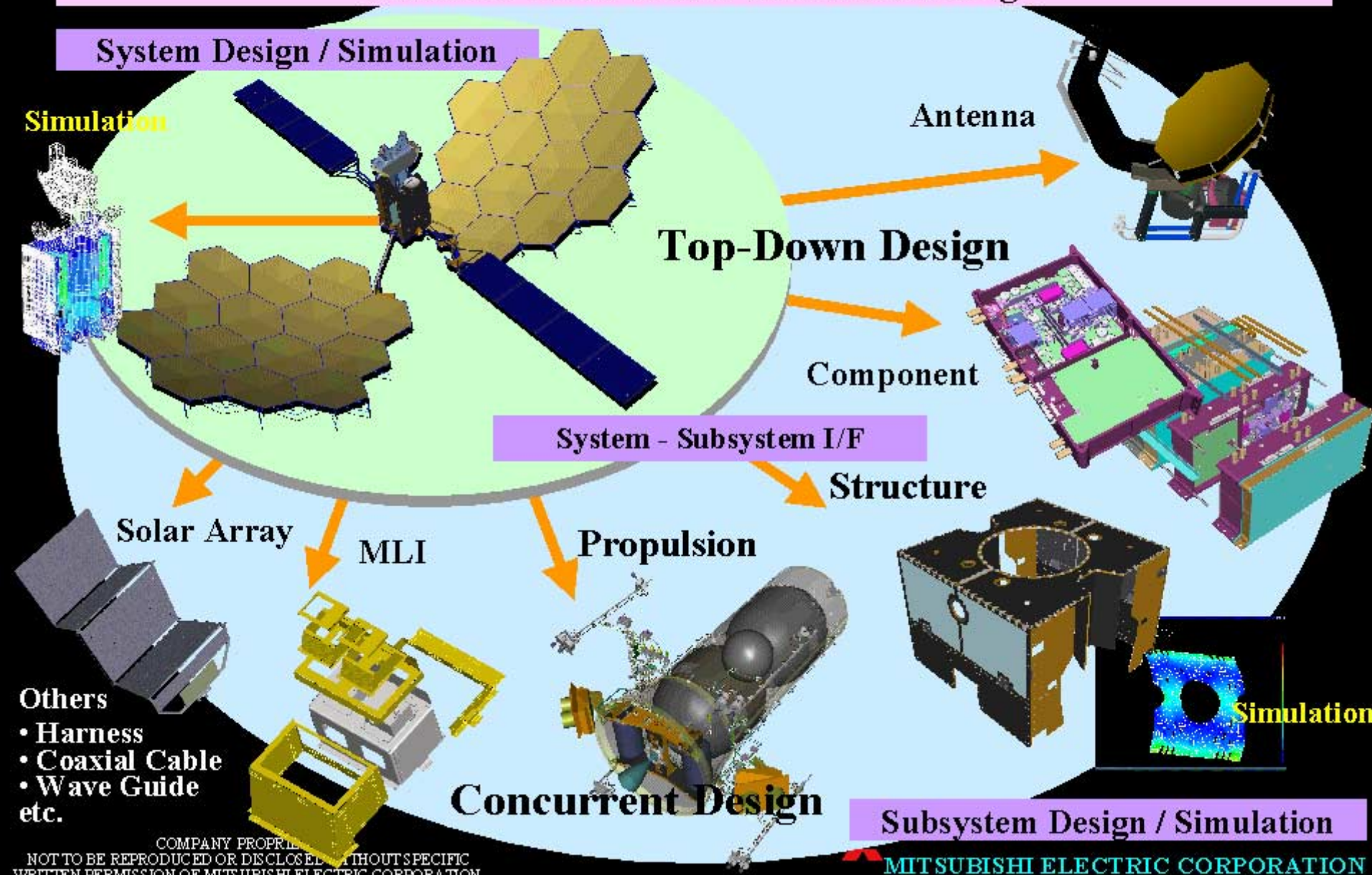
3D Top-Down Design

Method / Rule / Know-how of Modeling



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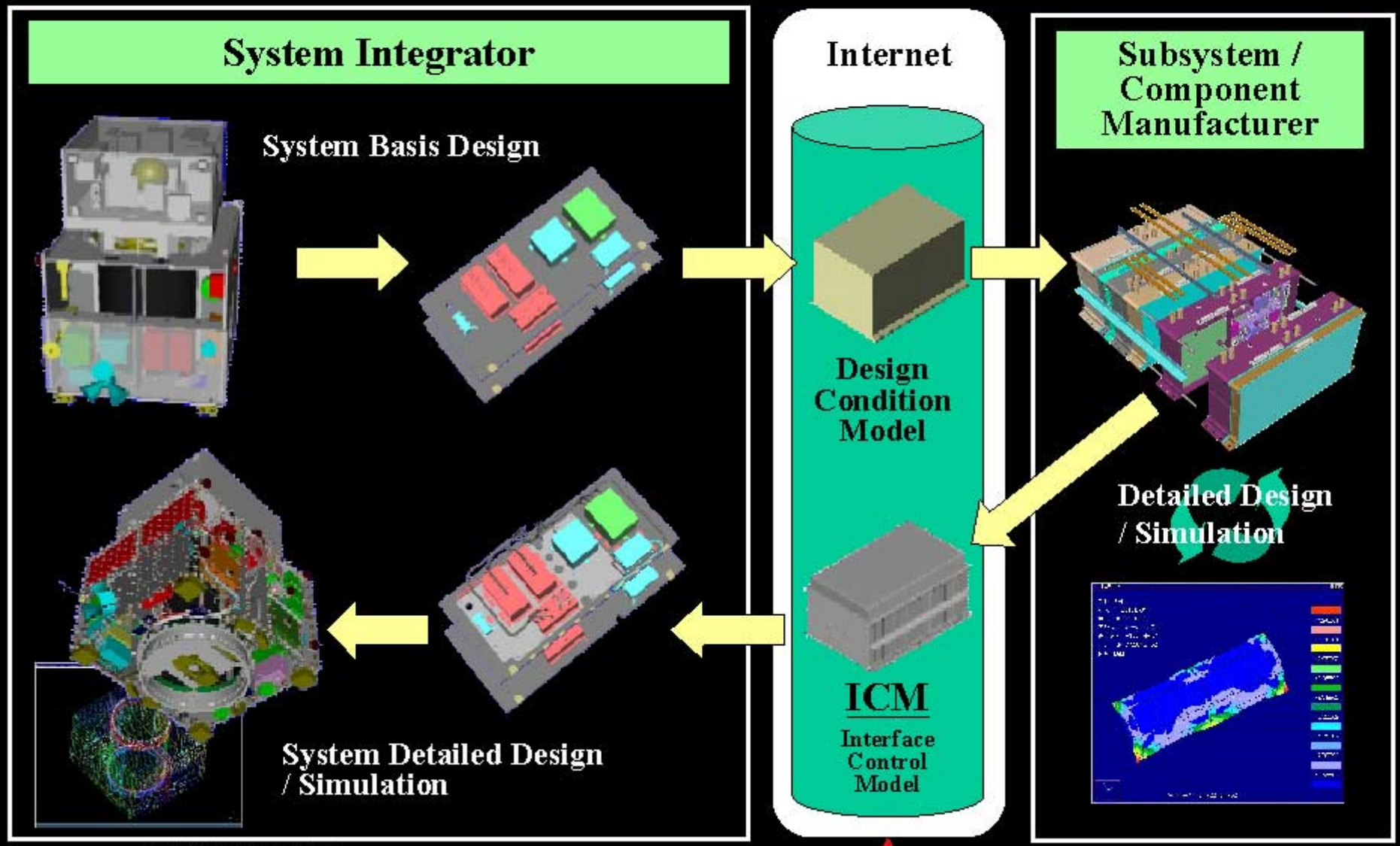
3D Virtual Integration

System Design Information Management by ICM Exchange with Subsystem Side.



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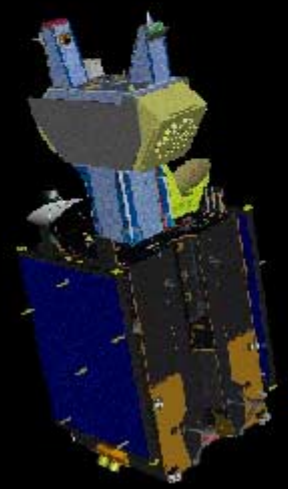
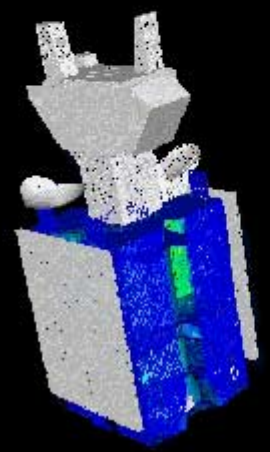
System Design/Simulation

Pro/E Model

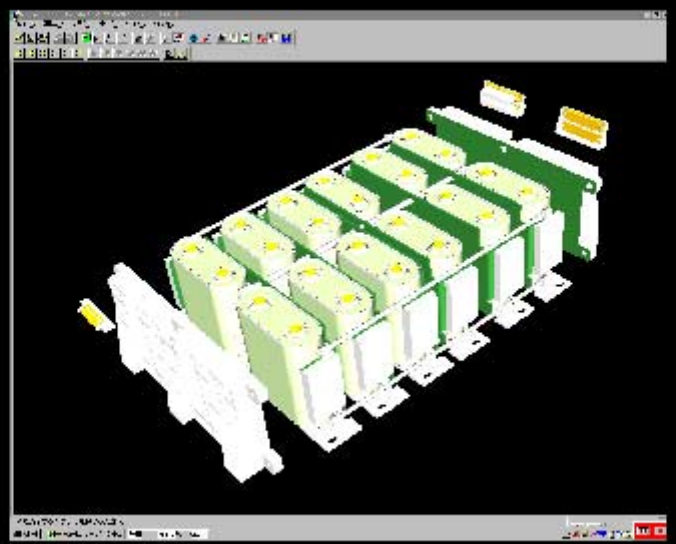
Structure Analysis Result

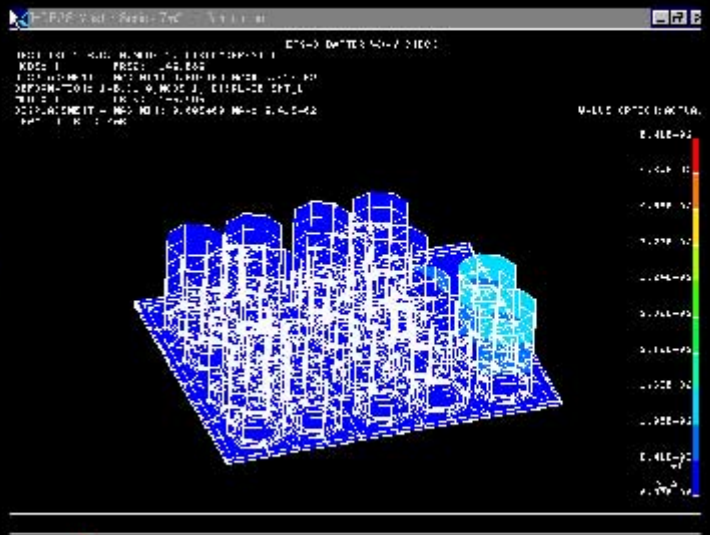
System Model





Component





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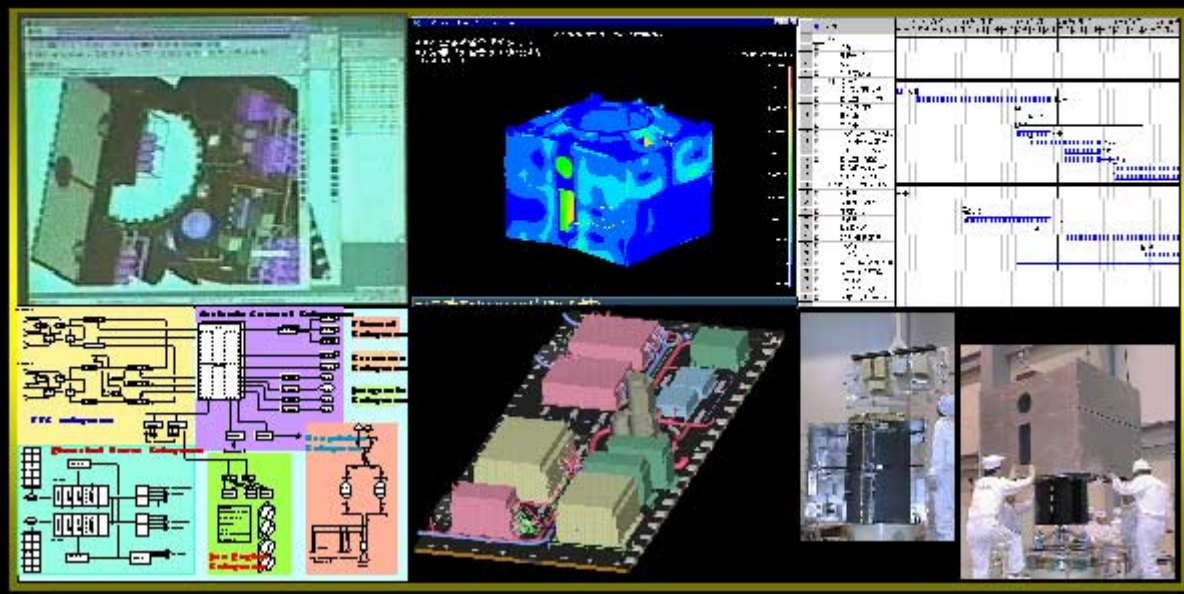
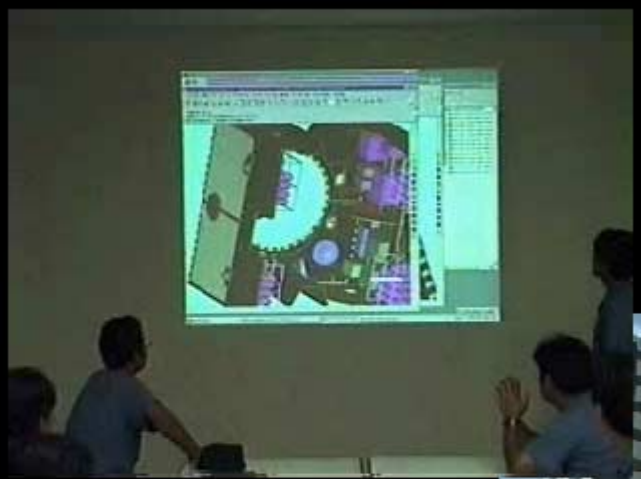
Design Review (Built-in Quality)

- Design Review
- Simulation
- Confirm/Adjust Interface
- Nature of Process/Construction /Test Verification
- Progress Advancement Meeting





Design Facility

M&S Center

LAN

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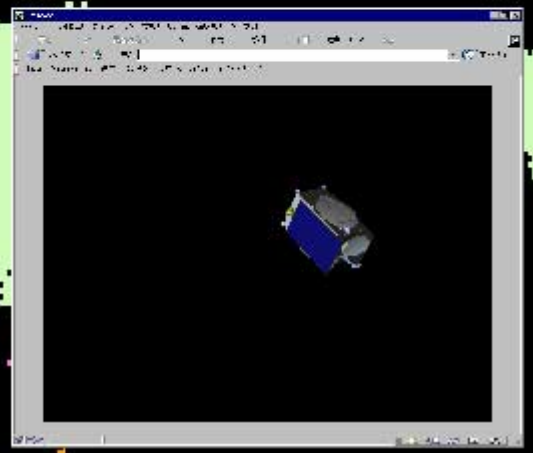
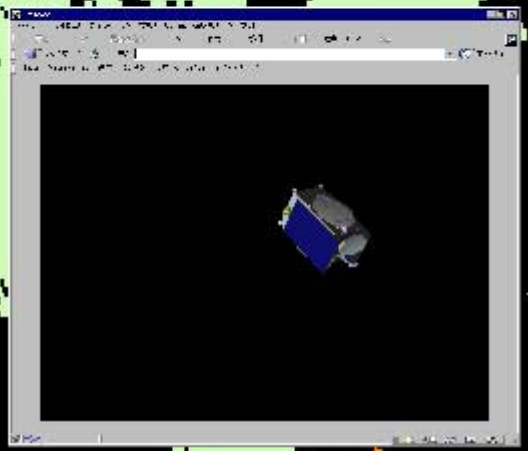
Collaboration

Domestic/International Collaboration

- NASDA Project: 5 companies
- USEF Project: 13 companies
- Commercial Satellite
  - OPTUS-C1: SS/L
  - MTSAT-2: Alcatel/BSSI
  etc.

