CAD Design In Modern Day Products

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And Marine Engineering

CAD Design in Modern Day Products

Challenge to Systems Engineers

- Meet the Operational Requirements of a Project
- Conducting Conceptual Analysis of Alternatives
- Allocation of Top Level Requirements
- Conducting Trade Off Studies
- Balancing Cost, Schedule and Performance

CAD Design in Modern Day Products

Why CAD Systems?

CAD Design in Modern Day Products

EVOLUTION OF CALCULATIONS

Hand Calculations

Written Calculations

Mechanical Calculator

Electronic Calculator

Personal Computer or Mainframe

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EVOLUTION OF CALCULATIONS AT A GROCERY STORE

Hand Addition

Cash Register

Electronic Swipe Out

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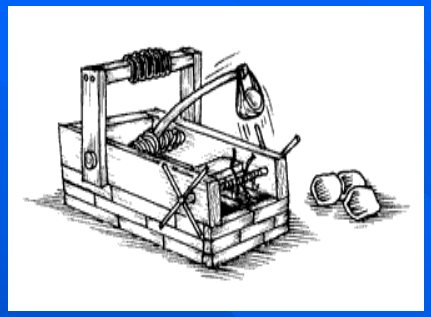
Engineer Drawings



Artist Sketch

Drafting Room

CAD

CAD Design in Modern Day Products

It's the Natural Course of Evolution

CAD Design in Modern Day Products

Background and History of CAD Systems

CAD – Computer Aided Design

- 1963 Ivan Sutherland at MIT Developed SKETCH PAD
  - Allowed the Designer to Interact With the Computer Graphically
- First Commercial Applications of CAD Were Large Companies in Automotive and Aerospace Industries
- Advances in Computer Technology Have Allowed Skillful Applications of Computers in Design Activities
- CAD is No Longer Limited to Drafting
- CAD Ventures into Intellectual Areas of a Designer's Expertise

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Background and History of CAD Systems

List of CAD Companies and Software

- AutoCAD
- Bentley Systems
- CADDS5
- Cadkey
- CATIA
- EDS
- Euclid
- i-DEAS
- Inventor
- Intergraph
- Matricus
- ME
- Pro/Engineer
- Qcad
- Solid Edge
- Solid Works
- Think3
- Unigraphs
- VariCAD
- Vectorworks
- AutoCAD
- Caddie
- Microstation

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Background and History of CAD Systems

Electronic Design Automation (EDA)

- Umbrella Term for Computer-Aided Design and Computer-Aided Manufacturing of Electronics
- Moores LAW

Electronic Design Automation (EDA) Companies and Software

- Avanti (Merged into Synopsys)
- Cadence Design Systems, Inc.
- IC-Ed
- Mentor Graphics
- MyCad
- Stable-Soft
- Silvaco
- Synopsys
- Tanner Research
- Hewlett Packard

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Background and History of CAD Systems

Moores LAW

- Technology Development Complexity and Advances in the Semiconductor Industry for Integrated Circuits Doubles Every 18 Months
- Equates to Performance Improvement of 1% Per Week

Bottom Line

- Product Improvements Occur at a Fast Pace

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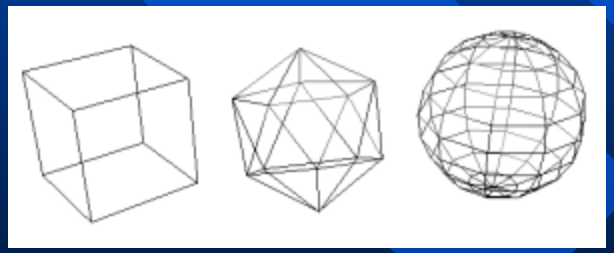
Background and History of CAD Systems

Terminology

- Wire Frame Model is an Electronic Representation of a 3-Dimensional Physical Object
  - It is Created by Specifying Each Edge of the Physical Object
  - It is Created by Connecting an Objects Constituent Vertices Using Straight or Curved Lines



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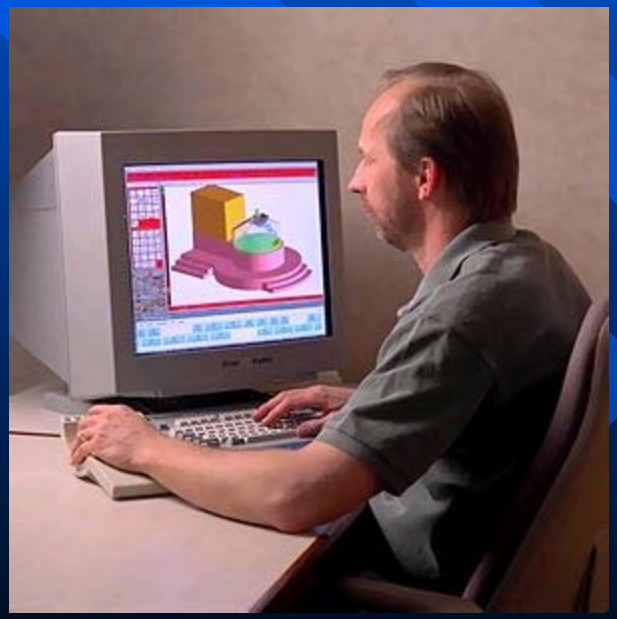
Background and History of CAD Systems

Terminology

- Solid Modeling
  - Models of Solid Objects Suitable for Computer Processing
  - Sometimes Referred to as Volume Modeling



