From Computer Aided Engineering Software to Information Driven Decision Making for High-Consequence Engineering Systems (*)

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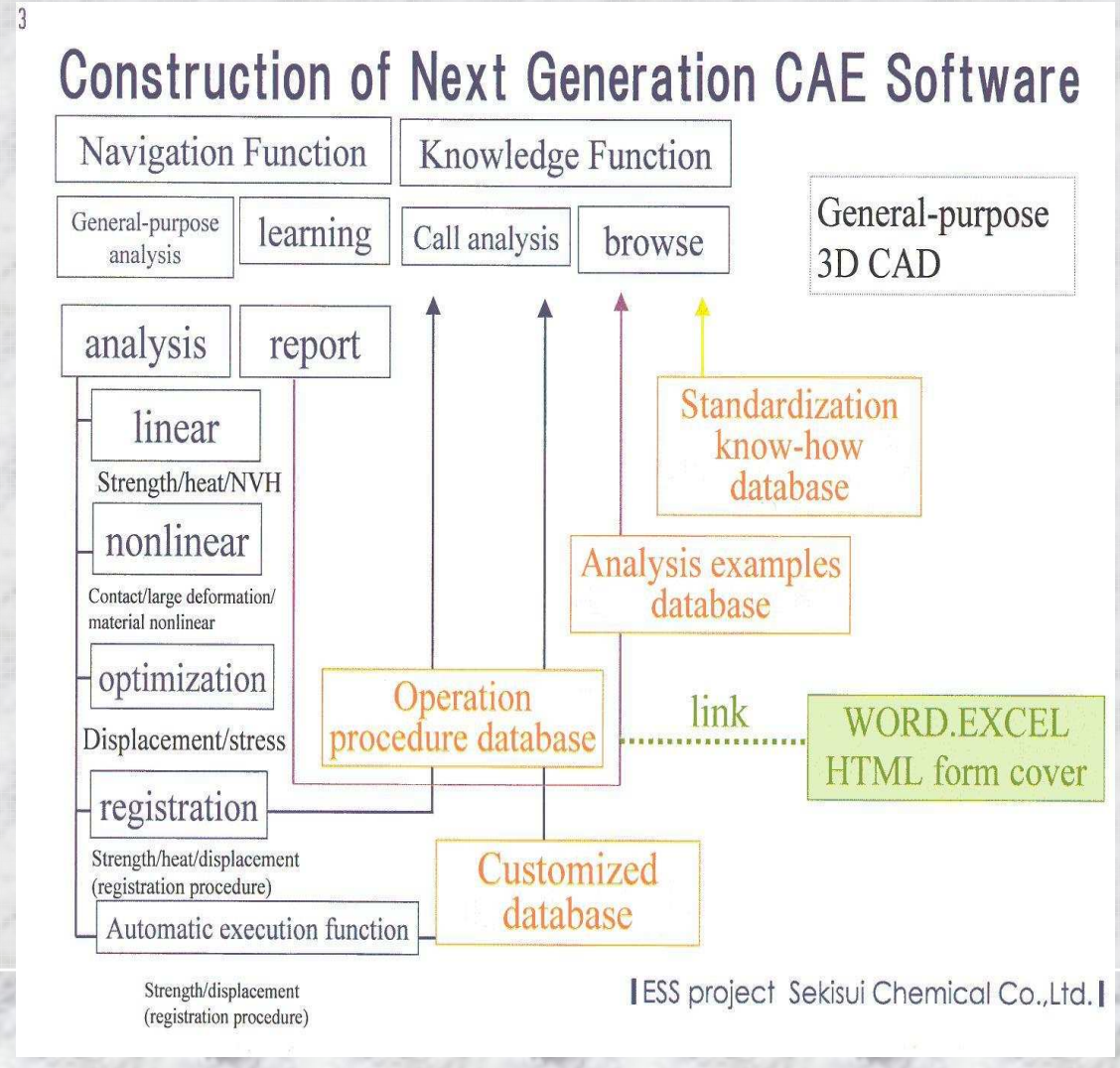
Introduction

- Evolution of CAE tools in the 80s to today's Adaptive Visual Environments (AVE) incorporating intelligent GUIs
- Example of AVE in the NAVIA_EO program based on the MPAVE pre and post processor. Links to FE solvers(NASTRAN, MARC, MPACT) for decision making
- The development of a laser based hand held instrument (Green's Strain Rosette) for the direct measurement of strains during the life cycle of a component.