Real-time Collaboration System





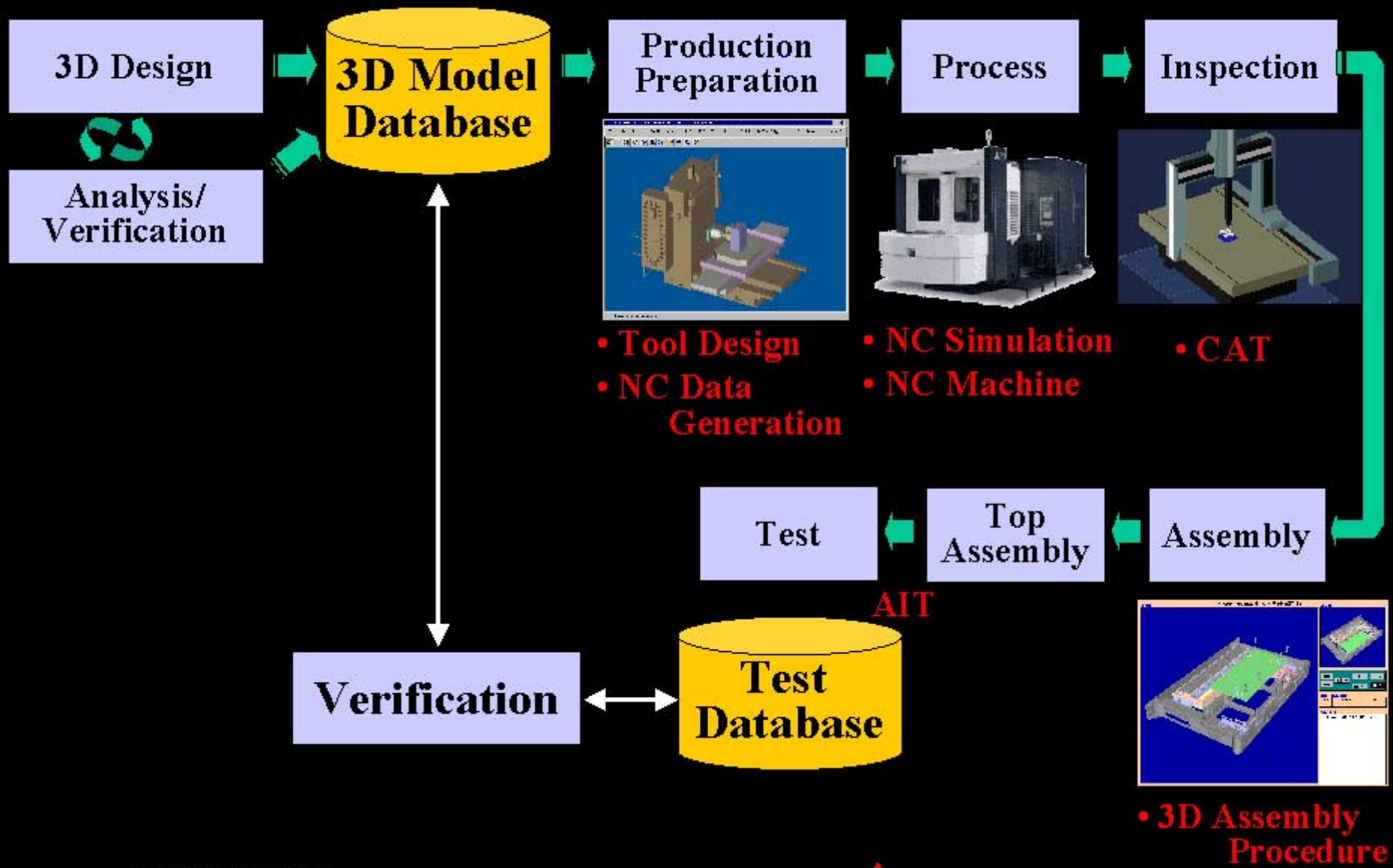
Interface with 3D Models

NASDA

High Security
High Speed Network

Manufacturer

3D Consistent Production (Manufacturing/Assembly/Testing)



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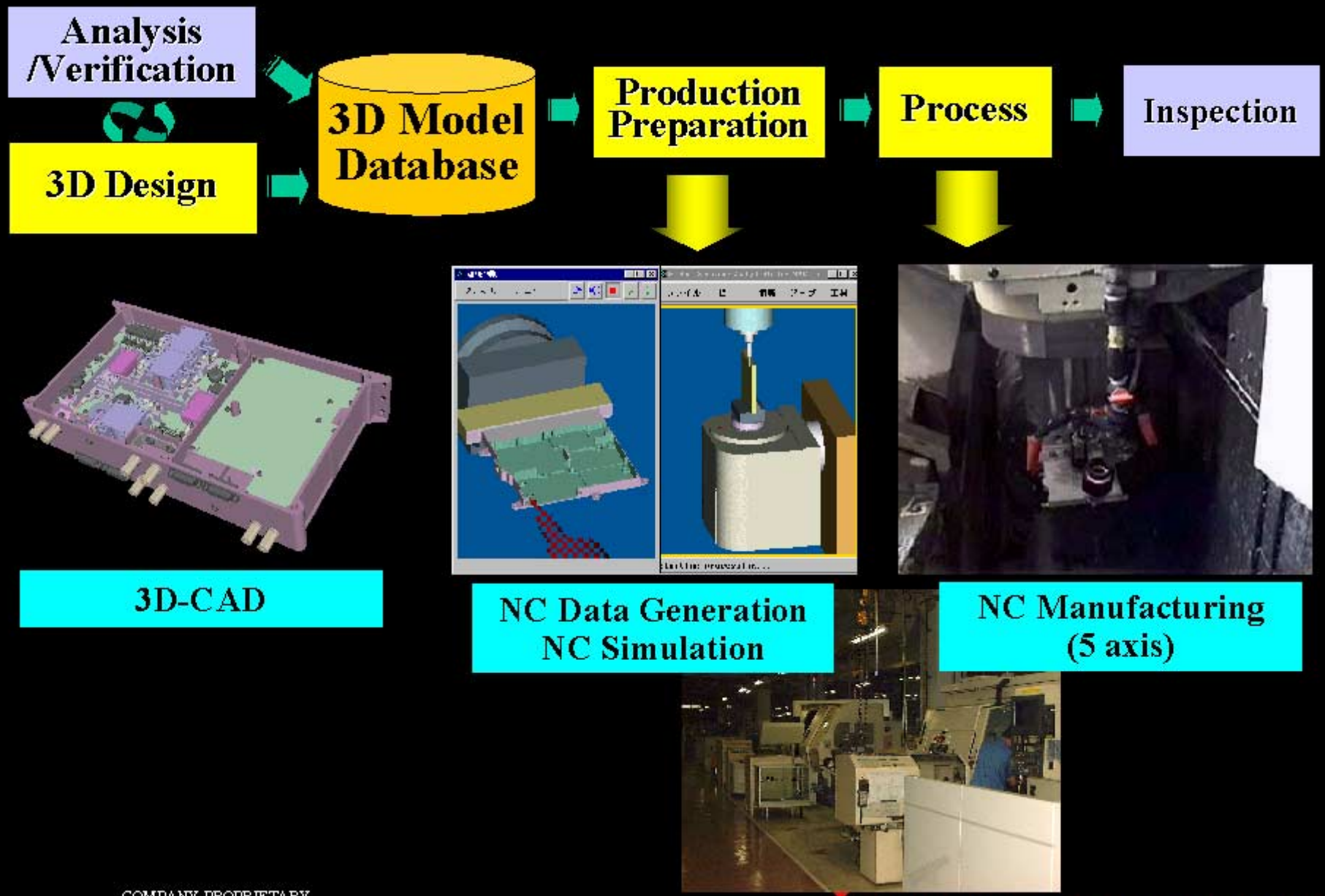
3D Production



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3D Assembly

Analysis /Verification

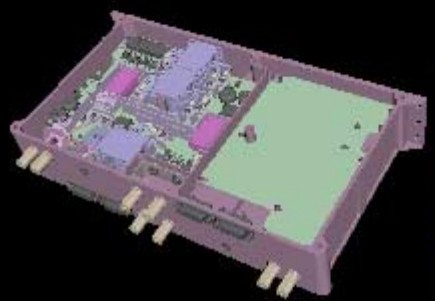
3D Design

3D Model Database

Production Preparation

Process

Inspection



3D Assembly Procedure

Component Assembly

Test

Top Assembly

Assembly

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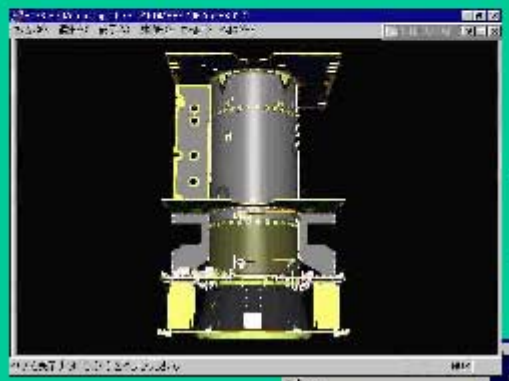
3D AIT/Test Planning

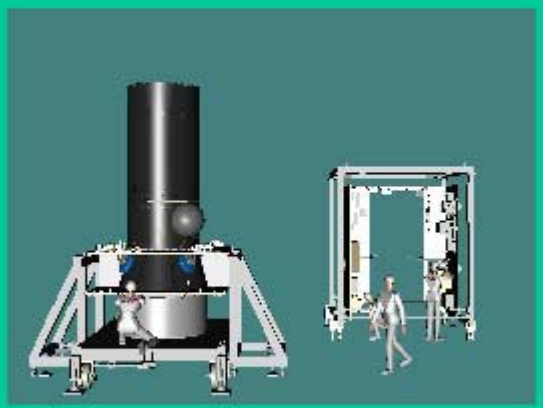
Structure Assembly

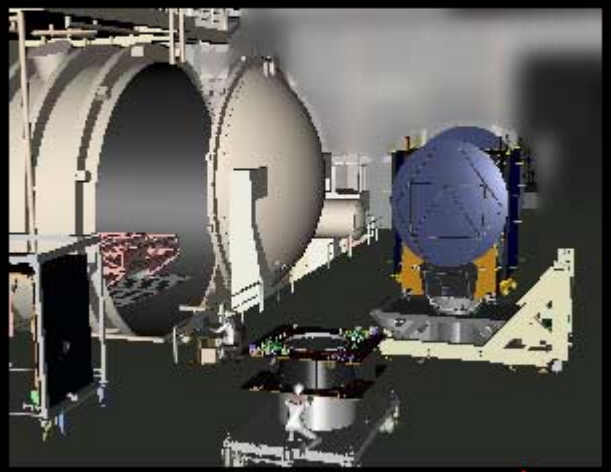


Test (Space Chamber etc.)

3D Assembly Procedure

Test Planning





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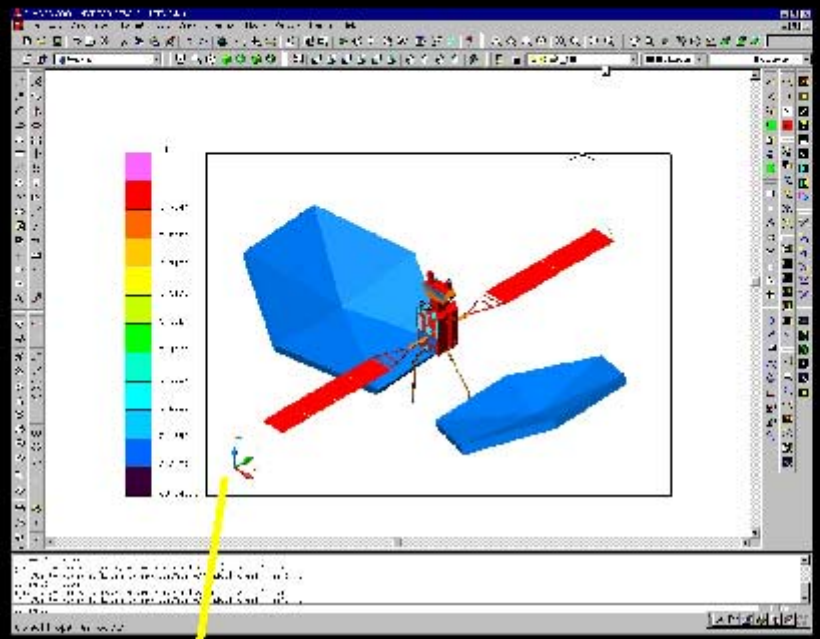
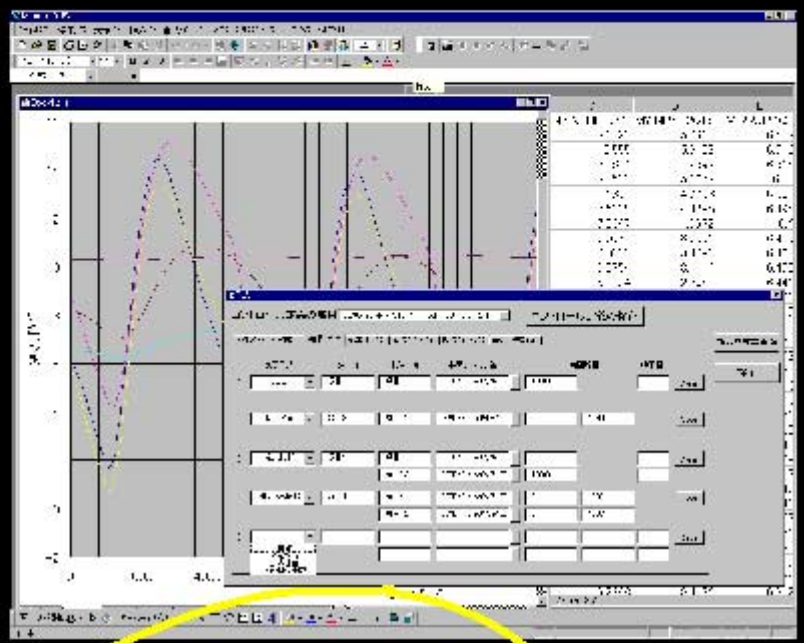
Test/Design Network





Design Facility

Test Facility

High Security
High Speed LAN

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KDI-e Digital Factory

- Electrical Design/Assembly
- 3D Assembly
- Example: Link to KDI-m
- Analysis Comparison of Test Data/Verification