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Advantages of a CAD System

- Ability to Composite or Interface Check 3D Systems
- Lends Itself to Evaluate the Design
- Acts as a Prototype
- Accurate
- Permanent Record
- Repeatability, Copy or Redraw Rapidly
- Transportable Electronically

CAD Design in Modern Day Products

Advantages of a CAD System

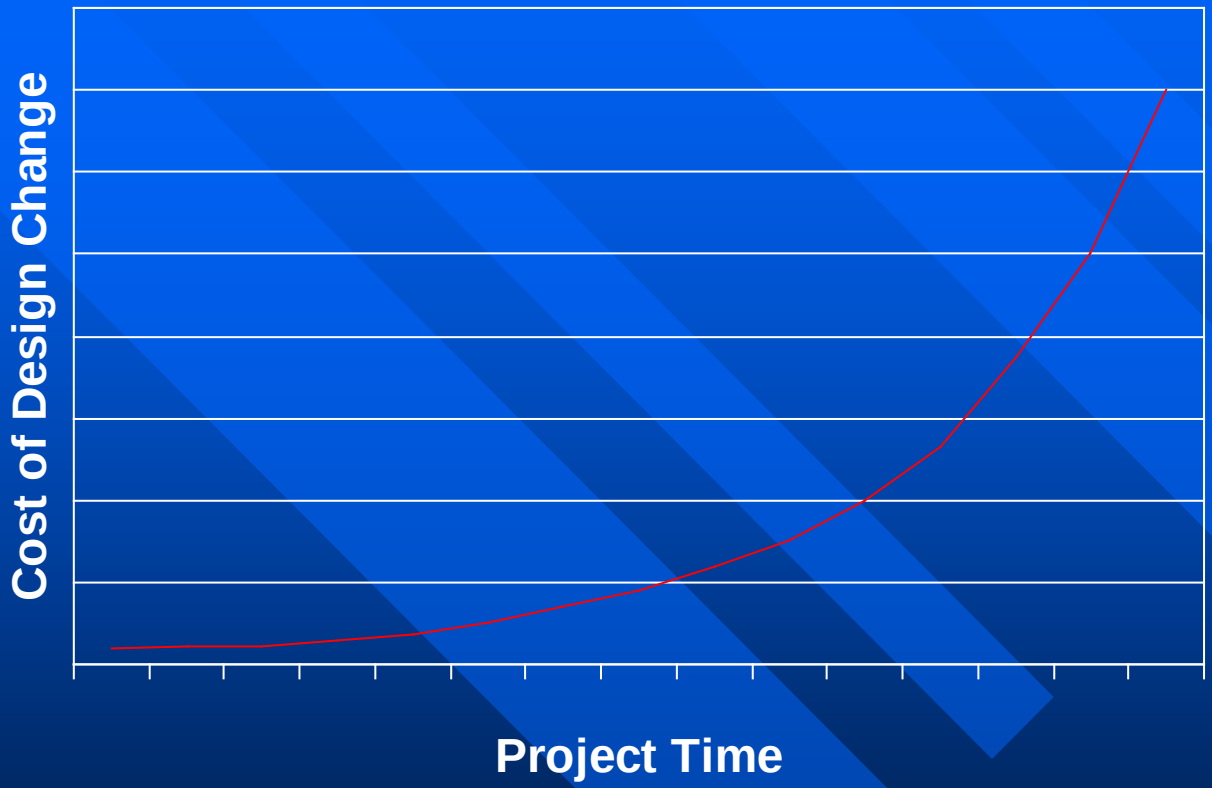
- Reduce Storage
- Standardize Formats
- Standardize Material
- Standardized Components
- Allows Human Engineering Studies
- Allows Trade-off Studies
- Make Changes Easily
- Facilitates Checking

CAD Design in Modern Day Products

Disadvantages of a CAD System

- High Initial Capital Cost
- Extensive Training
- Continued Development Cost of Software
- Continued Development Cost of Hardware
- Special Real Estate Considerations
  - HVAC
  - Lighting
  - Arrangements
- High Cost to Expand Capabilities

CAD Design in Modern Day Products



CAD Design in Modern Day Products

MORAL OF THE STORY

- Make Changes as Early as Possible
- Reduces Design Development Cost

CAD Design in Modern Day Products

Applications of a CAD System

- Interface With Manufacturing and Drive the Process
- Ability to Interface With Purchasing Automatically
- Allows for Planning Electronically
- Logistics Support and Life Cycle Management
- Technical Manual Development
- Integrate With Engineering Analysis
- Database for Weight Control
- Ability to Interface With Vendor Data
- Facilitates the Use of Integrated Product Teams