NAVIA_EO

- Origins in the Kyoto Earthquake in 98? Sekisui Chemical Corp. was required to replace Fibre Composite pipes that contained Electric and gas services for the whole city according to new Standards.
- Lack of manpower resulted in decision to make software to standardize designs. Analyses could be performed by designers as opposed to FE experts.

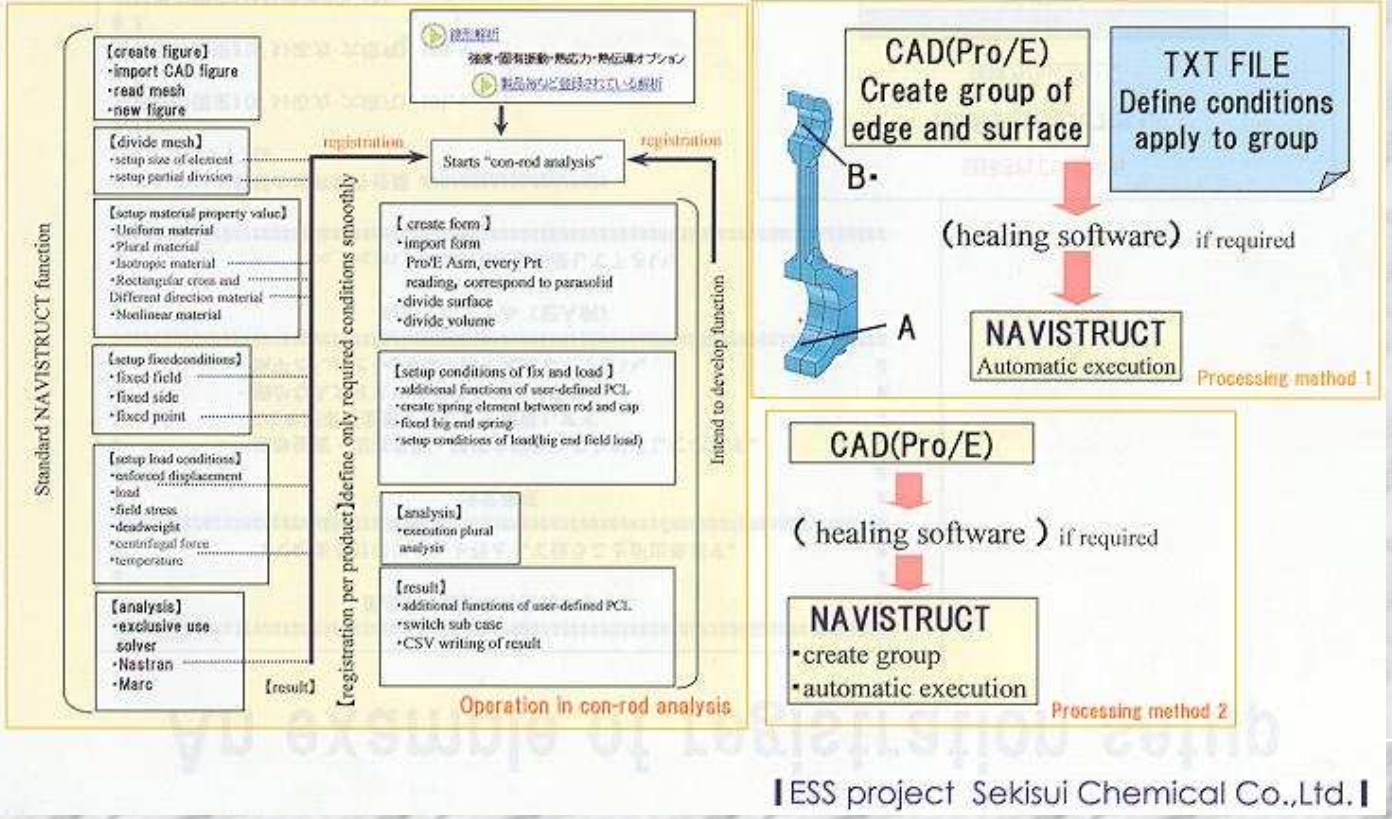
Navigation program



Defined and registered procedures

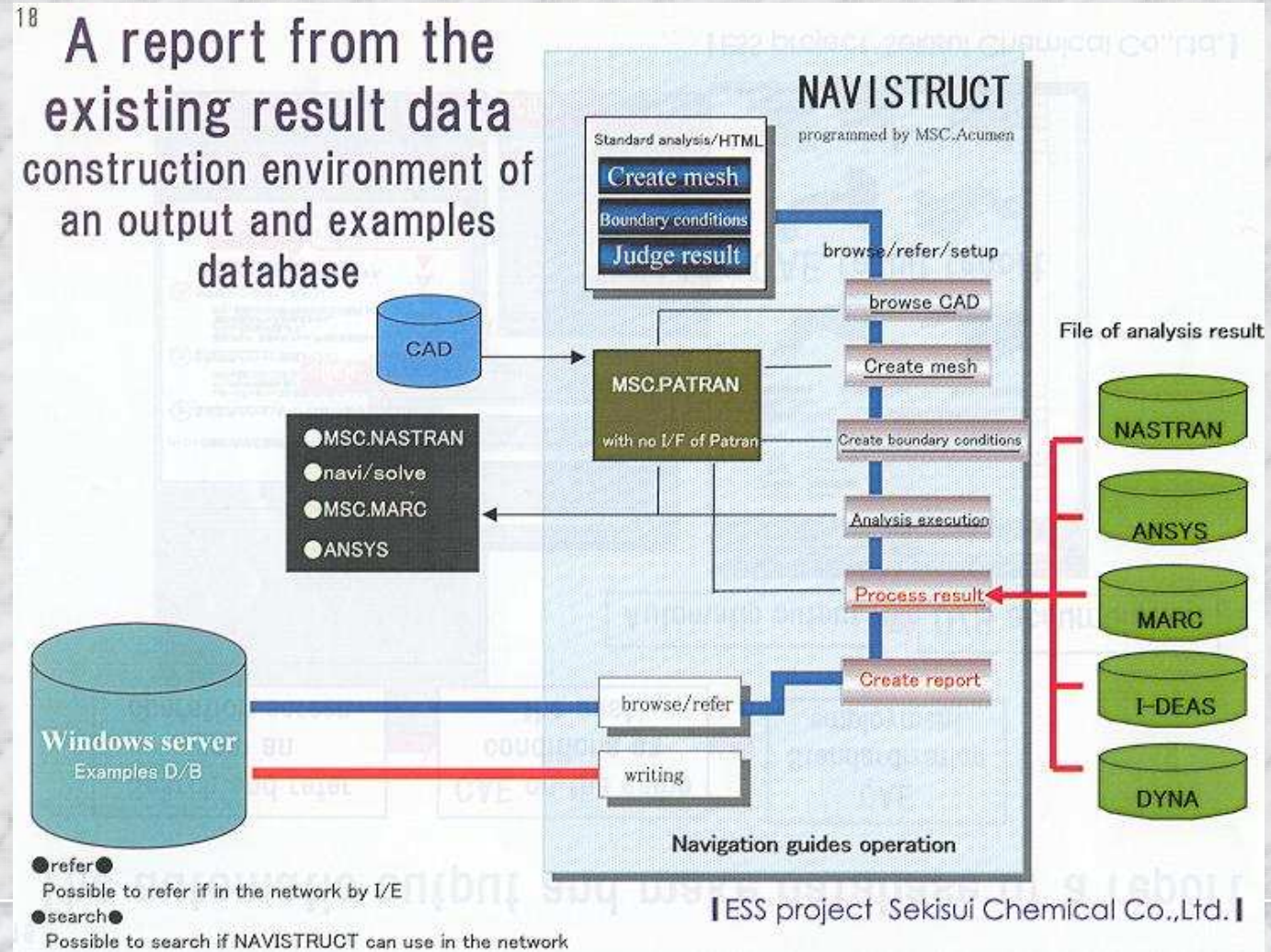
15

An example of customize using a registration function



ESS project Sekisui Chemical Co.,Ltd.

Reporting and Examples database



Generalization of Navigation Programs

- Through better procedures to handle knowledge database
- Stress Analysis Consultant (SACON) expert system built to give advice to nonlinear FE users (MARC). Joint work with Feigenbaum at Stanford.
- SACON was only complete closed world in AI that was small enough to be manipulated. Hence many extensions such as Computer Based Teaching

Generalization

- SACON dispensed advice
- SACON II can build models through API calls and built up scripts
- CLIPS Python based Expert system from NASA
- Python has built in Dictionary feature. Prefer to write my own expert system with tailored GUI

MPAVE supporting Pre Post Proc.

- Python based
- CAD Centric. Sat, parasolids, pro E, Catia Iges, Stl, Step, Open Cascade
- Journaling, Scripting
- Completely open. Scripts can be modified. Scripts can be created to run all programs on Computer (network)
- API calls from any programs using XMLRPC protocol.