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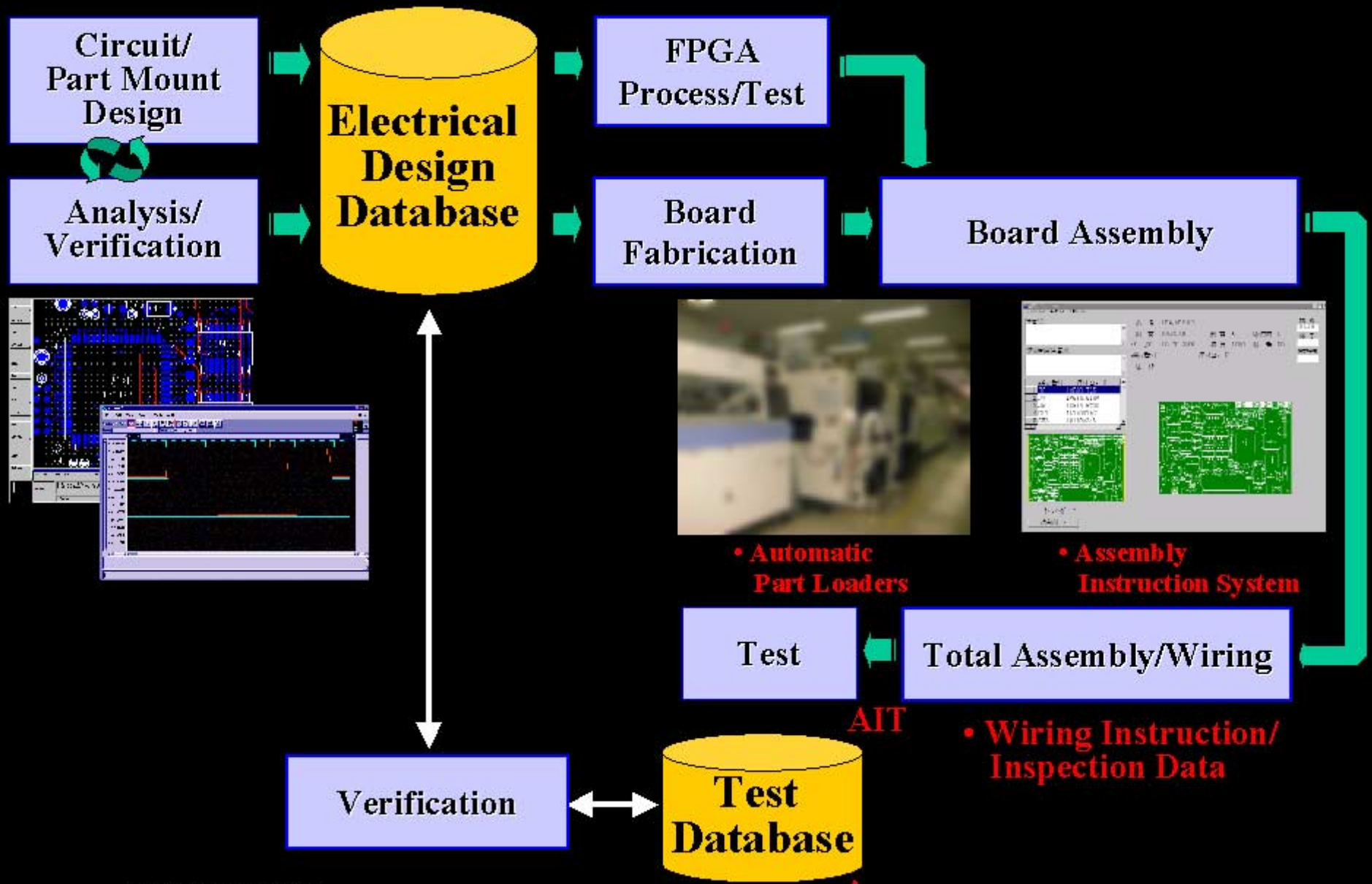
Electrical Design/Assembly



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3D Assembly

Analysis /Verification

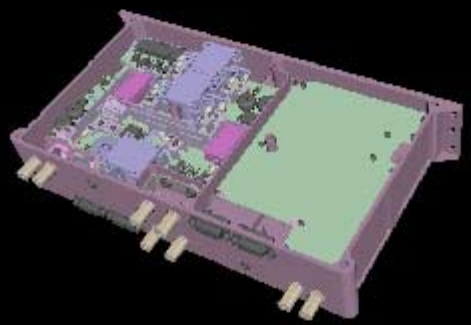
3D Design

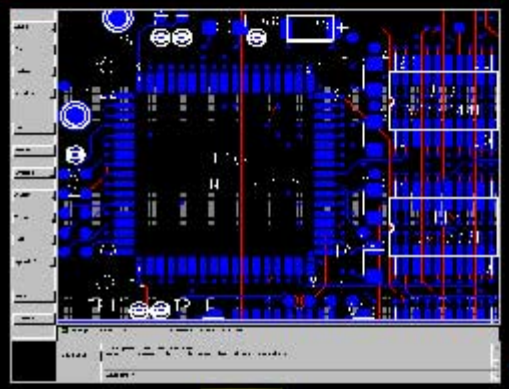
3D Model Database

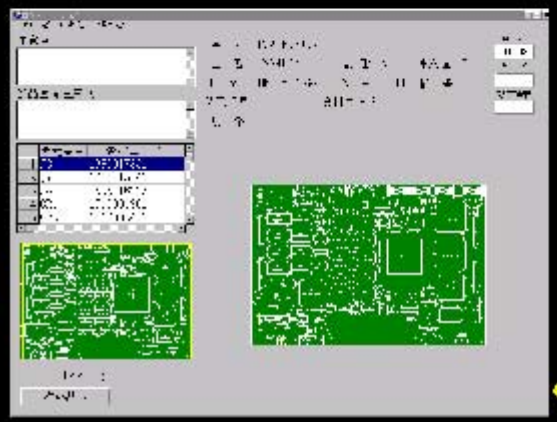
Board Assembly

Inspection

Board Design CAE/D

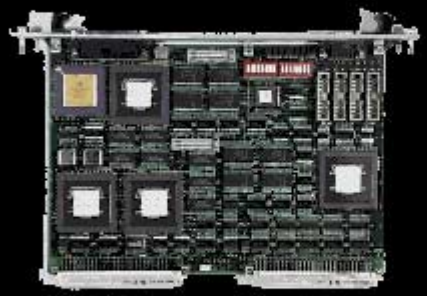






Board Assembly Instruction System

PCA



Automatic Loader

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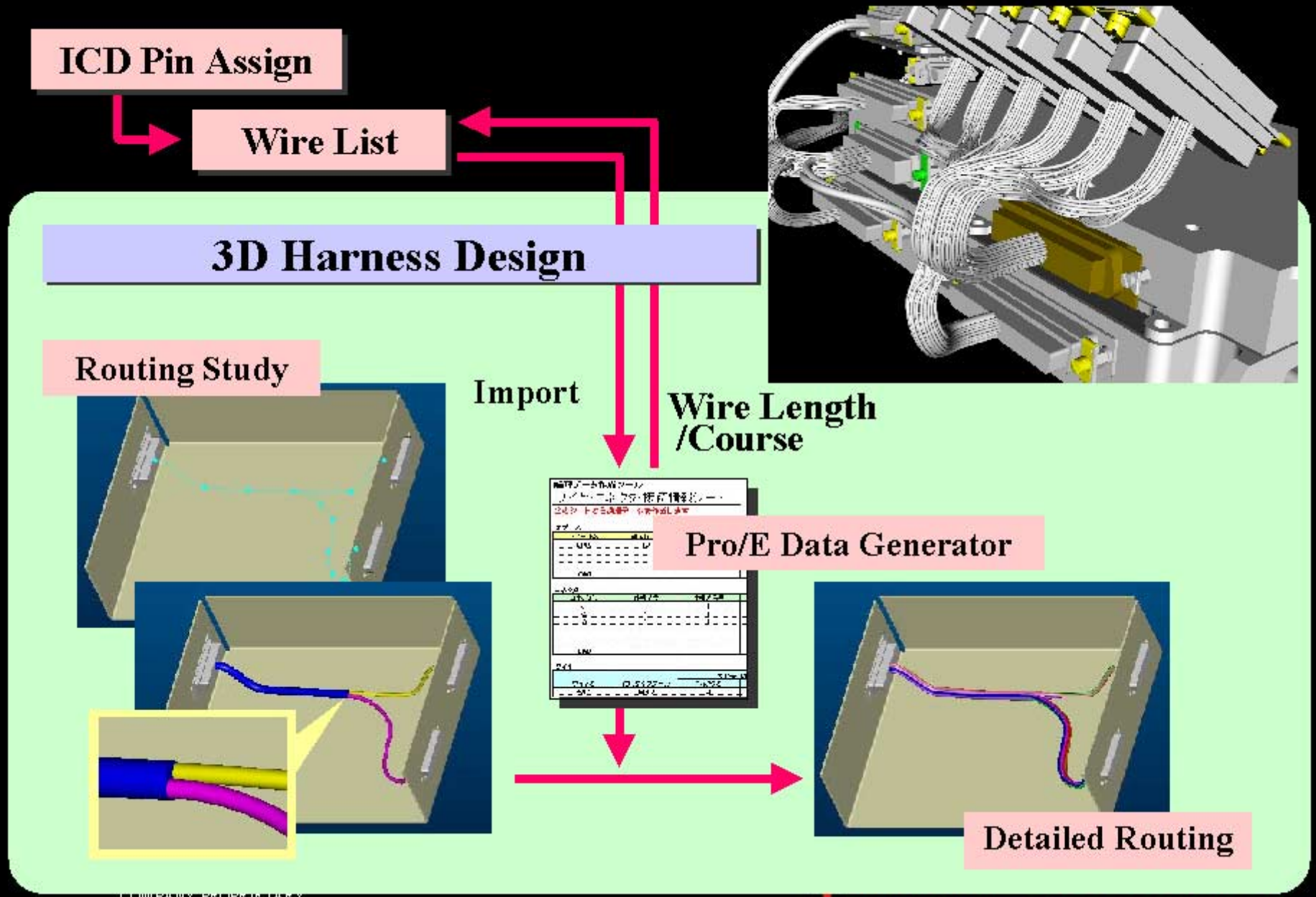
Example: Interface with KDI-m



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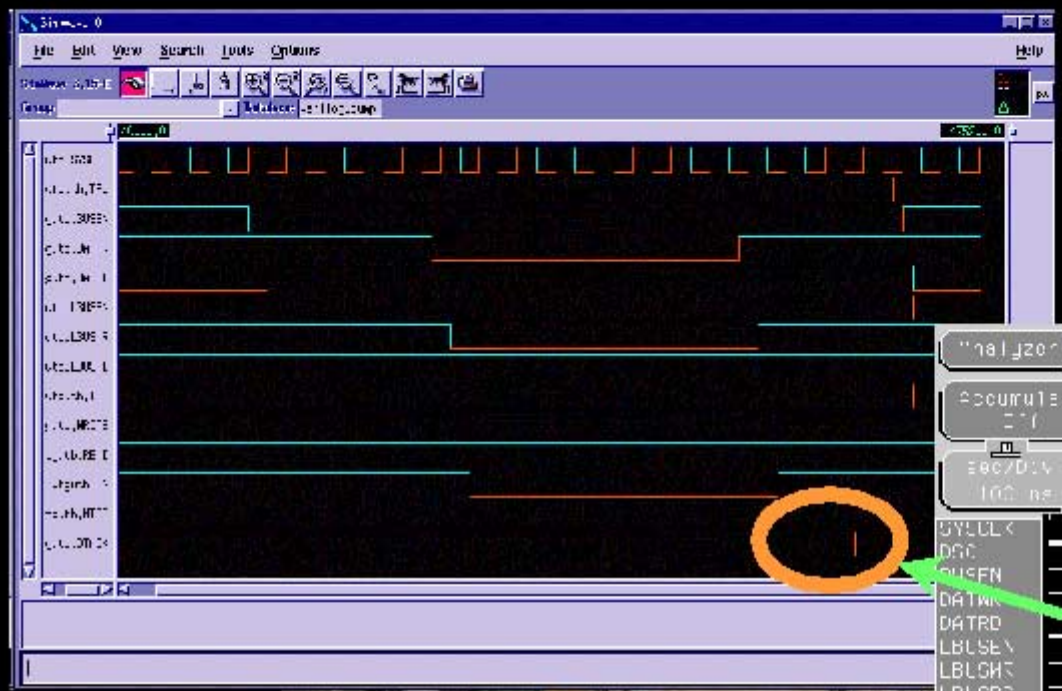
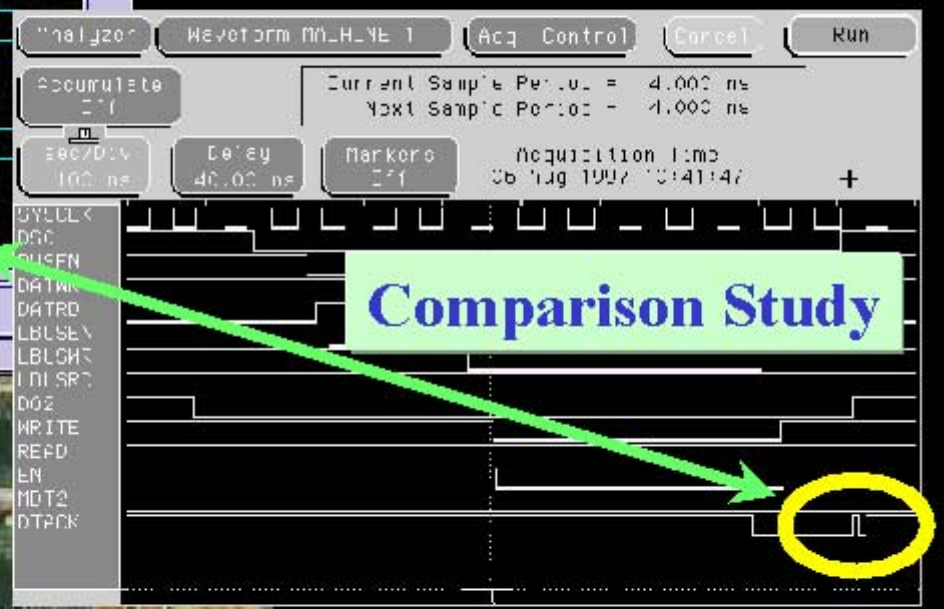
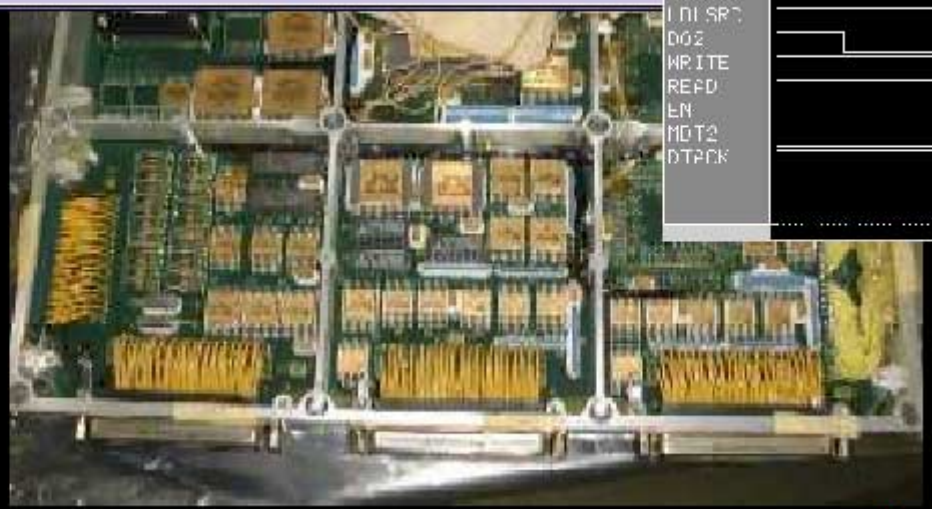
Analysis/Comparison of Test Data/Verification