CAD Design in Modern Day Products

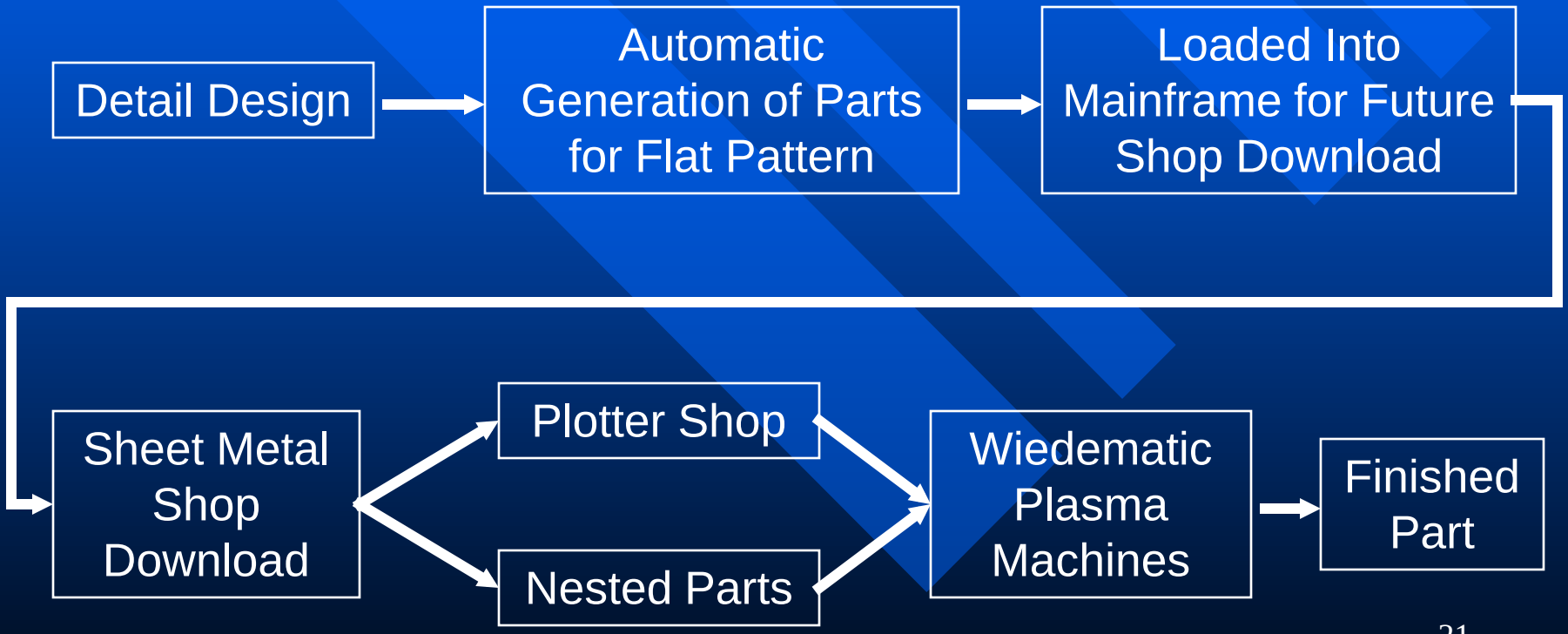
Applications of a CAD System

- Interface With Manufacturing and Drive the Process
  - Sheet Metal
  - Pipe Bending
  - Structural Cutting
  - Welding

CAD Design in Modern Day Products

Applications of a CAD System

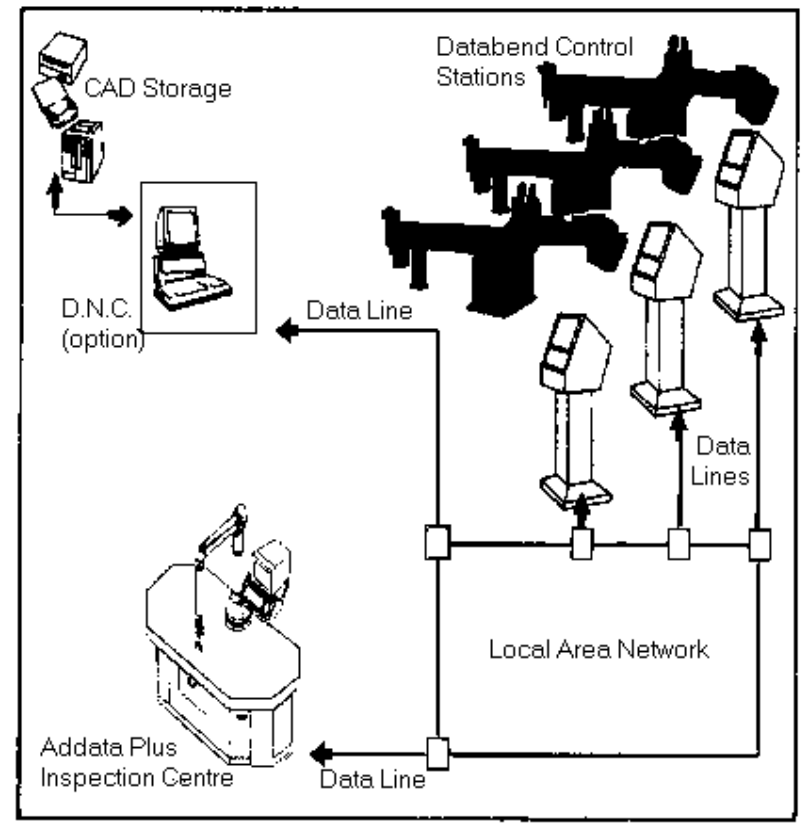
- Interface With Manufacturing and Drive the Process
  - Sheet Metal



CAD Design in Modern Day Products

Applications of a CAD System

- Interface With Manufacturing and Drive the Process
  - Pipe Bending



CAD Design in Modern Day Products

Applications of a CAD System

- Interface With Manufacturing and Drive the Process
  - Structural Cutting

CAD Design in Modern Day Products

Applications of a CAD System

- Interface With Manufacturing and Drive the Process
  - Welding (Robotics)

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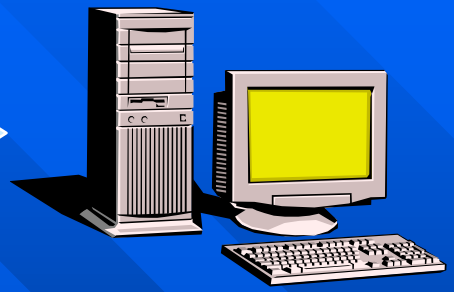
Applications of a CAD System