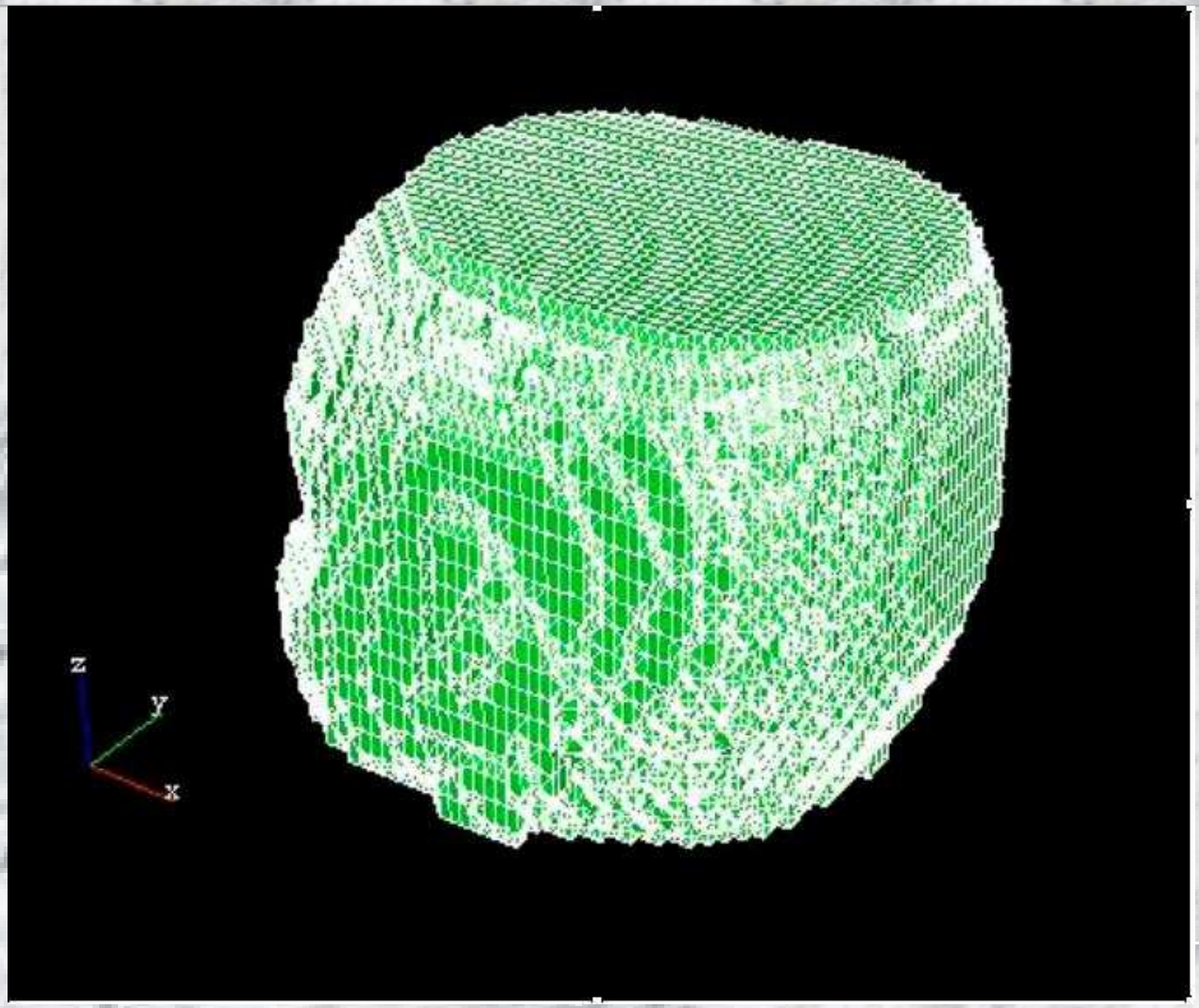
XMLRPC

- 1. Embed Python interpreter in calling program
- 2. Call xmlrpc client
- 3. Client calls xmlrpc server embedded in MPAVE
- 4. Server issues call to API (script)