Simulation Results



Comparison Study



Actual
Measurement Data

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KDI-db Knowledge Engineering

- Unified Knowledge Database (Knowledge-Engineering)
- Workflow Document Management
- Schedule Management (e-Process Maintenance)
- Integrated Info Search System
- Knowledge Management
- Skills Inventory (Sharing of Talent Information)
- IT Literacy (e-Education)

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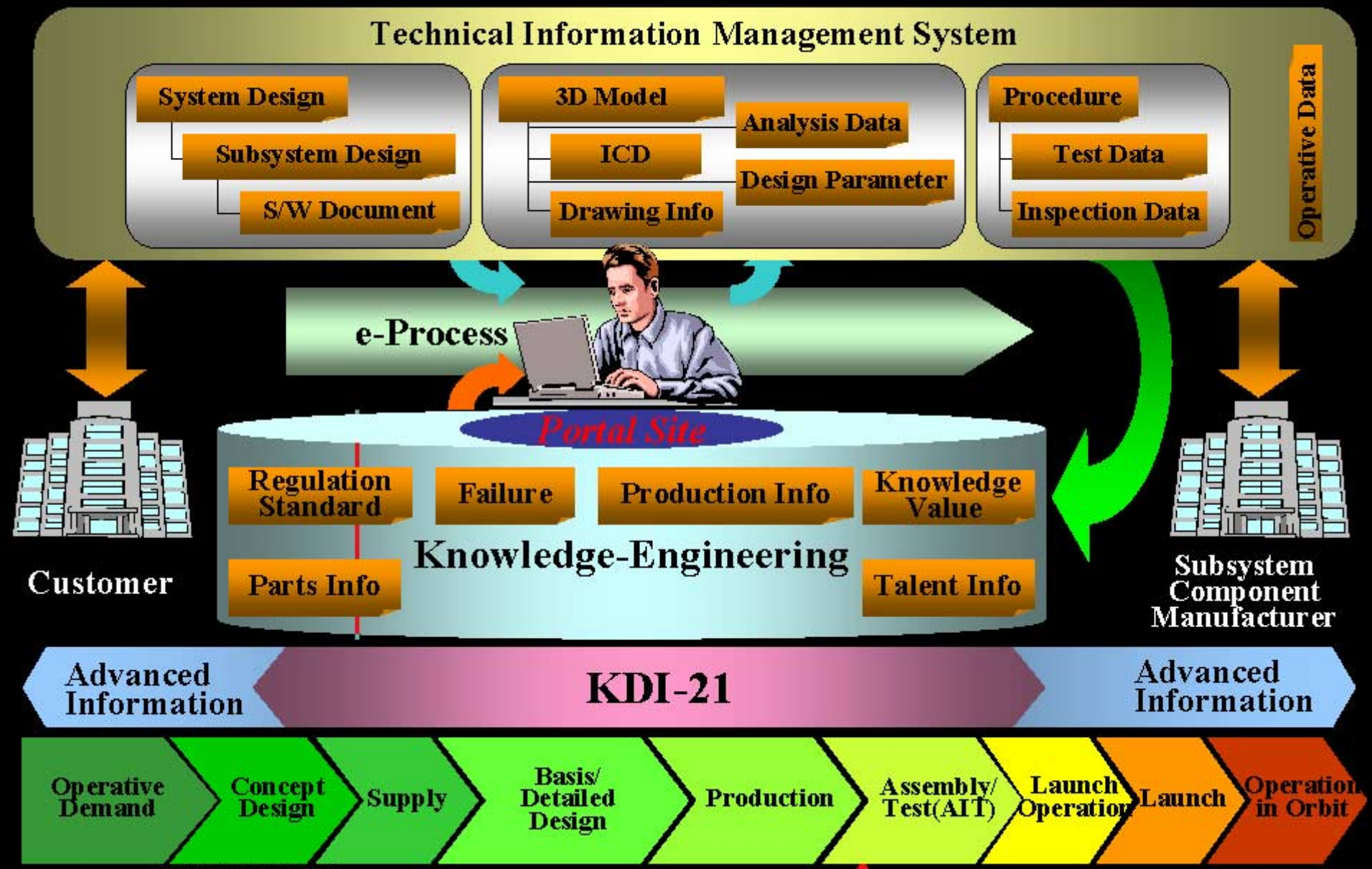
Unified Knowledge Database (Knowledge-Engineering)



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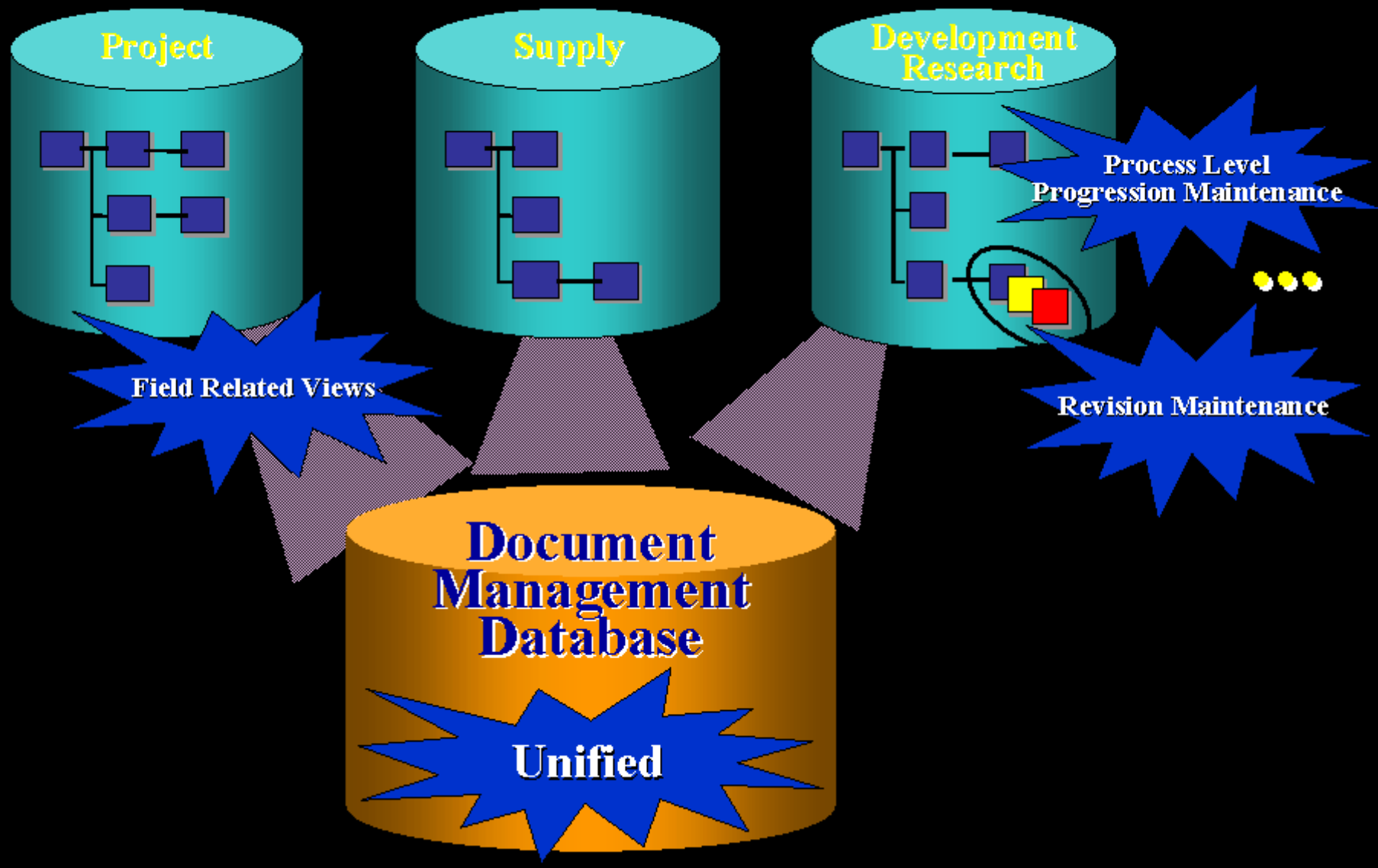
Work-flow Document Management



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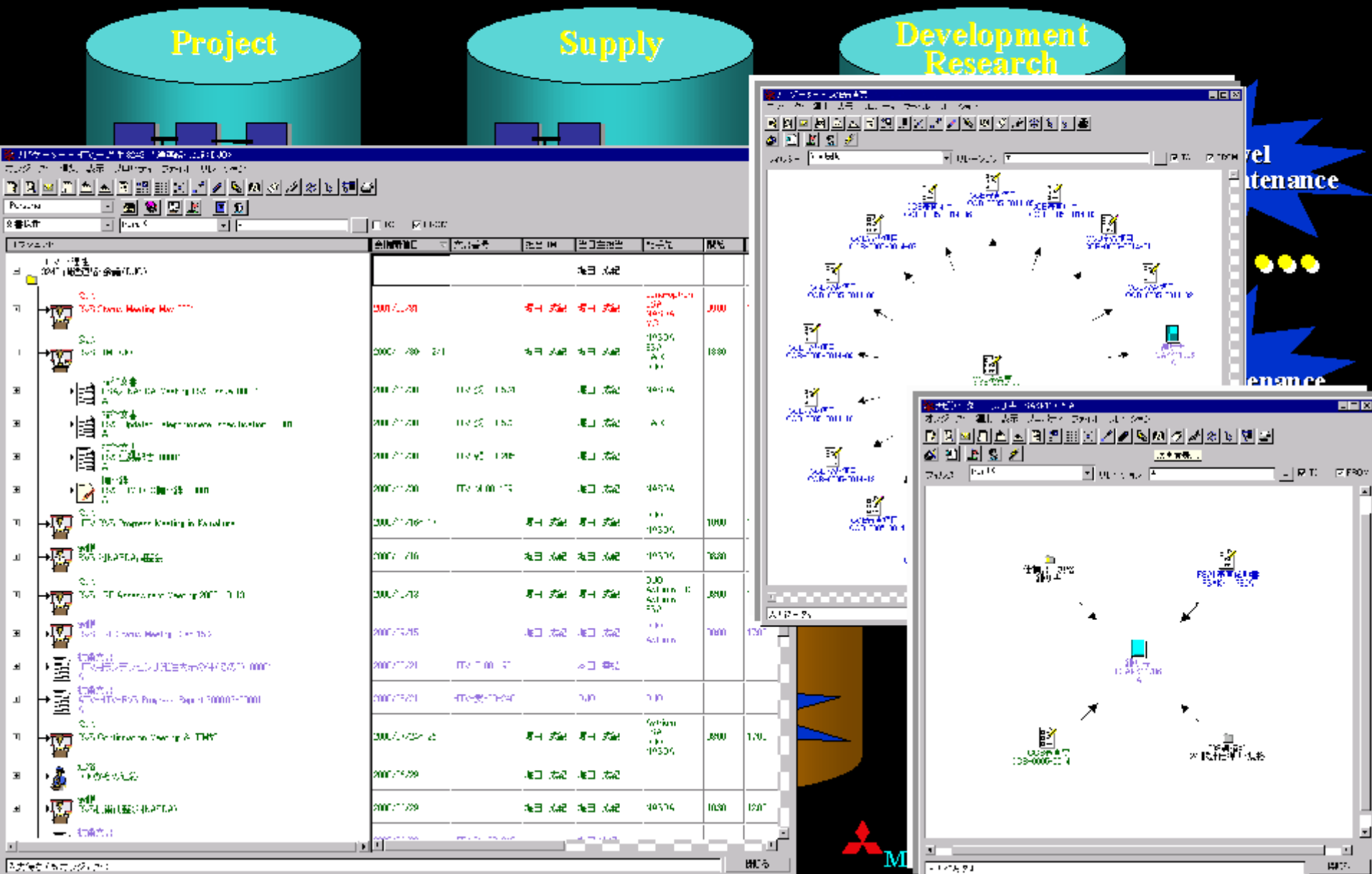
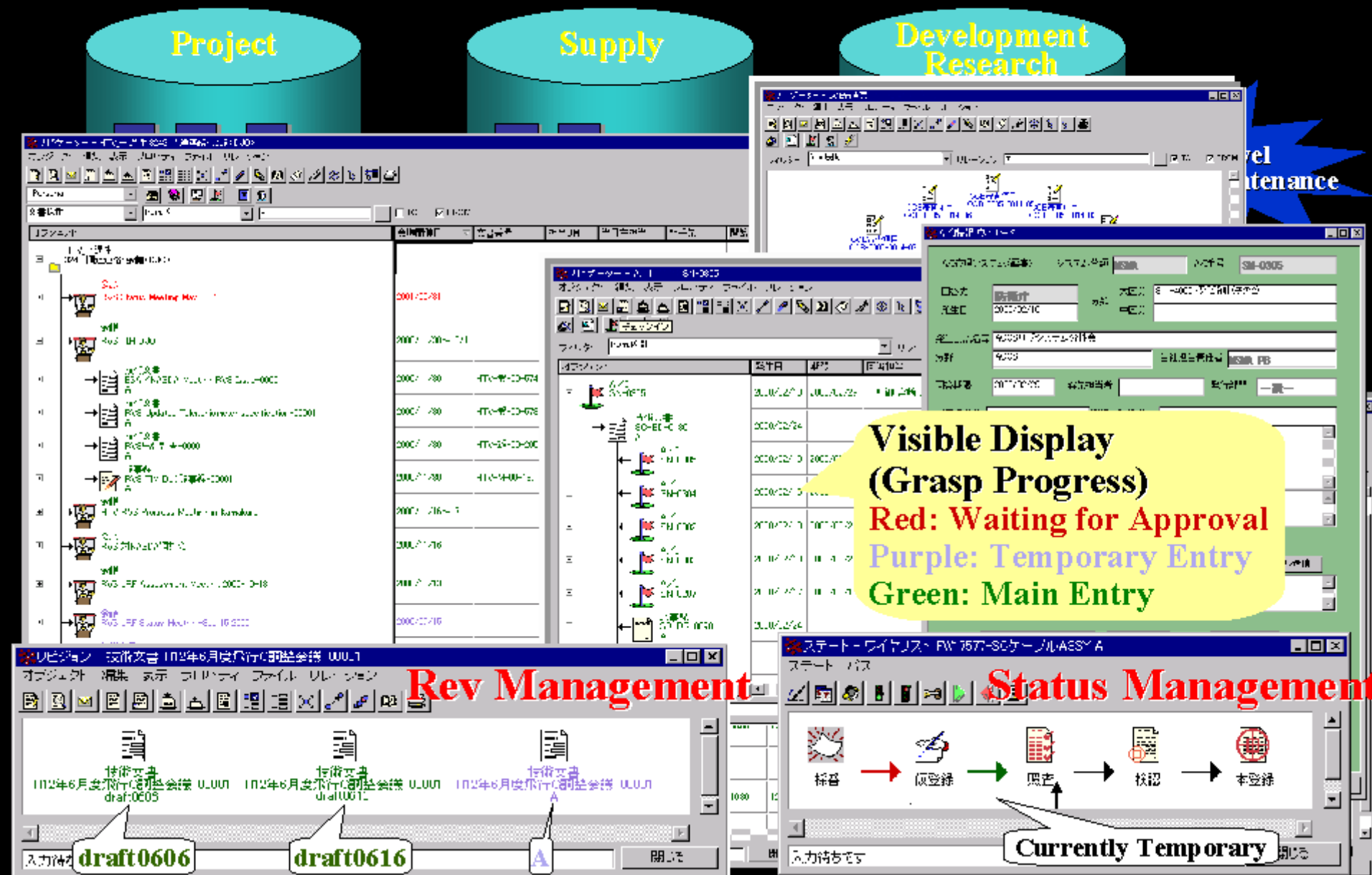
Work-flow Document Management