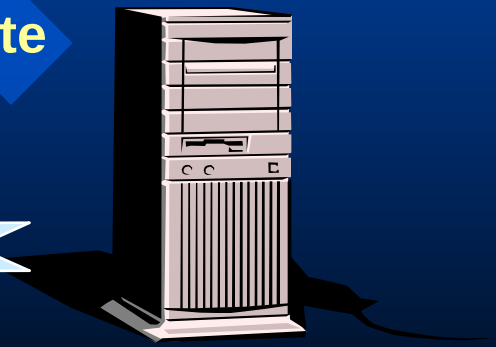
Input Data to Catalog

Material Catalog



CAD

Delta Change Process Catalog Transactions – nightly update



Issue Purchase Requisition – Manual/Electronic Process

Issue Purchase Order

Ability to Interface With Purchasing Automatically

CAD Design in Modern Day Products

Applications of a CAD System

- Logistics Support and Life Cycle Management

CAD Design in Modern Day Products

Applications of a CAD System

- Technical Manual Development

CAD Design in Modern Day Products

Applications of a CAD System

- Integrate With Engineering Analysis

CAD Design in Modern Day Products

Common Finite Element Analysis Programs

- ANSYS
- NASTRAN
- PATRAN
- ABAQUS
- LS-DYNA
  DYNA3D
- LUSAS
- FRANC 2D&3D
- FEMAP
- FEMLAB
- i-DEAS
- ALGOR
- NE NASTRAN
- TRIFLEX
- SIMSMART
- STAAD.PRO

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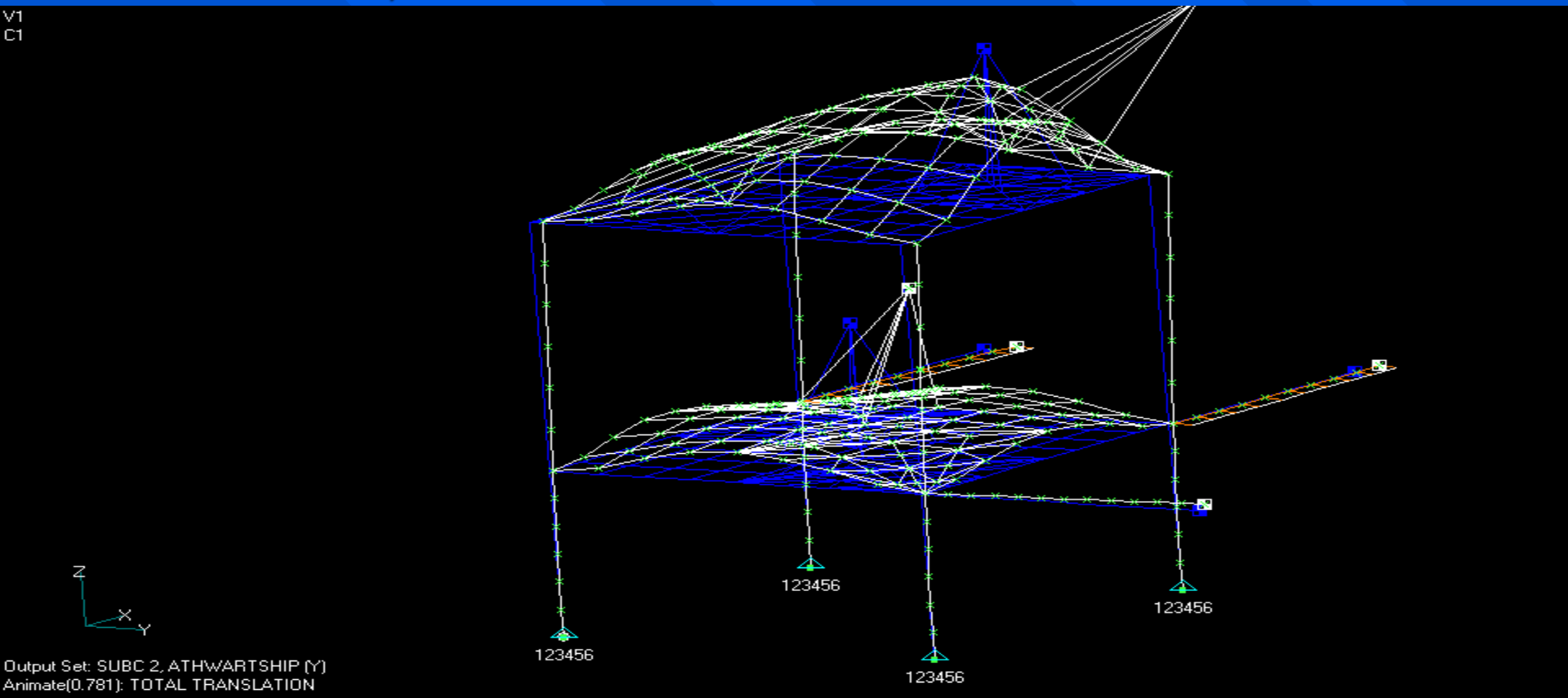
Integrate With Engineering Analysis

- Computer Aided Structural Analysis
  - Stress
  - Shock
  - Vibration
  - Thermal Stress