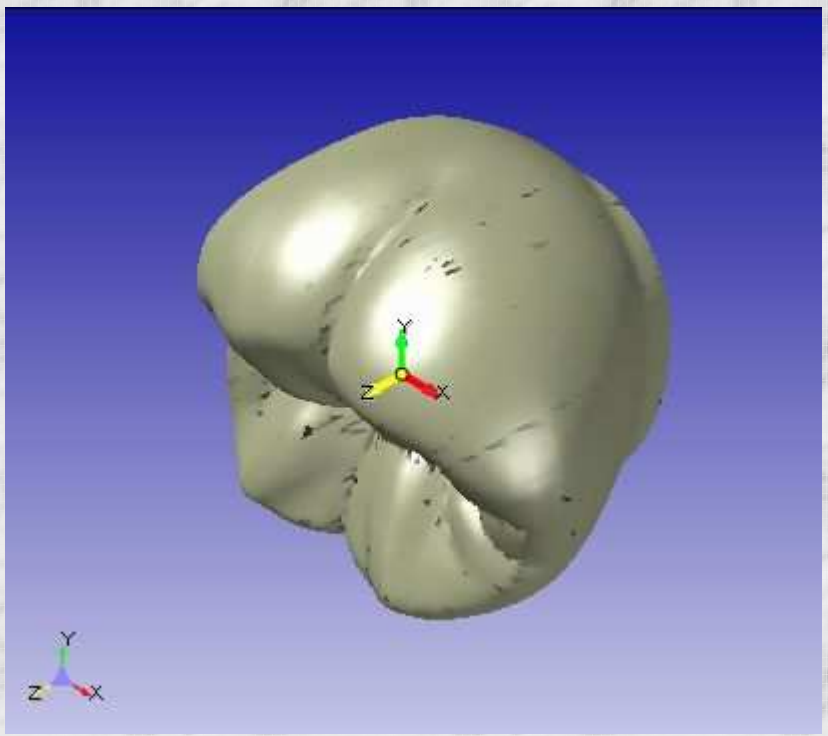
MPAVE Extensions

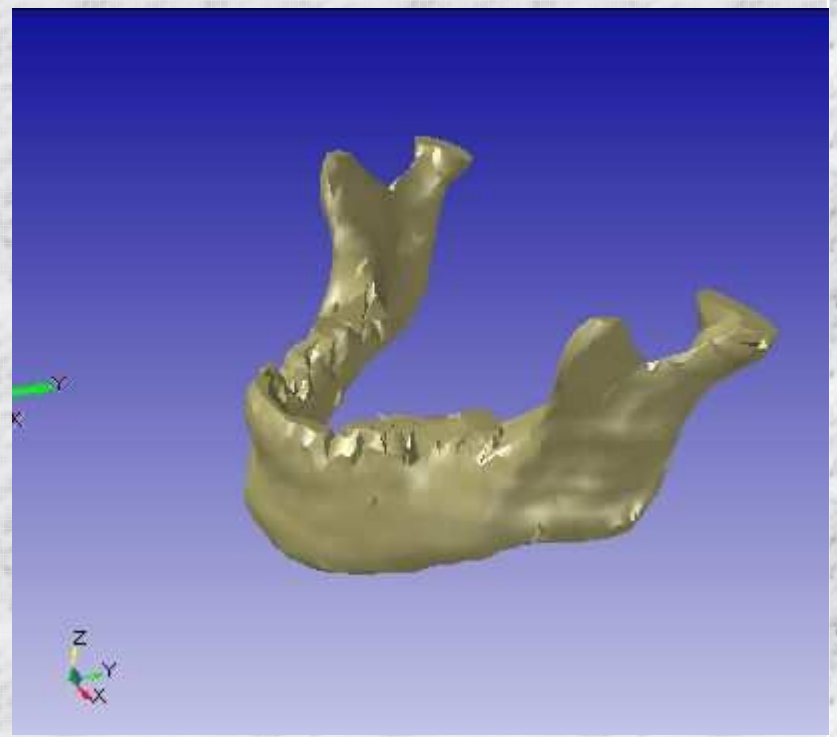
- Weakly Coupled Systems & Iterations
- Design of Experiments
- Optimization
- Expert Systems
- Procedures for Life Cycle Verification and Validation
- Virtual Testing Labs. Such as race tracks.
- First step standardize Database interface around XML

Dicom Files to FE, Uses Python Image Library (PIL)