Work-flow Document Management



Schedule Management (e-Process Maintenance)

Unified Maintenance and Visualization of Progress Situation for Design through Test by Electrical Process Maintenance

Progress Gathering Methods

Design Progress Level

Concept/Base Planning

Report by Designer/ Supervisor

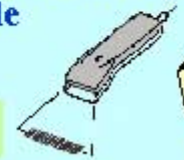
Output Diagram/Table

Detailed Table/Diagram

K-CIM

Manufacture Progress Level

Work Instruction Table



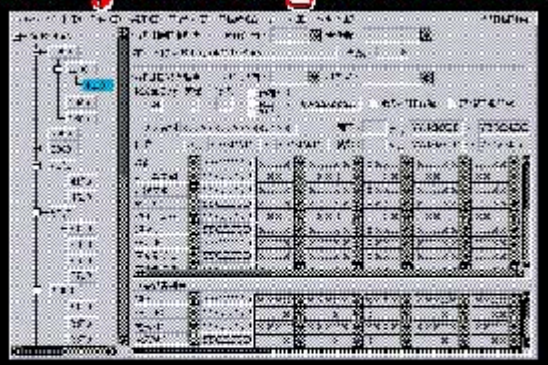
Barcode Entry

Test Progress Level

Production Flowchart

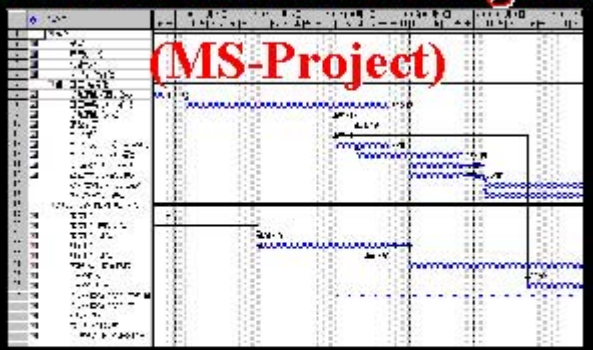
Report by Supervisor

Project Registration



Engineering Database

Visualization of Progress



System Design	Subsystem Basis Design	Subsystem Detailed Development	Electrical Design	Mechanical Construction Design	Process	Assembly	Test

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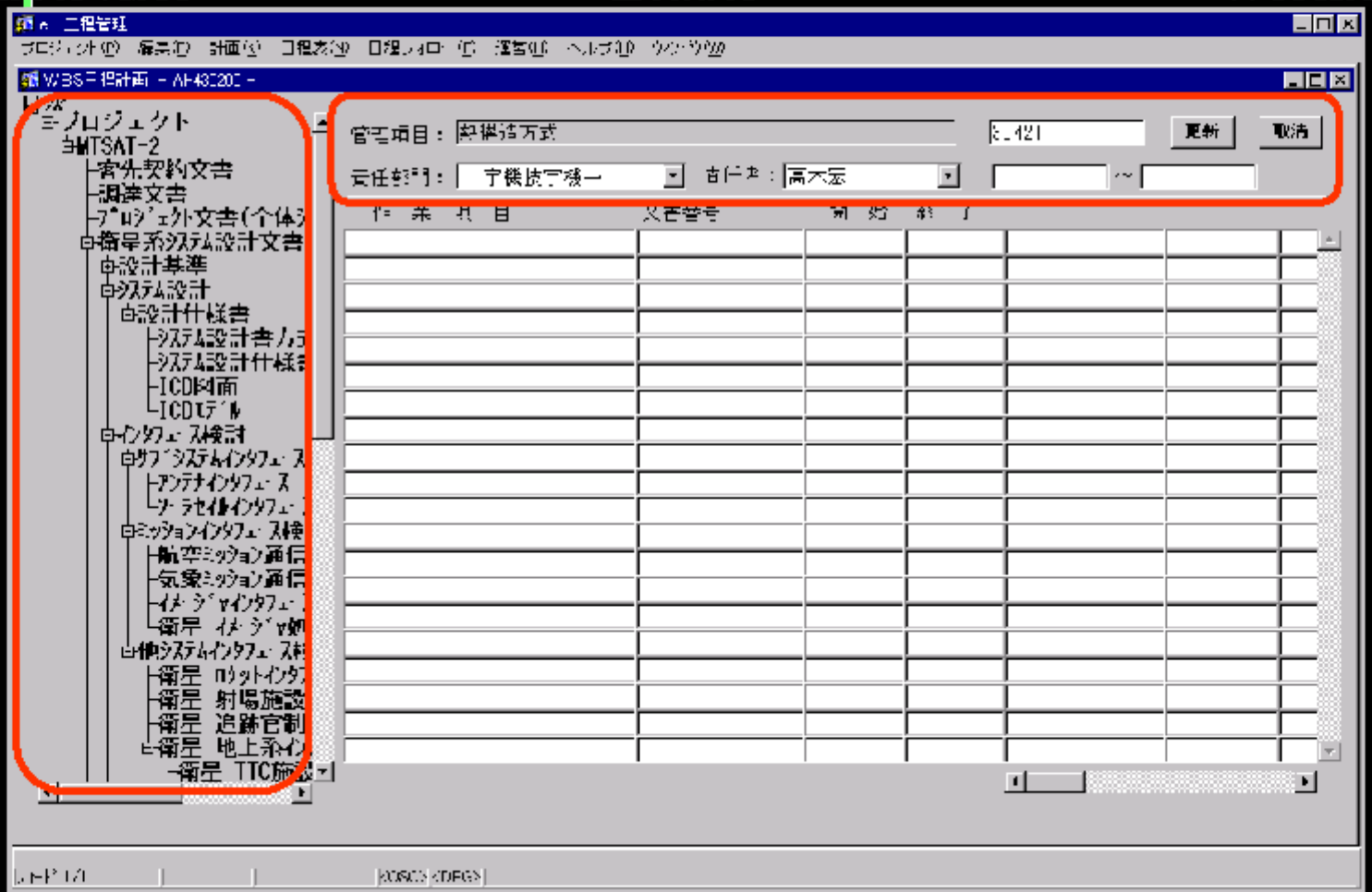
Schedule Management (e-Process Maintenance)

Supervisor

Distribute Work

Leader

Workers



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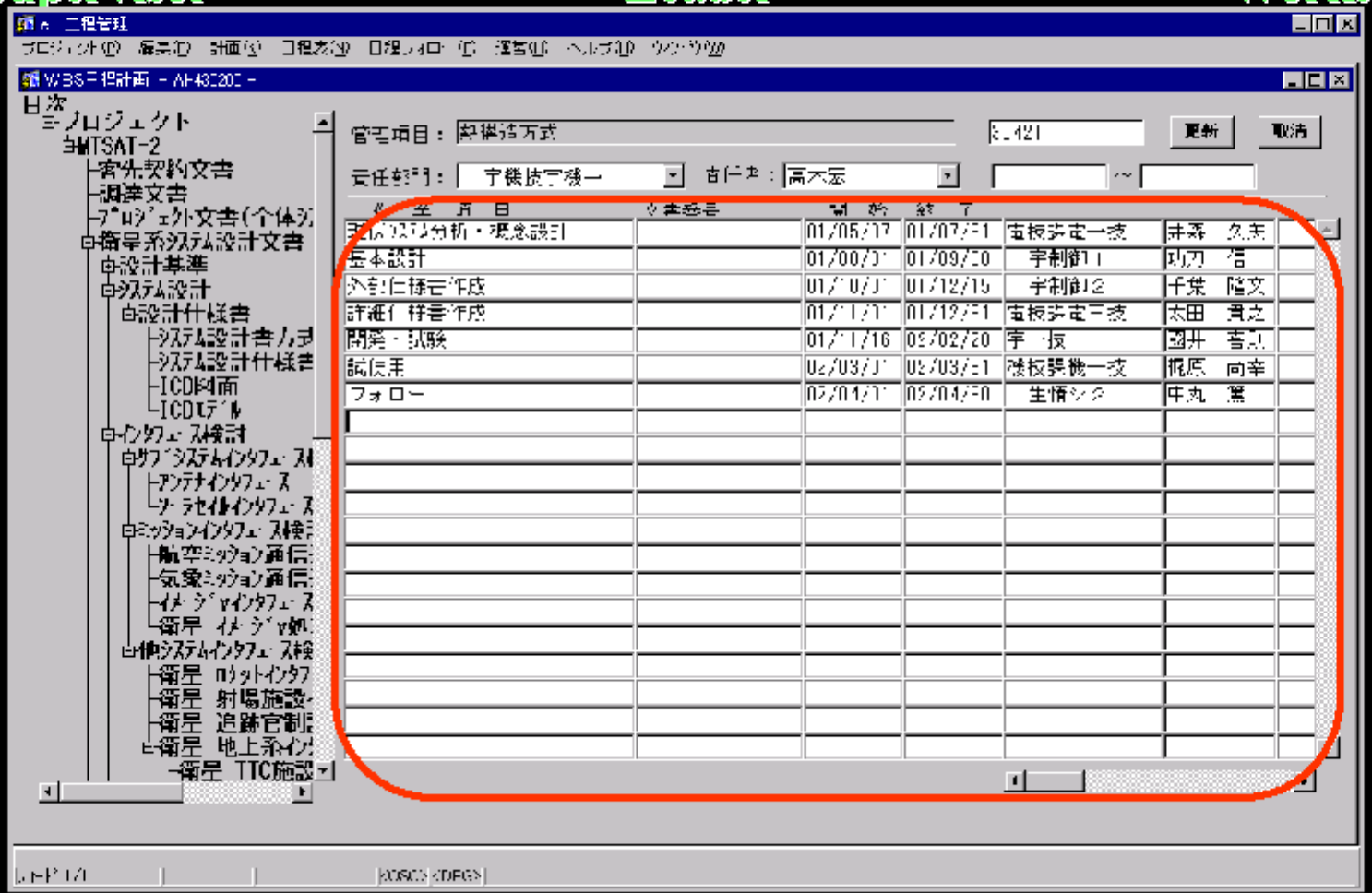
Schedule Management (e-Process Maintenance)

Supervisor

Leader

Job Definition

Workers



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Schedule Management (e-Process Maintenance)

Supervisor

Leader

Work Report

Workers

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Schedule Management (e-Process Maintenance)

Supervisor

Progression Status

Leader

Workers

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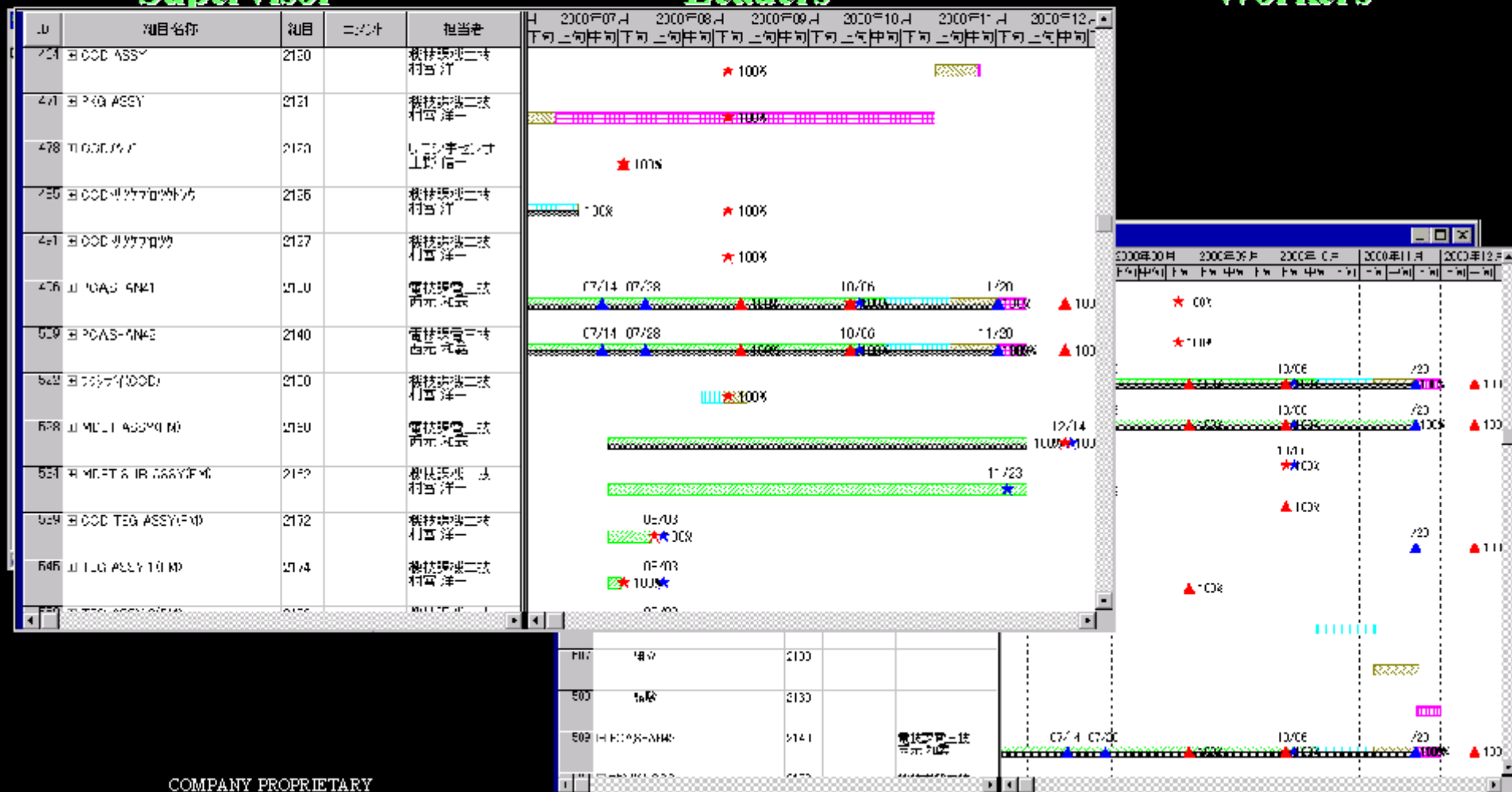
Schedule Management (e-Process Maintenance)

Progression Status

Supervisor **Leaders** **Workers**



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Schedule Management (e-Process Maintenance)