CAD Design in Modern Day Products

Integrate With Engineering Analysis

- Computer Aided Structural Analysis
  - Stress, Shock and Vibration

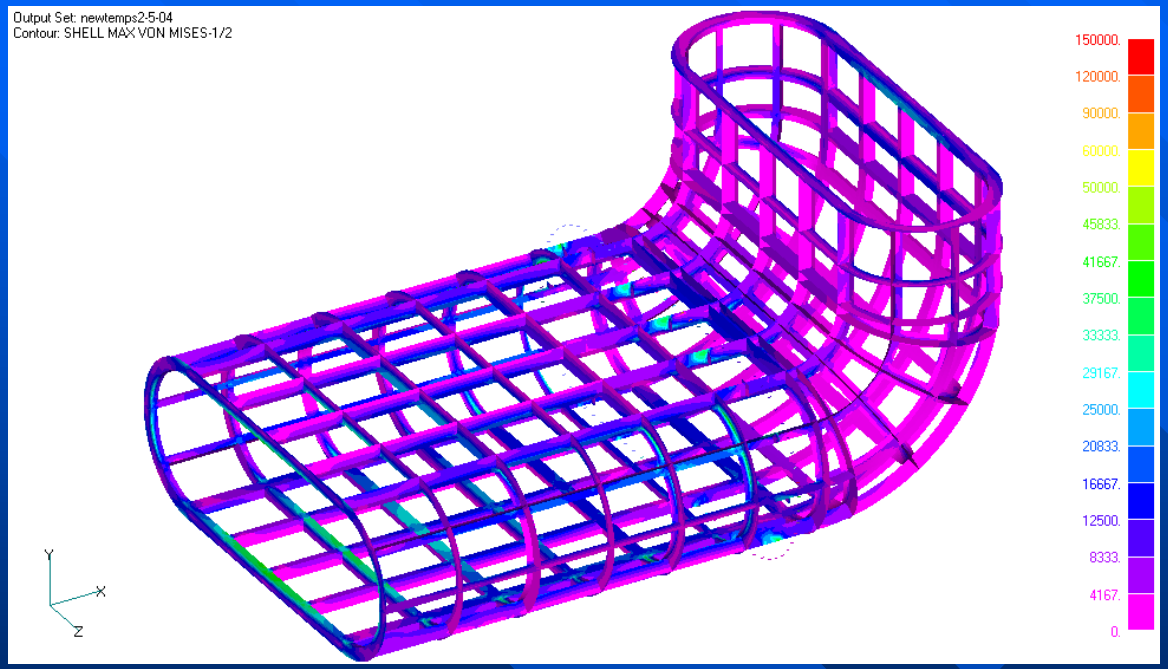


CAD Design in Modern Day Products

Integrate With Engineering Analysis

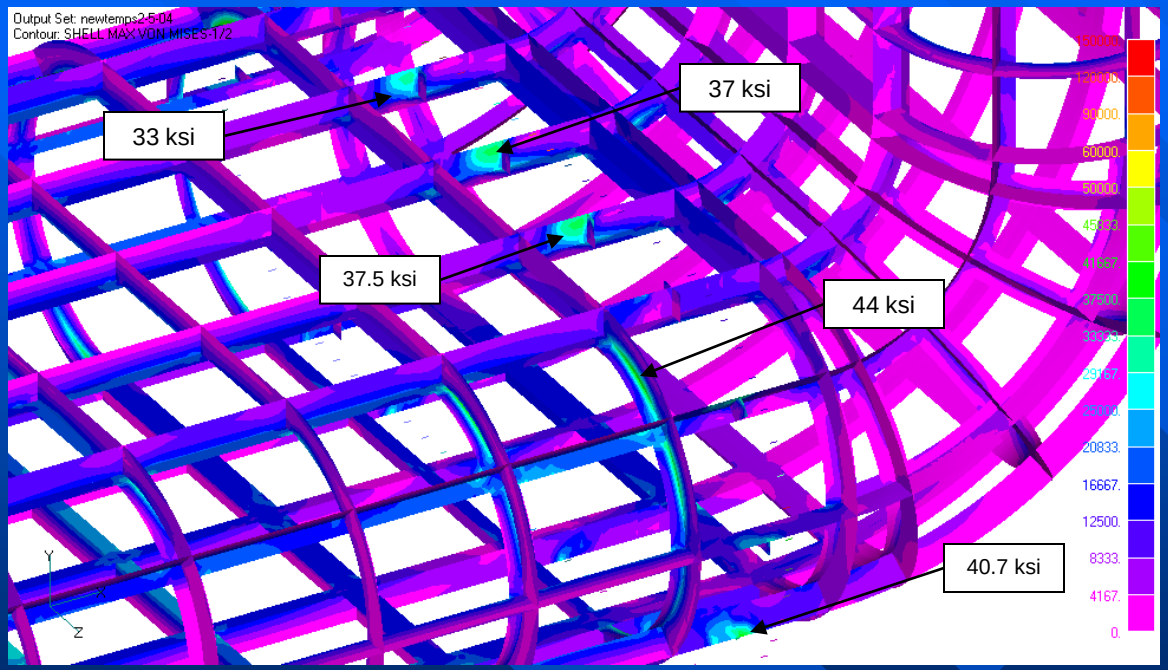
- Computer Aided Structural Analysis
  - Thermal Stress