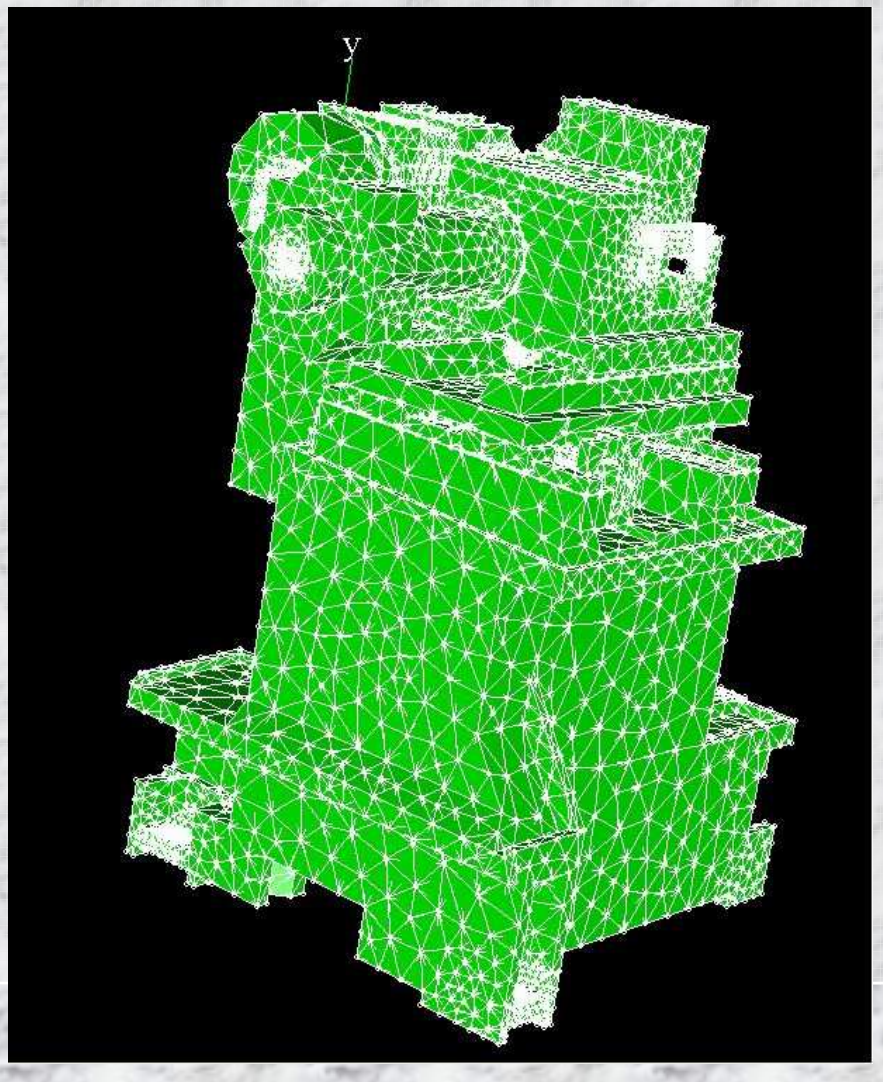


STL Files to FE, CAD healing of last resort





Value of well defined Model Data Base (MDB), program., 120 contact surfaces



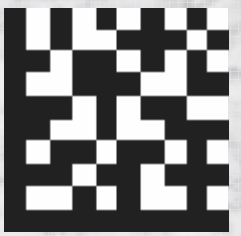
DMI

- Uses 2D Laser Markings as base.
- Deformation of boundaries gives Green's strain Rosette
- Deformations read by a hand-held laser instrument.
- Location of markings indicated by nonlinear analysis with MPACT.
- Tracking and historical data stored in Mpave. Fatigue life data stored in DB

Gage conforms to …

Marking Standards

- **AIAG B-4, Automotive marking**
- **EIA 706, Electronics Industry Marking Standard**
- **EIA 802, Electronics Industry Marking Standard**
- **MIL-STD-130L – DoD Marking Standard**
- **NASA STD 6002 – NASA Marking Standard**
- **NASA-HDBK-6003 – NASA Marking Handbook**
- **SAE AS9132 – Aerospace Industry Marking Standard**