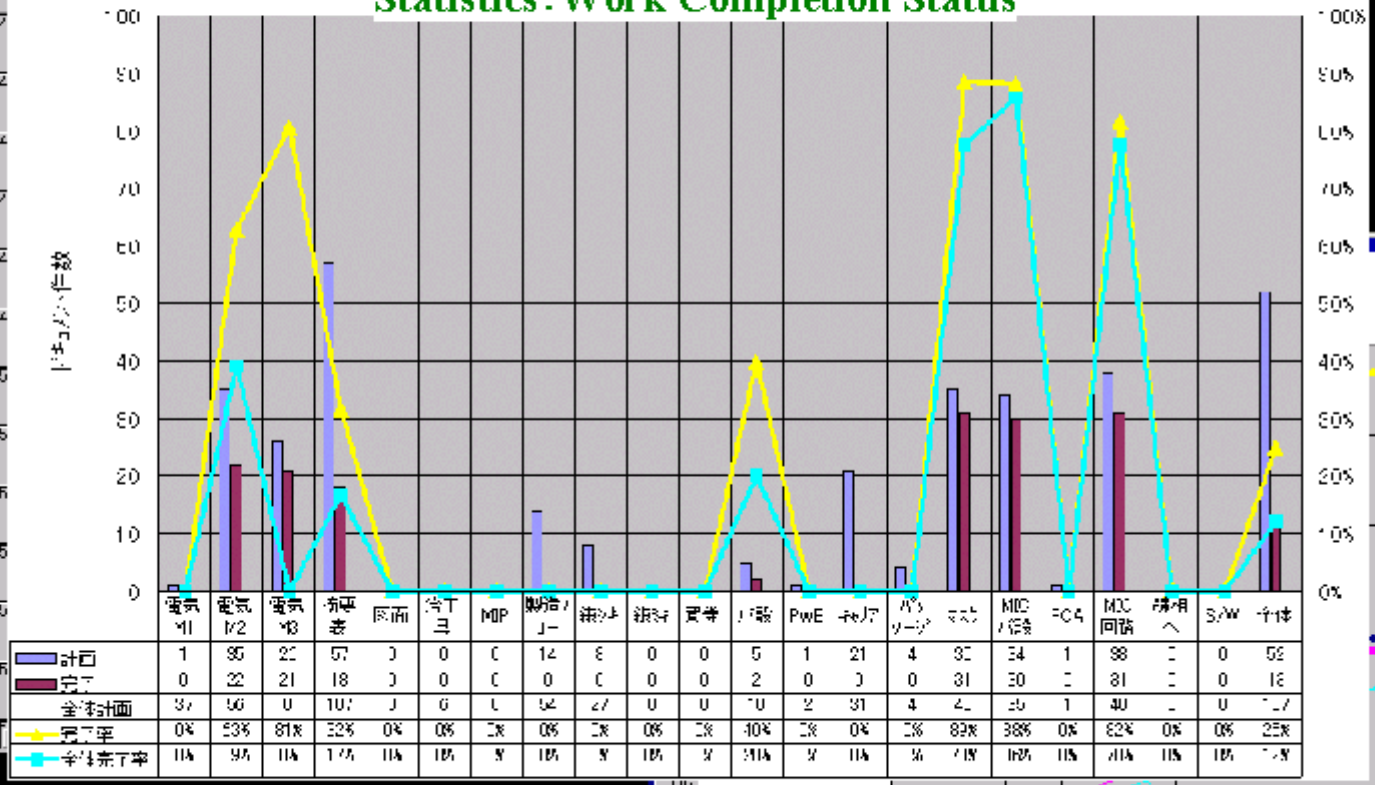
Supervisor

Progression Status

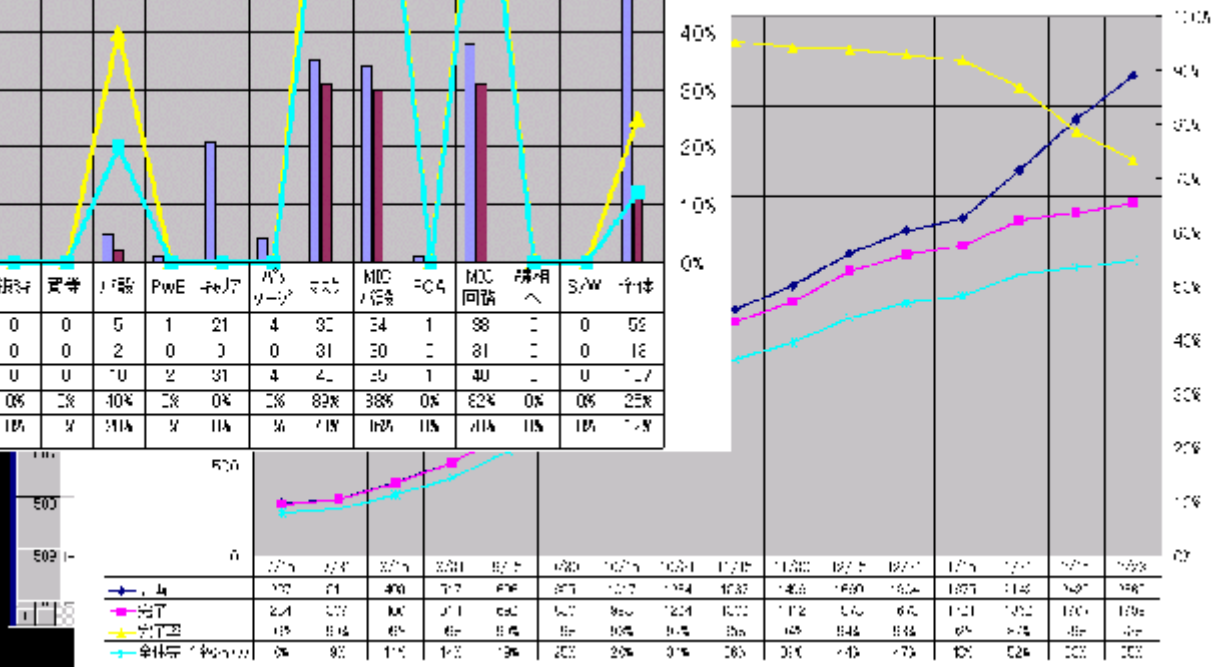
Leaders

Workers

Statistics : Work Completion Status



Status Graphs



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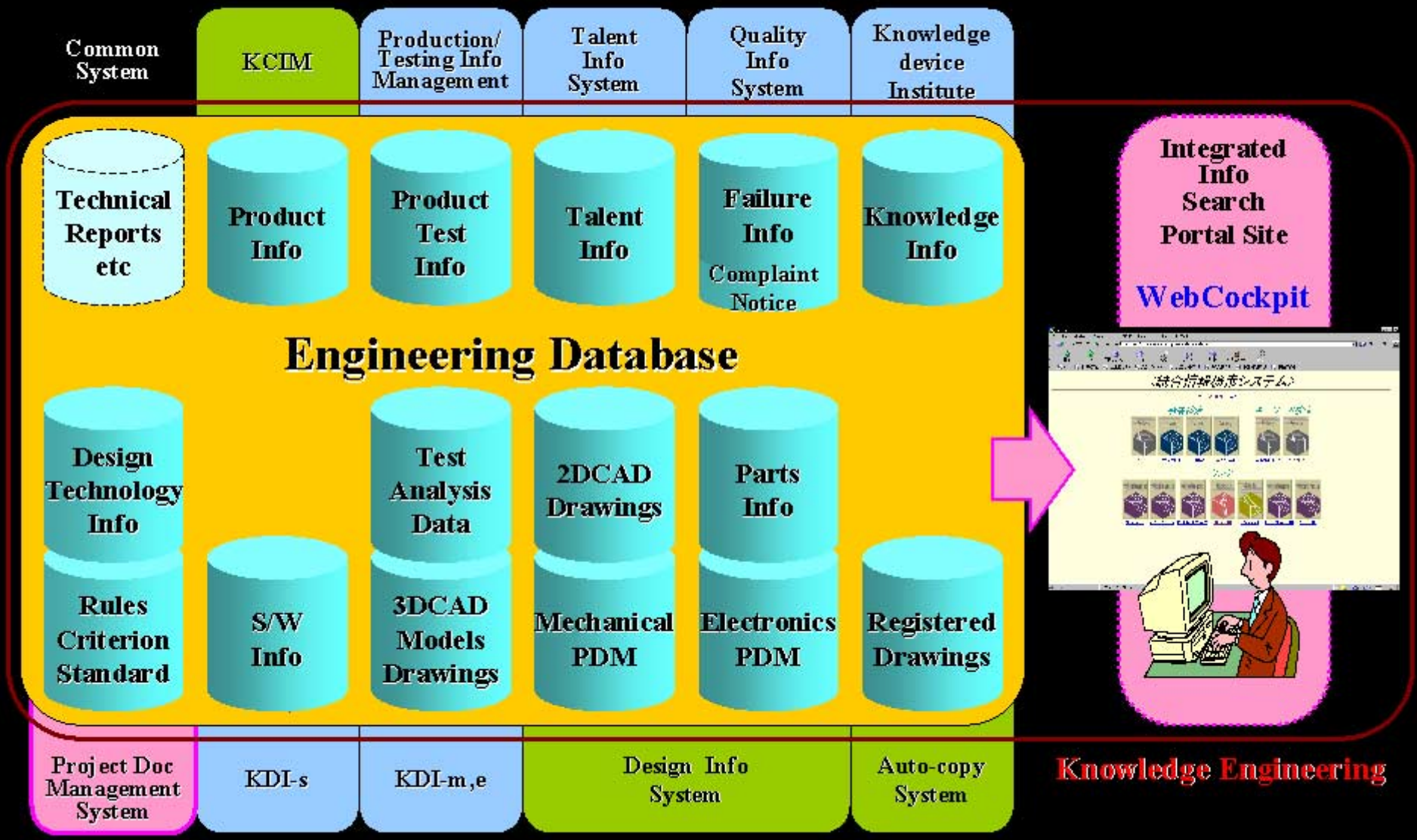
Integrated Information Search System



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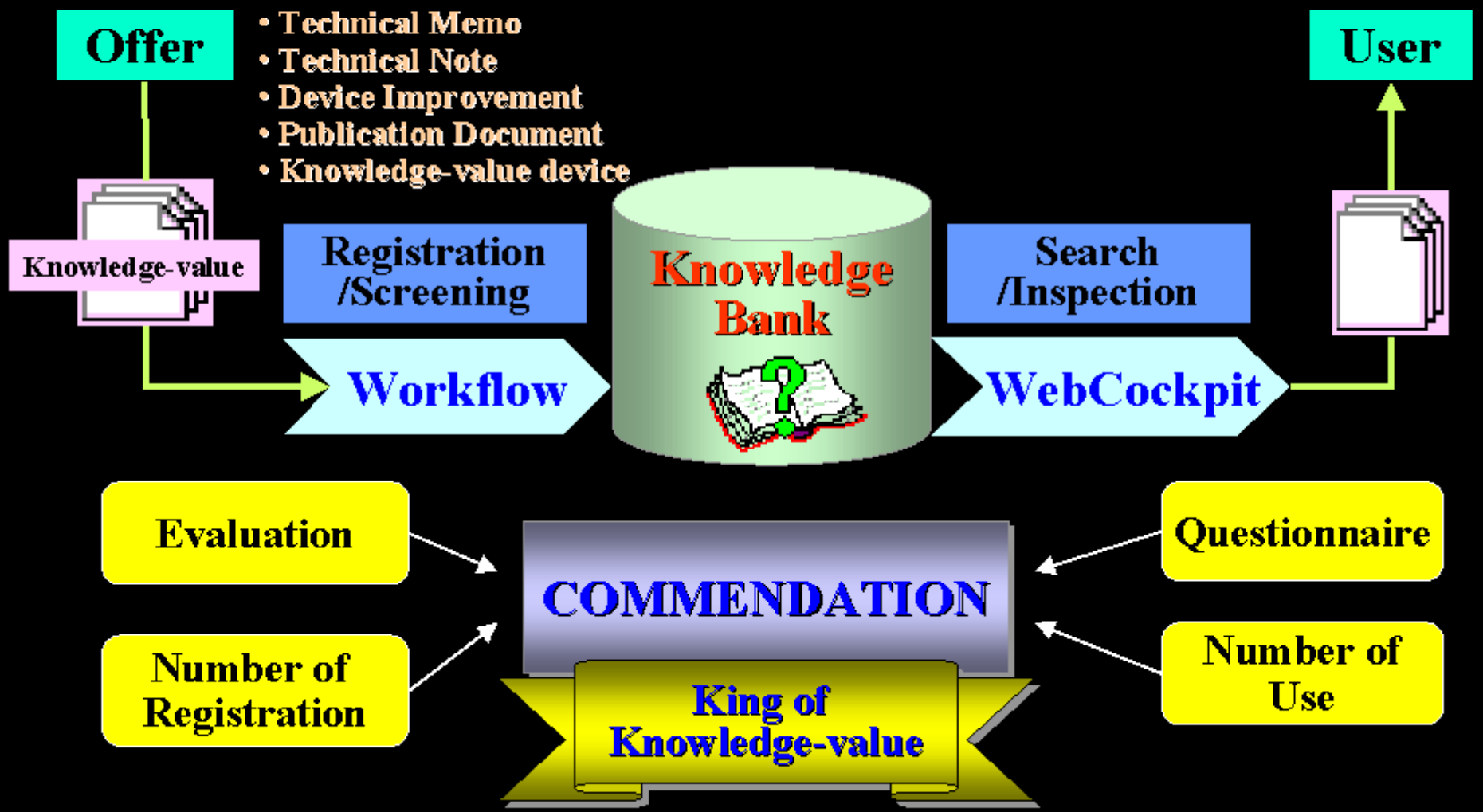
Knowledge Management

Contribution to Technology: Reuse of Knowledge-value
Contribution to Quality: Standardization of Know-how/Past Exams



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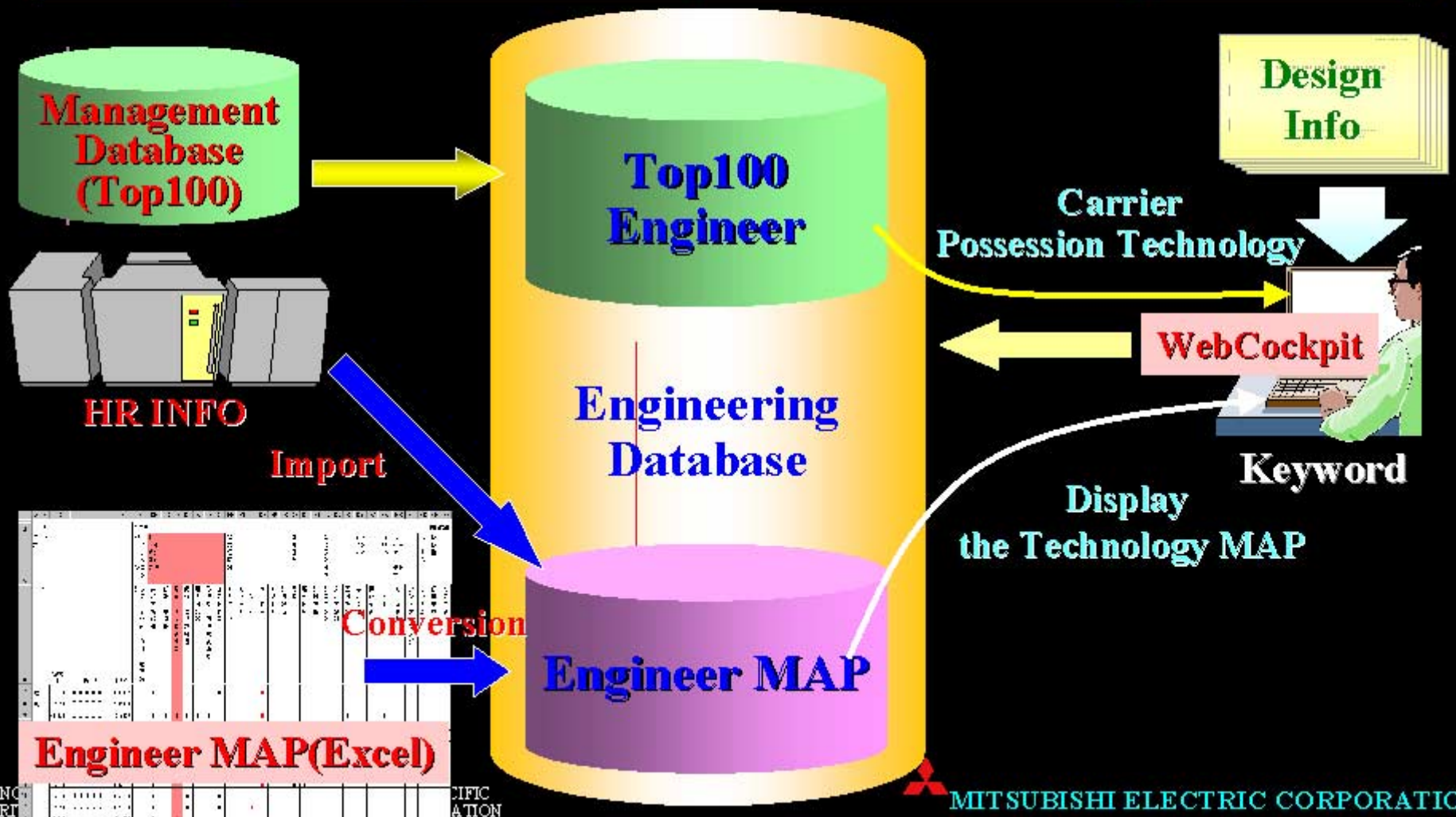
Skills Inventory (Sharing of Talent Information)

Engineer MAP

Searchable Technical Information (Technology MAP, Top100 Engineer etc.) by Element Technology unit.