CAD Design in Modern Day Products



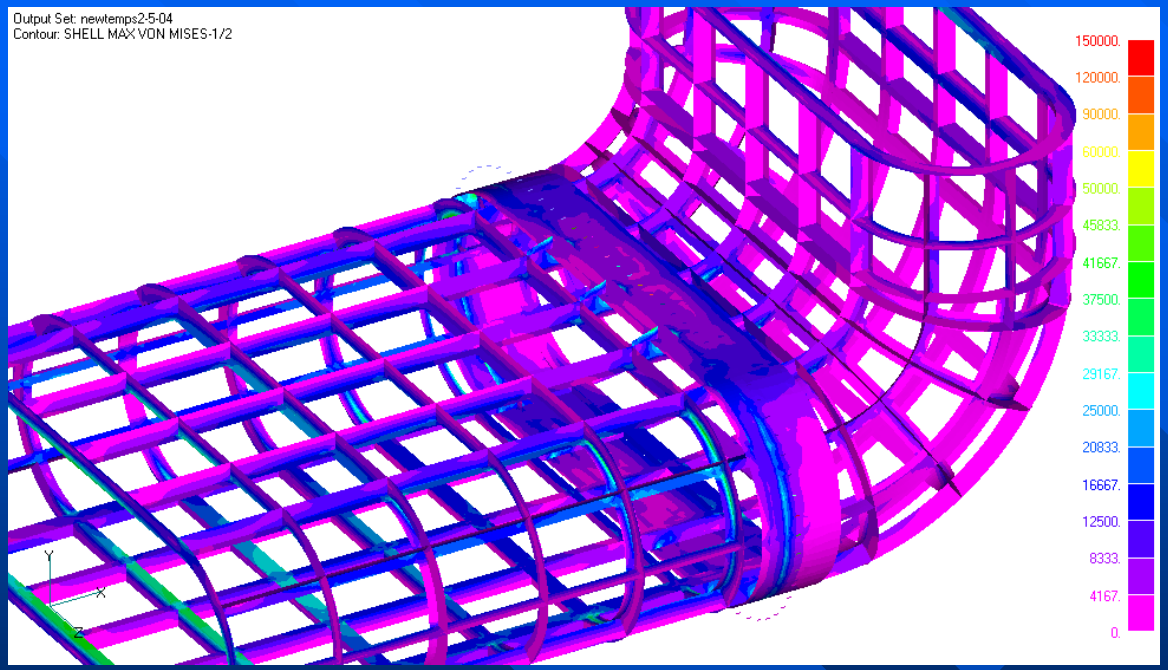
Thermal Stress Analysis

CAD Design in Modern Day Products



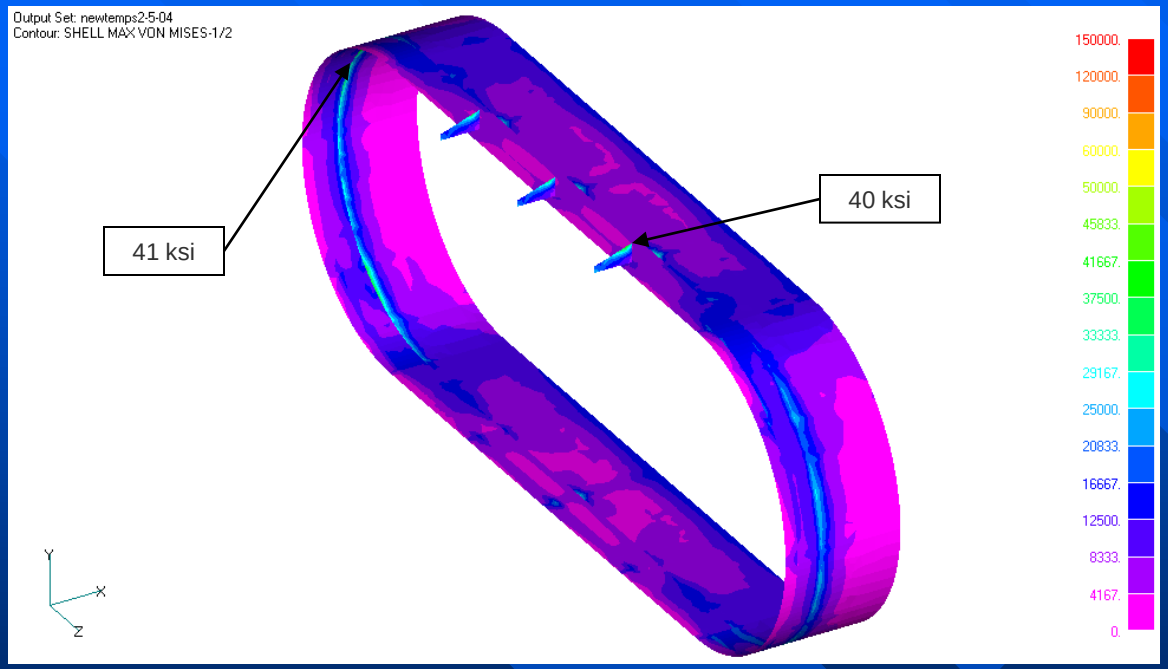
Thermal Stress Analysis

CAD Design in Modern Day Products



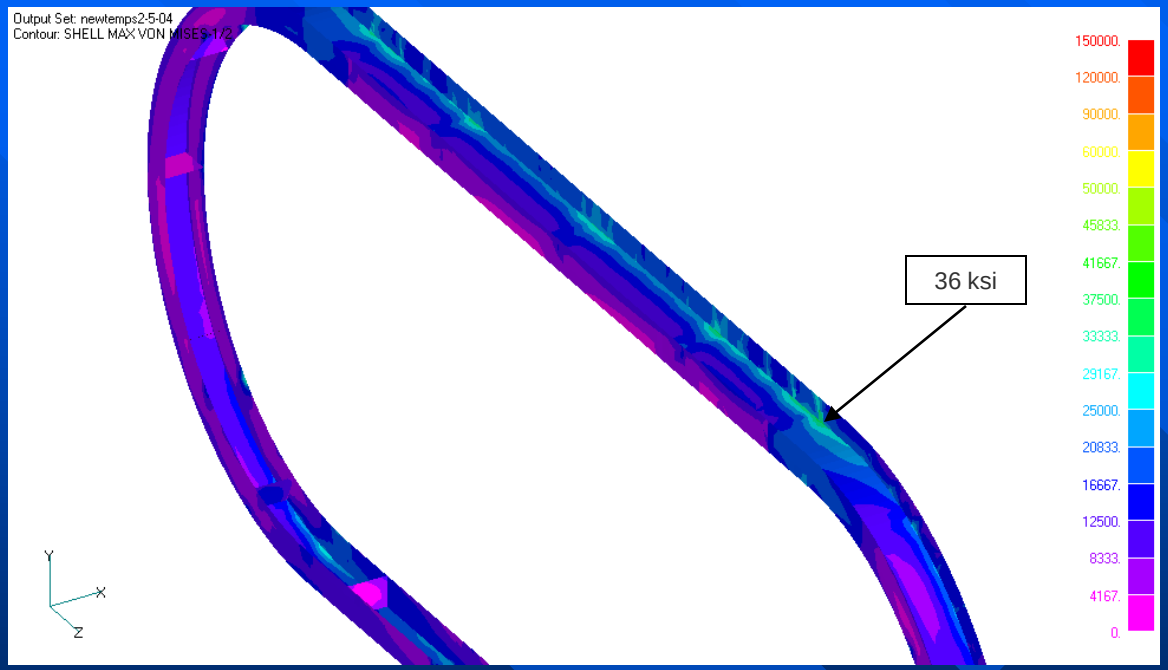
Thermal Stress Analysis