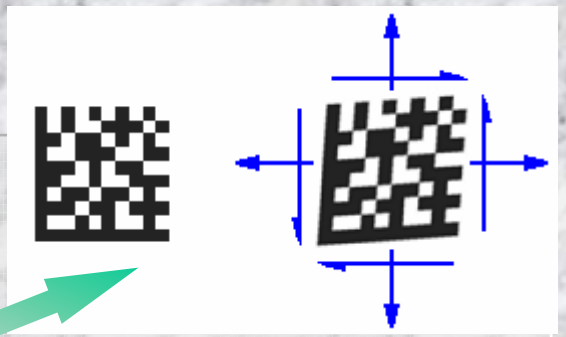


Symbol Data Format Standards

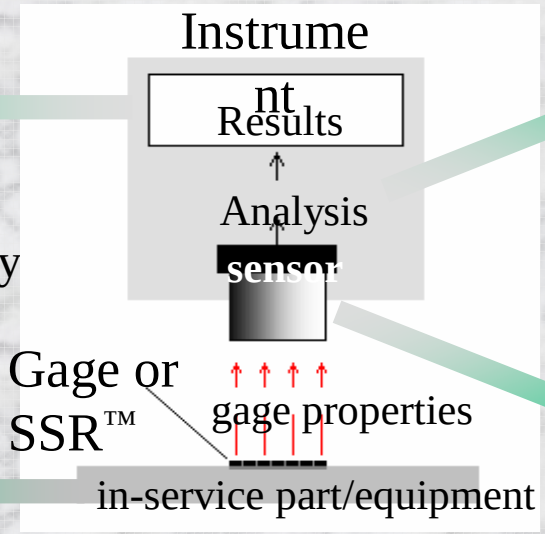
- **ISO/IEC 15418:1999 - Semantics**
- **ISO/IEC 15434:1999 - Syntax**