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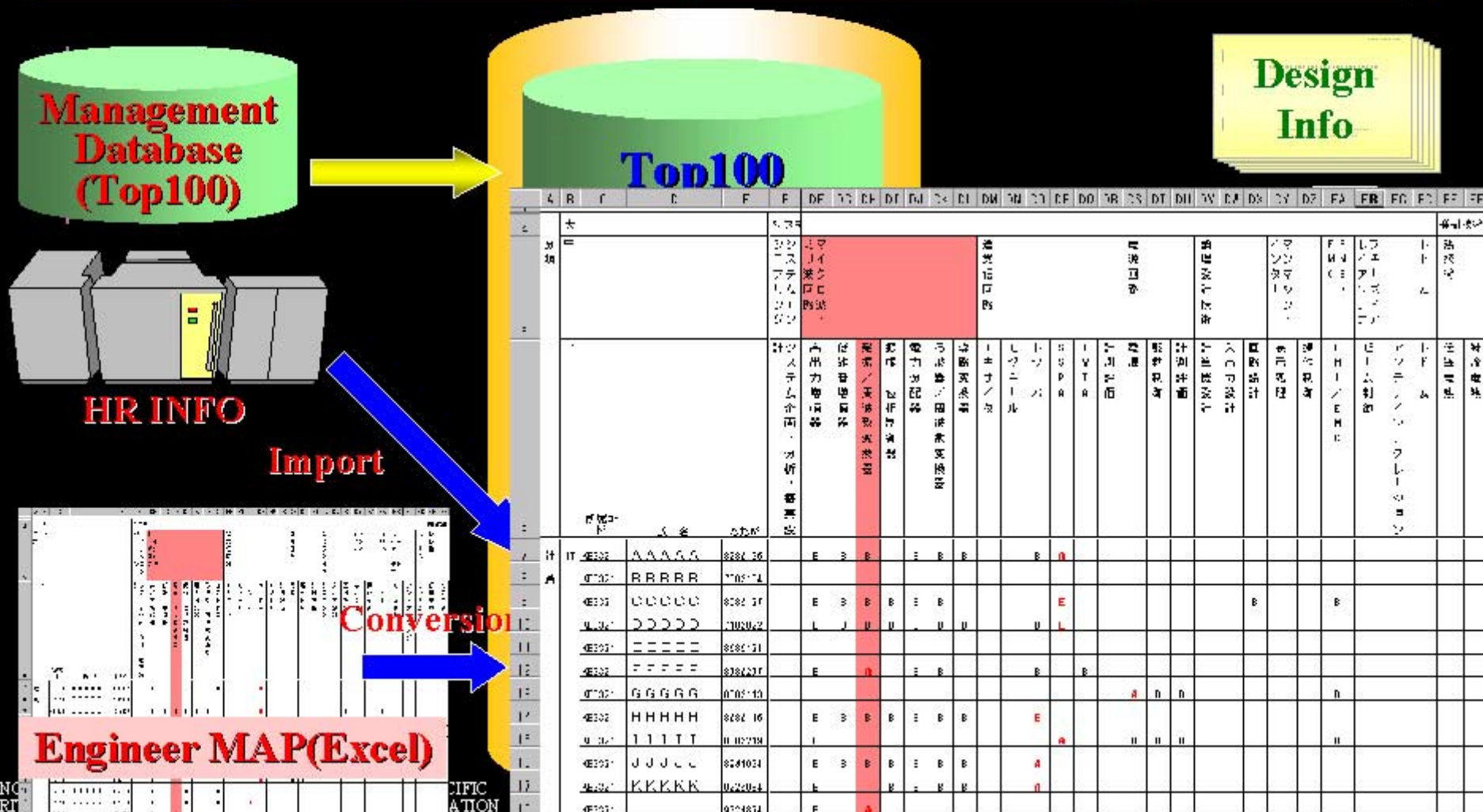

Skills Inventory (Sharing of Talent Info)

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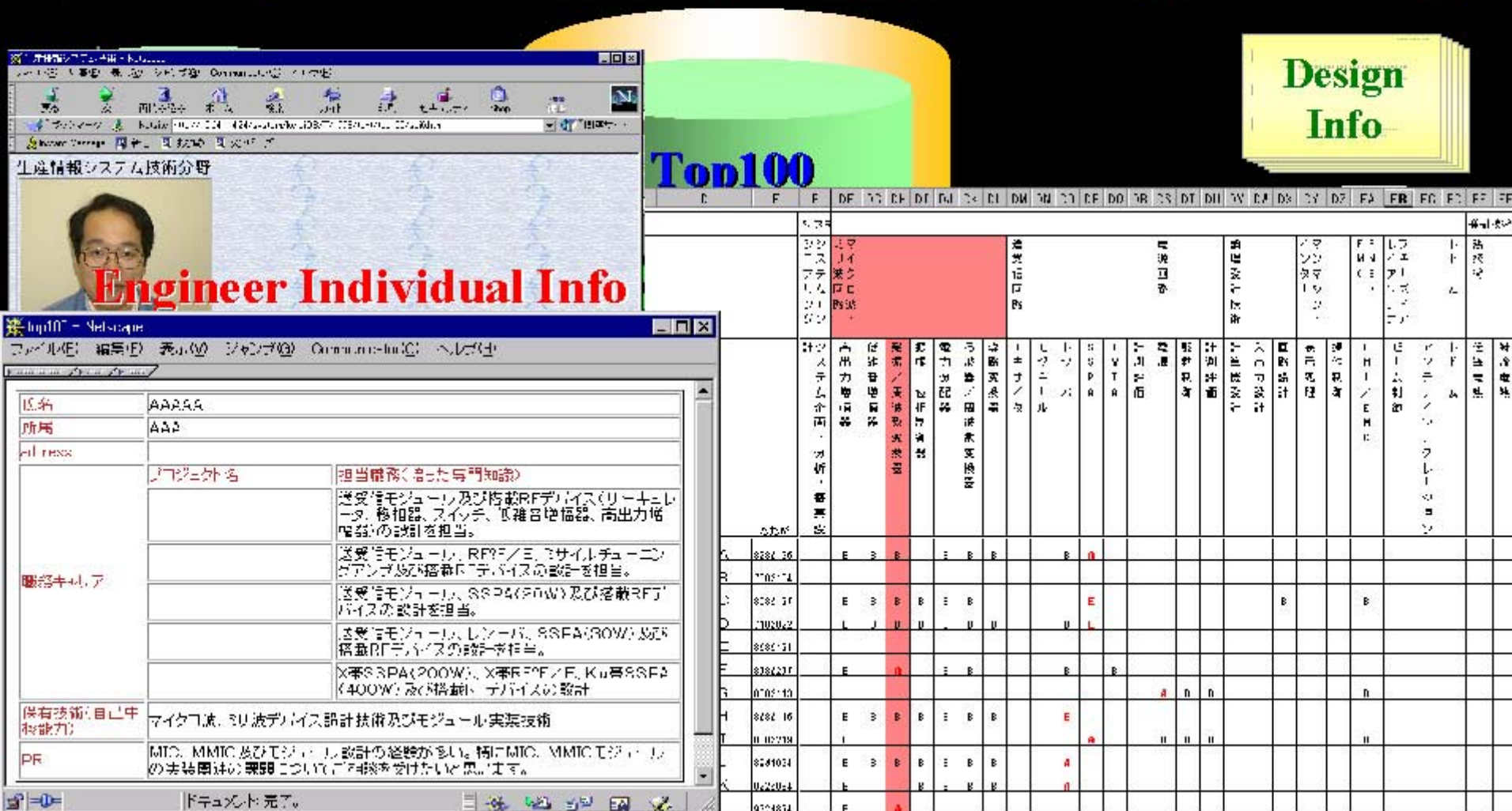

IT Literacy (Skill Recognition/Education)

Eg: Education / Testing

Other Skill Recognition 32 types

3DE		3DE	3DE	LSE		MDE	
1st Level/ 2nd Level Test		3rd Level Test	Supervisor Test	1st Level/ 2nd Level Test		1st Level/ 2nd Level Test	
Skill-up Education		e-Education		Skill-up Education		Skill-up Education	
Basic Education			Supervisor Education	Basic Education		Basic Education	
3D CAD (Pro/E)				Logic Design		Micro Wave	

Database

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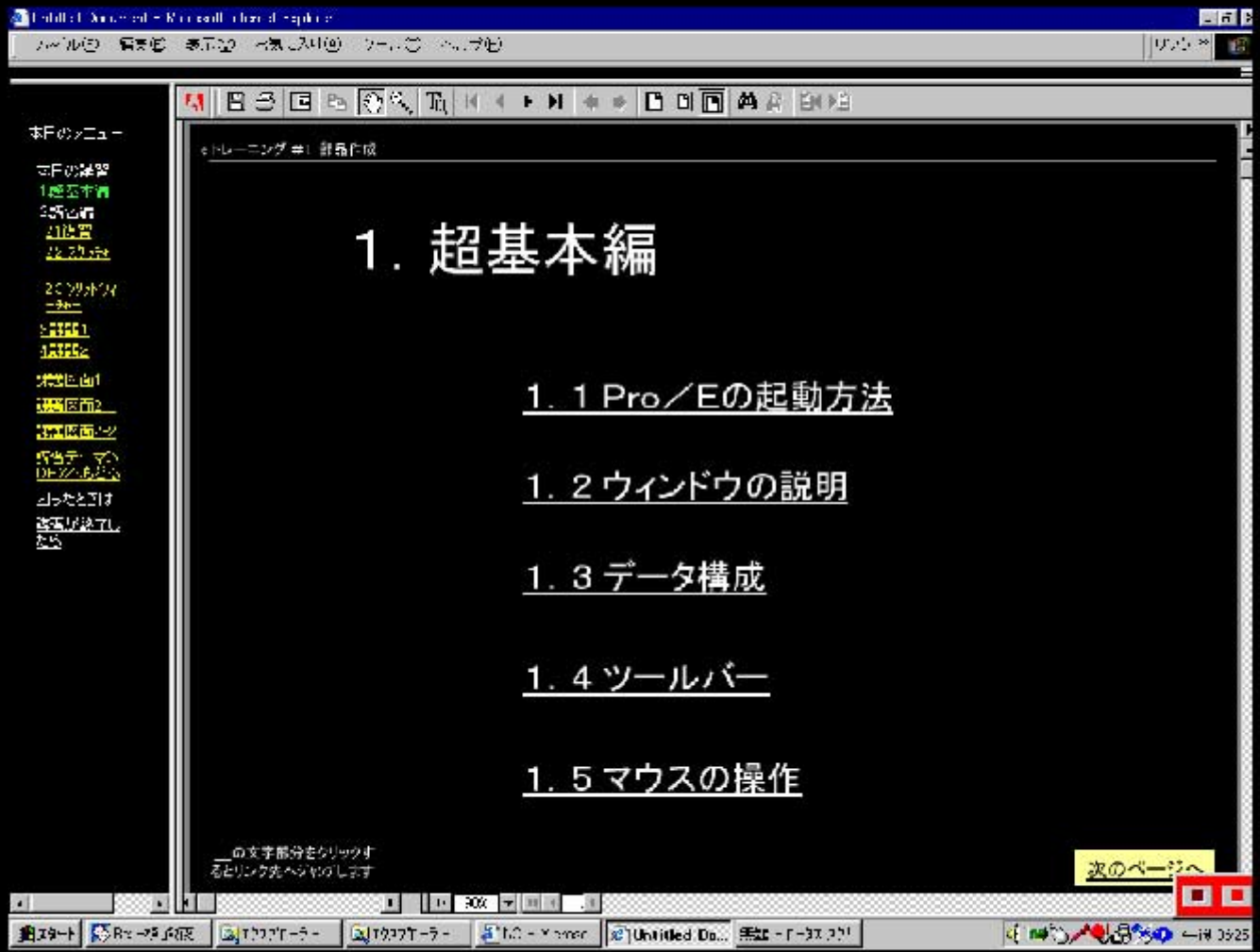
IT Literacy (e-Education)

Teacher

Electronic Q&A

Student



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KDI-s
S/W Development

- S/W Development based on CMM
- CMM: MELCO Kamakura Status & Trend of Other Companies