CAD Design in Modern Day Products



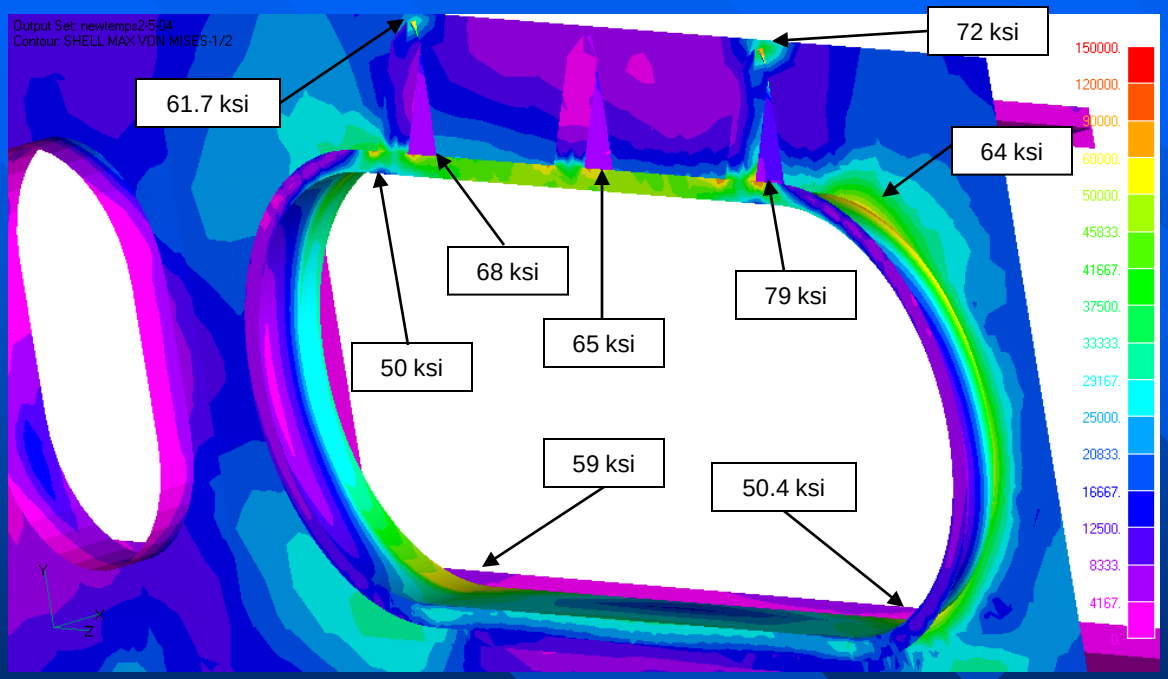
Thermal Stress Analysis

CAD Design in Modern Day Products



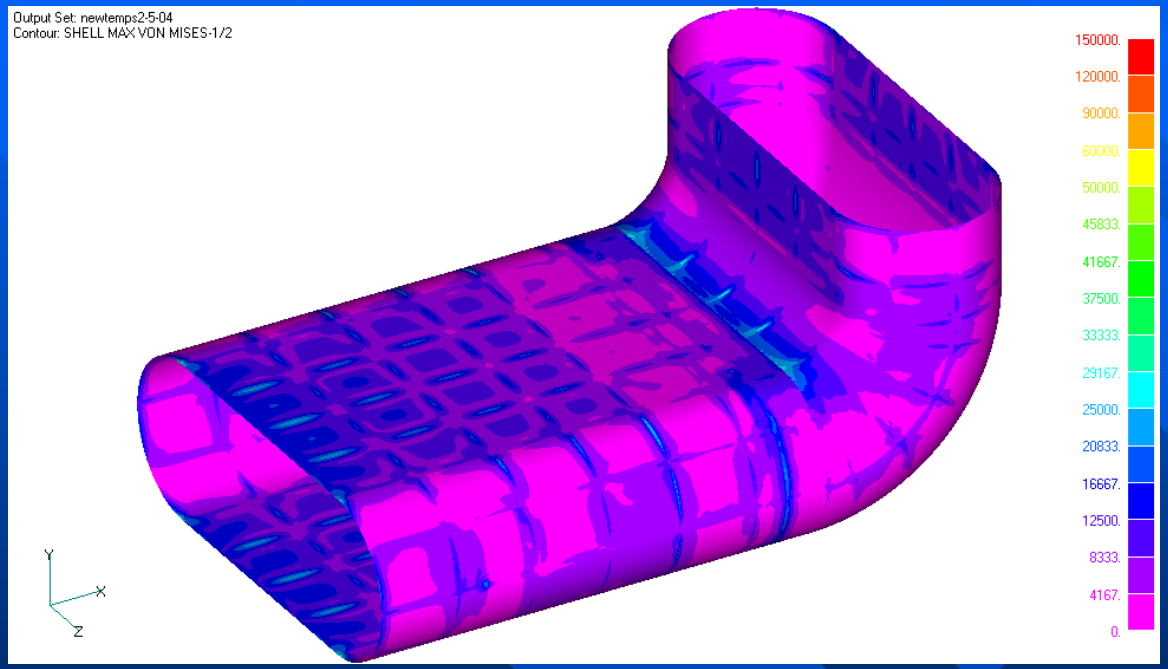
Thermal Stress Analysis

CAD Design in Modern Day Products



Thermal Stress Analysis

CAD Design in Modern Day Products