How it works …

System controls analysis, display and integration tasks



Gage is analyzed for strain



In-service part marked with gage

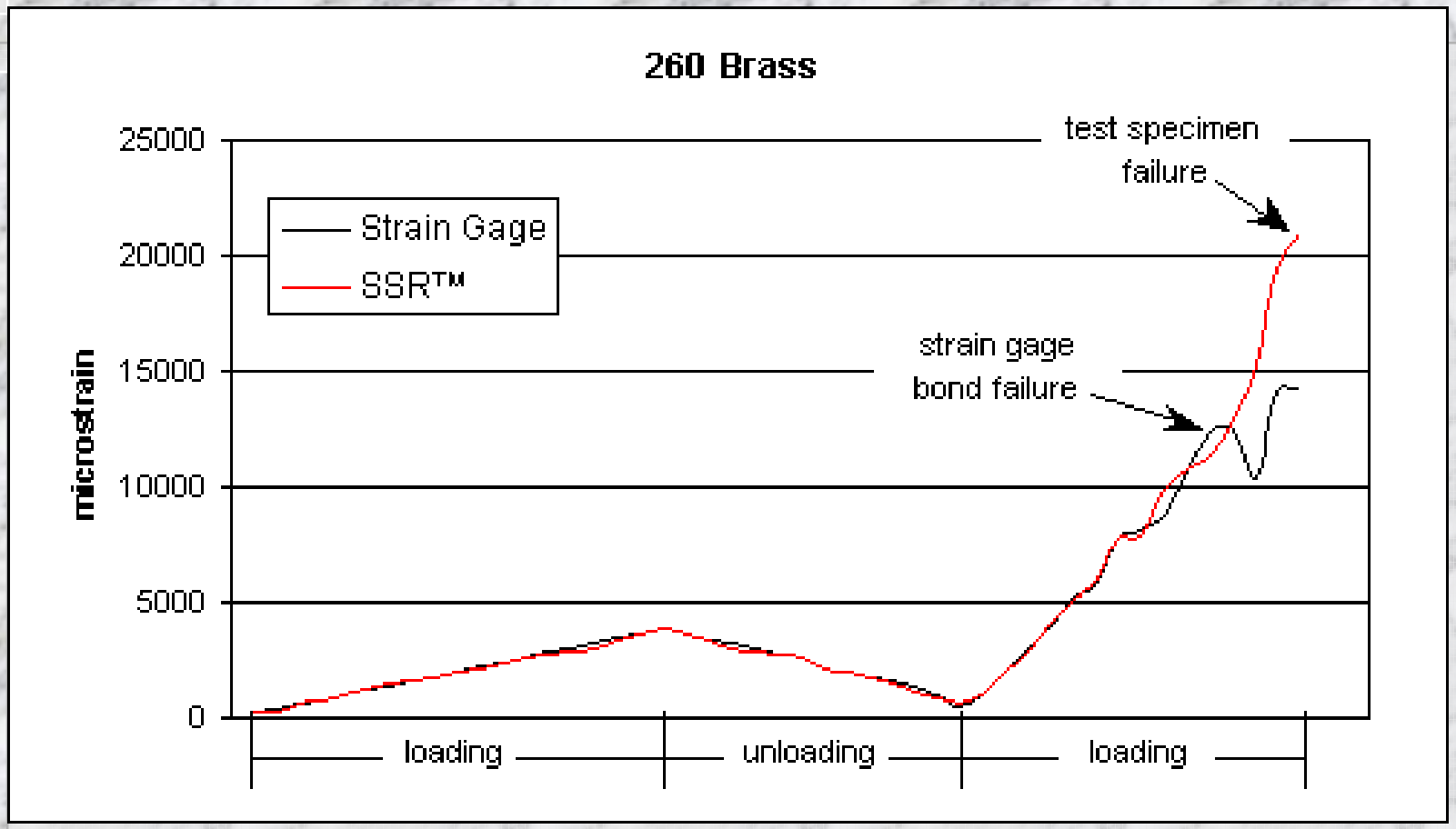
Handheld unit “reads” gage

Laboratory and Testing Equipment

- ✓ Complete system for strain/fatigue studies
- ✓ Strain measurement up to 100,000+ microstrain
- ✓ Versatile sensor for handheld or fixed use
- ✓ Works on most materials
- ✓ Make measurements up to 30 feet from computer

DMI Benchtop Instrument

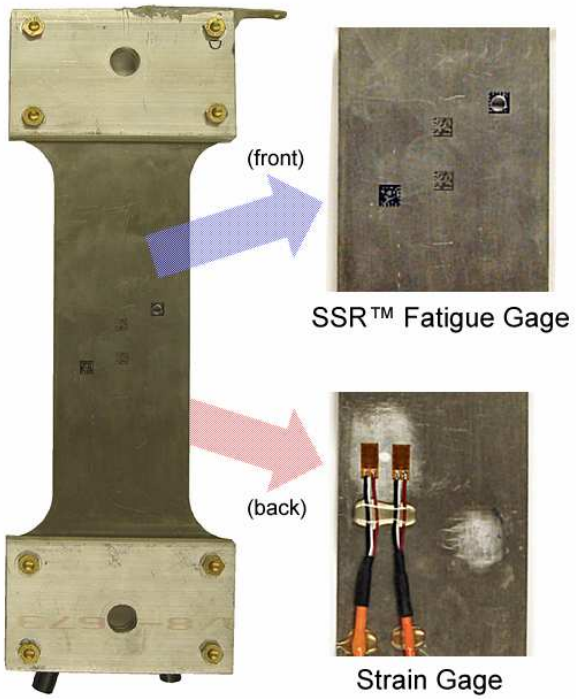
TEST DATA

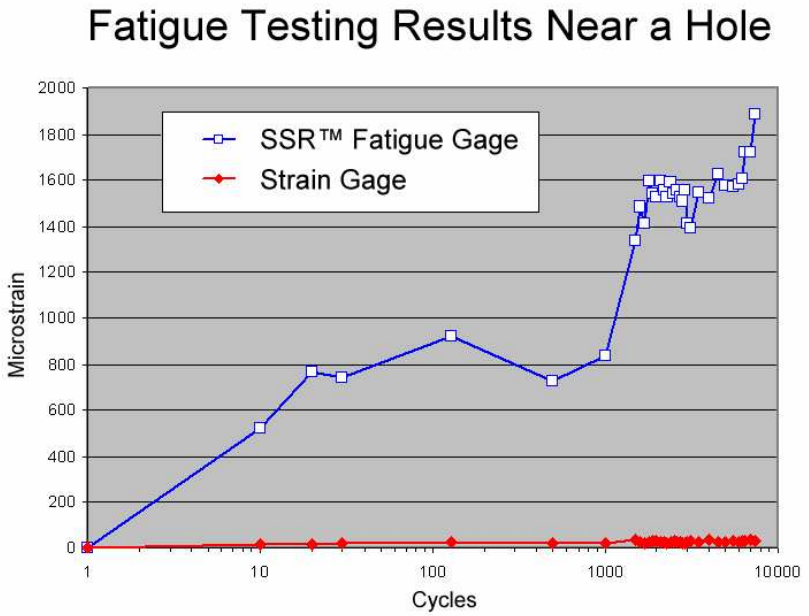

260 Brass
25000
20000
15000
10000
5000
0
microstrain
Strain Gage
SSR™
test specimen
failure
strain gage
bond failure
loading
unloading
loading

Pre-Crack Fatigue Data

Direct Measurements, Inc. www.directmeasure.com

PRE-CRACK FATIGUE DETECTION





Lifetime Cycle V&V