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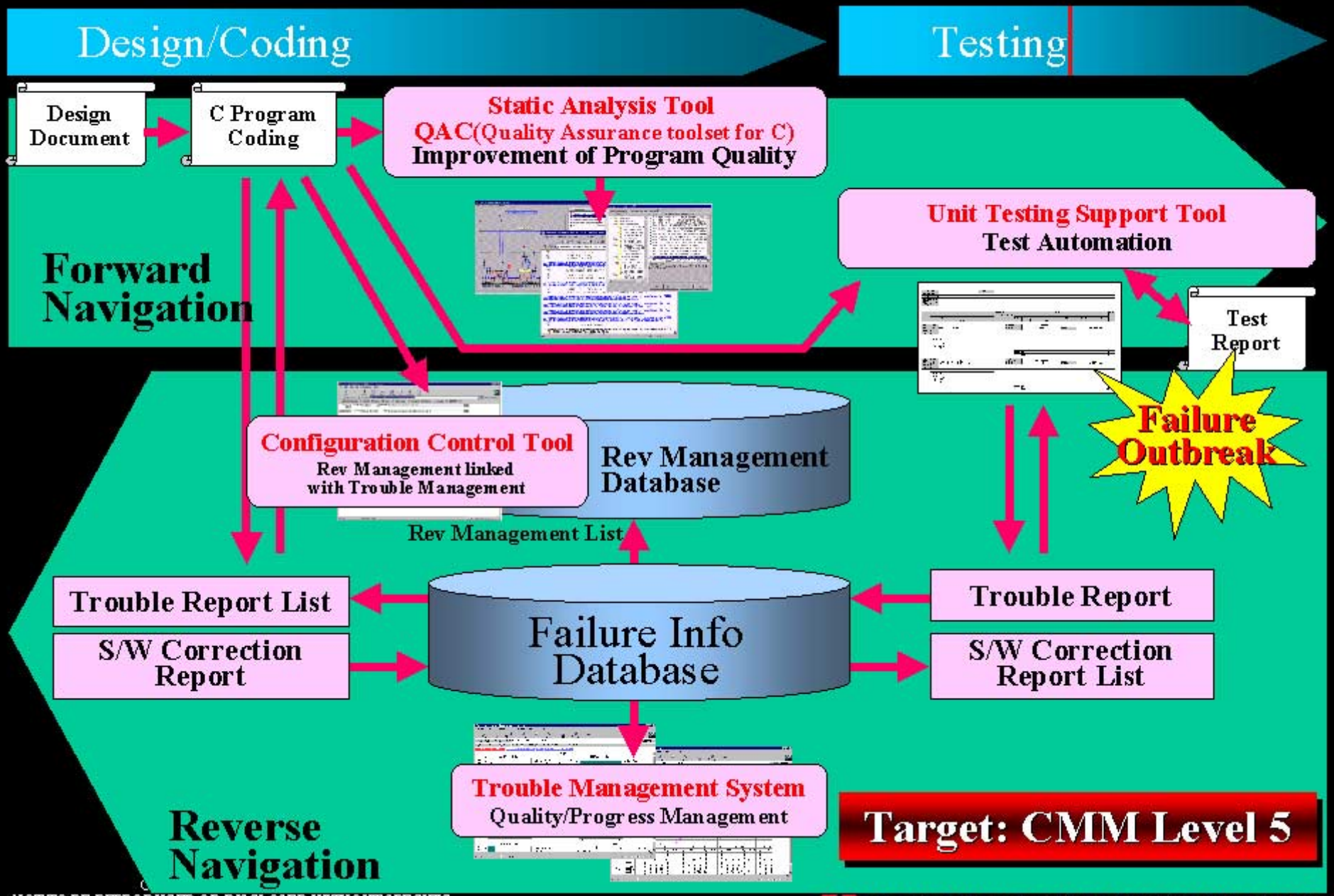
S/W Development on basis of CMM



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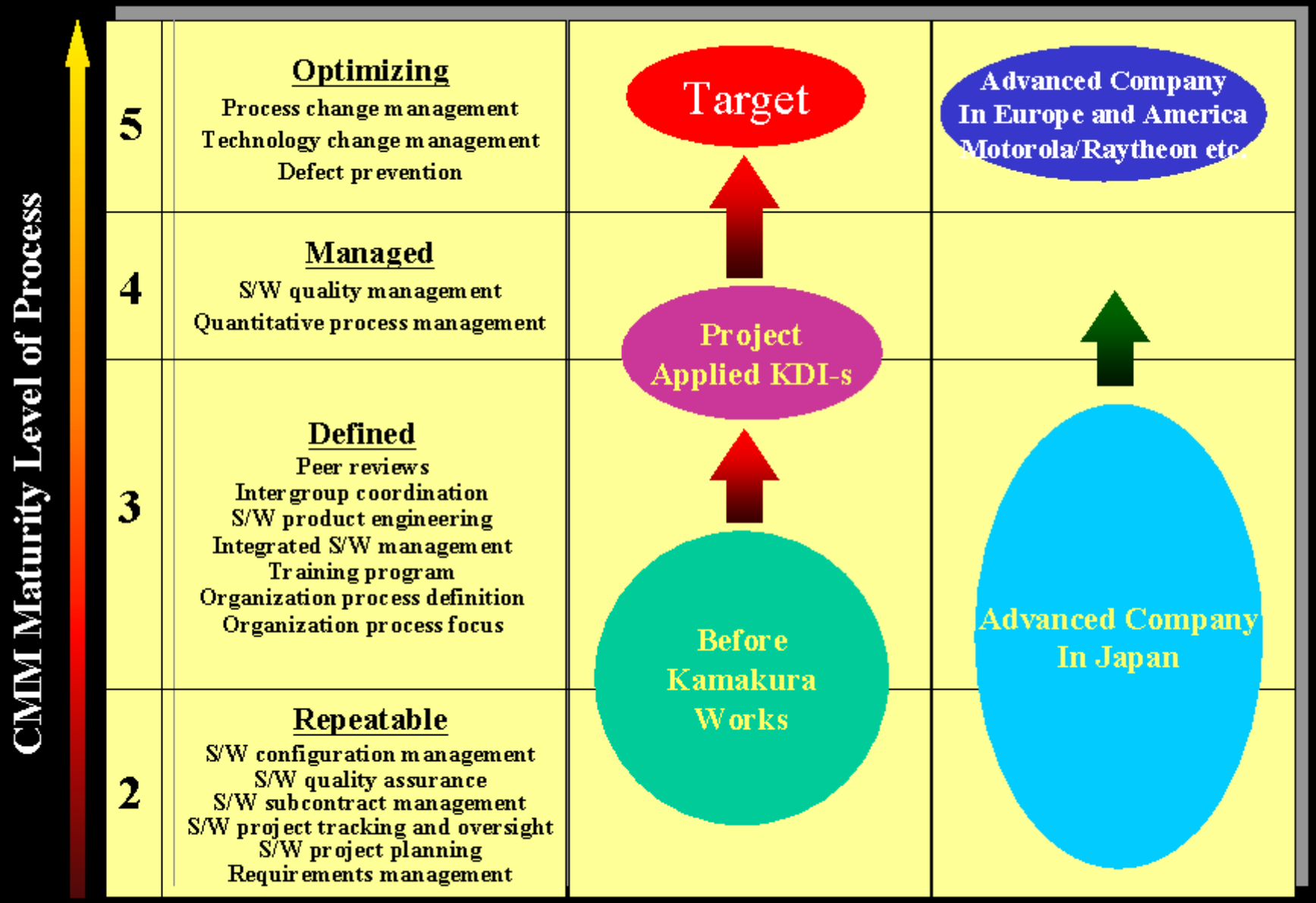
MELCO Kamakura Status & Trend of Other Companies



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- Future Activities- Distributed Simulator

- Distributed Simulator HLA
- Integration of Different Simulators
- Application to Spacecraft Life Cycle

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Space: Distributed Simulator HLA

- Standard Technology of Distributed Simulator: HLA(High Level Architecture)
  Architecture for Integration of Distributed Simulator

- **Objectives**
  - **Design Verification of Large scale system**
  - **Localized Verification**
  - **International Collaboration**
  - **Simulators as Value in Space Industry**
  - **Reusable Intellectual Property Improvement**
  - **Improvement of Model Precision**

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HLA: Integration of Different Simulators

Construction of Simulator (Example: Defense)

Defense Project

- Sensor Data Fusion System Simulation — HLA I/F
- Alternative Tracking Algorithm Simulation — HLA I/F
- Federation Developmental Tools
- Network Analysis Tools

Foundation of Common Simulation (HLA-eRTI)

- HLA I/F — Simulation Control; Testing & Evaluating Model — R&D Simulation
- HLA I/F — Simulation Control; Testing & Evaluating Model — Physical Simulation
- HLA I/F — Simulation Control; Testing & Evaluating Model — Training Simulation
- HLA I/F — Viewer

Testing & Evaluating Simulation Set

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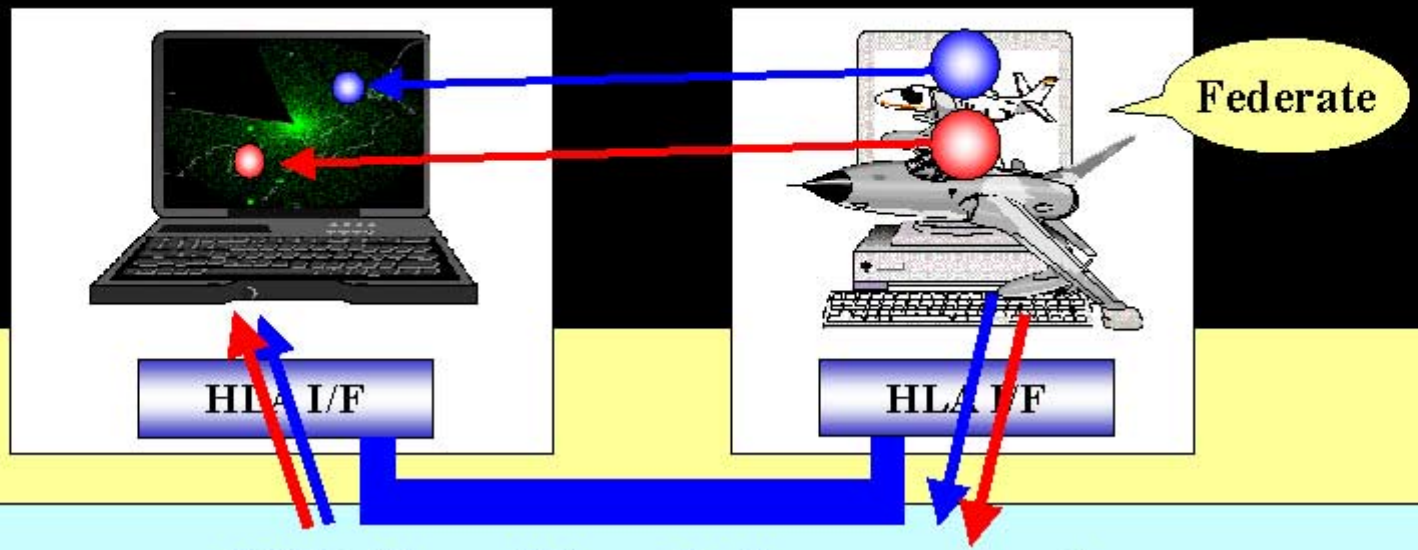
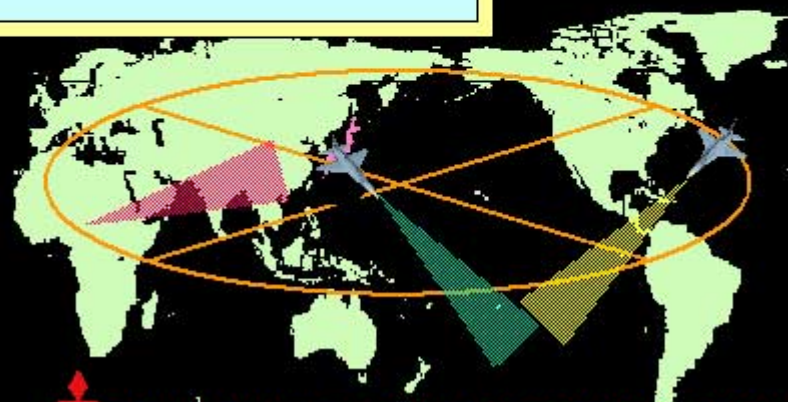
HLA



RTI (Run-Time Infrastructure)

1) Distributed Simulation Management
2) Distributed Object Management
3)Object Proprietary Management
4) Serving Data Management
5) Time Management
6) Declaration Management

Image of Simulator
(Example: Defense)



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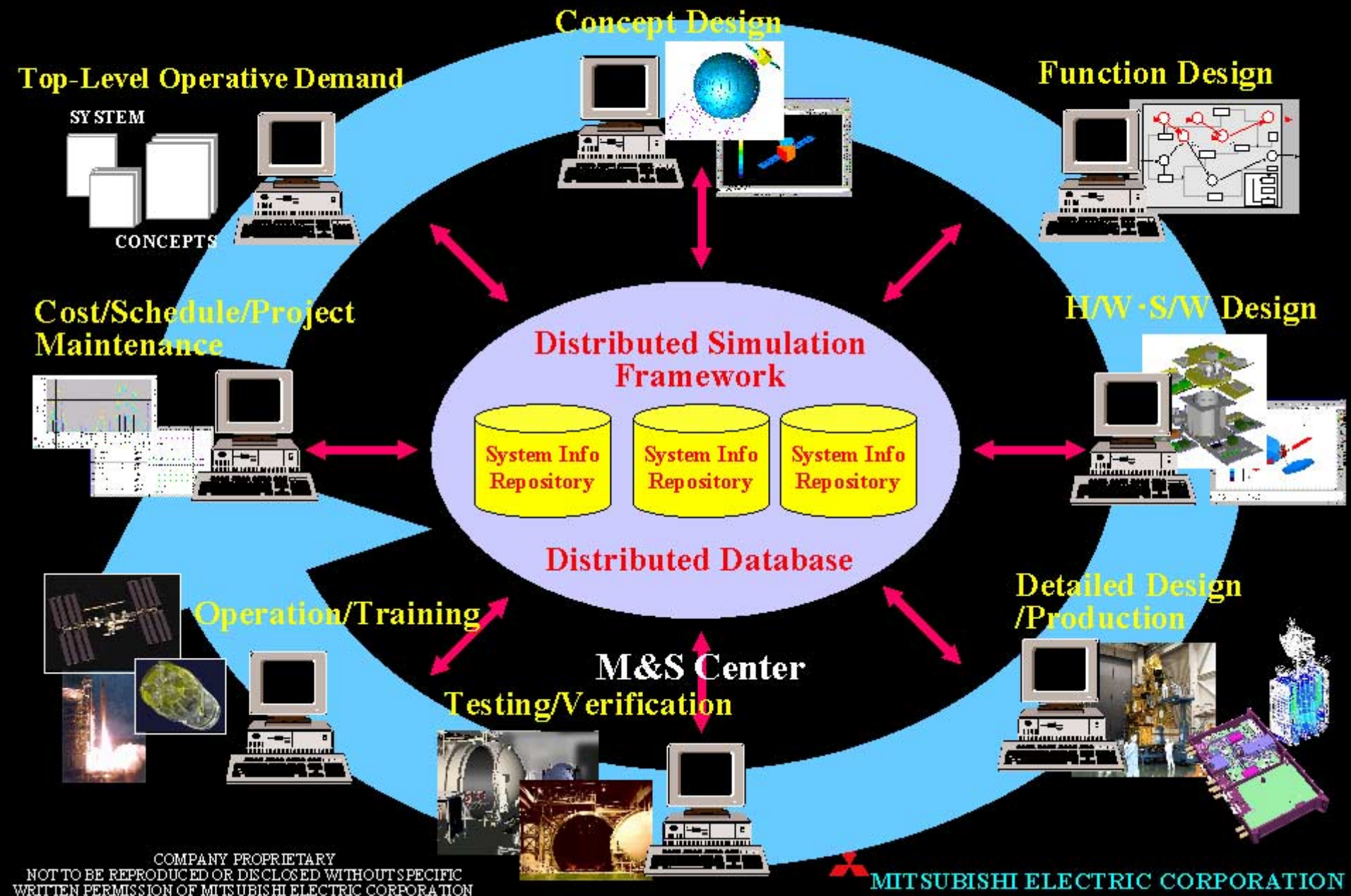
HLA: Application to Spacecraft Life Cycle



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The Keys to IT Reformation Success at Kamakura

- **Commitment at the TOP management level**
  - Business process reformation is the responsibility of managers.
  - IT is not a tool, but a management strategy.
- **Organization of reformation groups and support groups**
  - Comprehension of business practice, diligent and fervent about reform.
- **Selection of pilot model**
  - Pilot Success => Deployment to other projects
- **Reform IT literacy and awareness at the individual and organizational level.**
  - Aim to create a group of professionals that understand development and production design to utilize the newest technologies strategically.

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