Thermal Stress Analysis

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Integrate With Engineering Analysis

- Computer Aided Simulation
  - Pipe
  - Electrical
  - Pipe Flexibility

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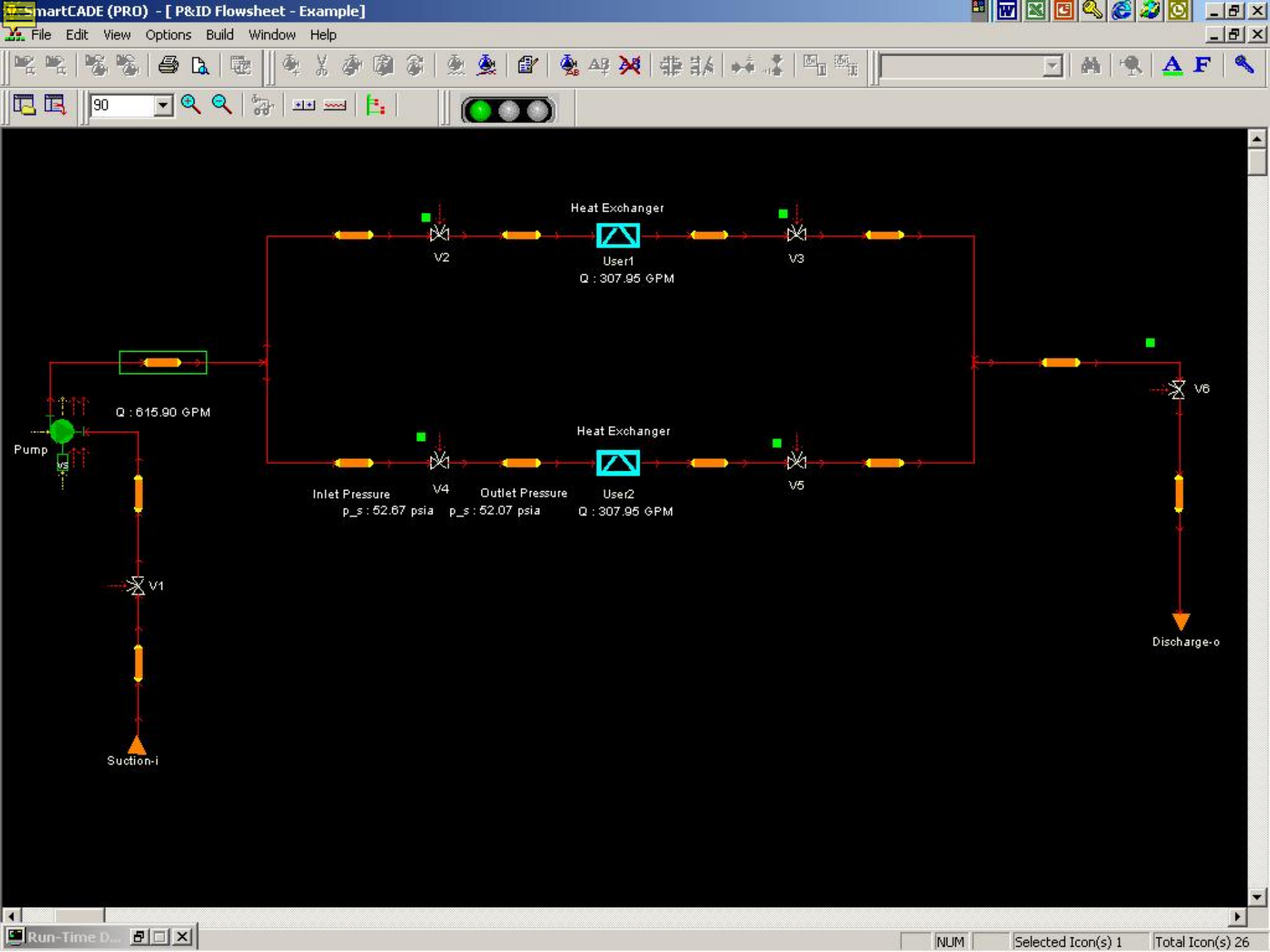
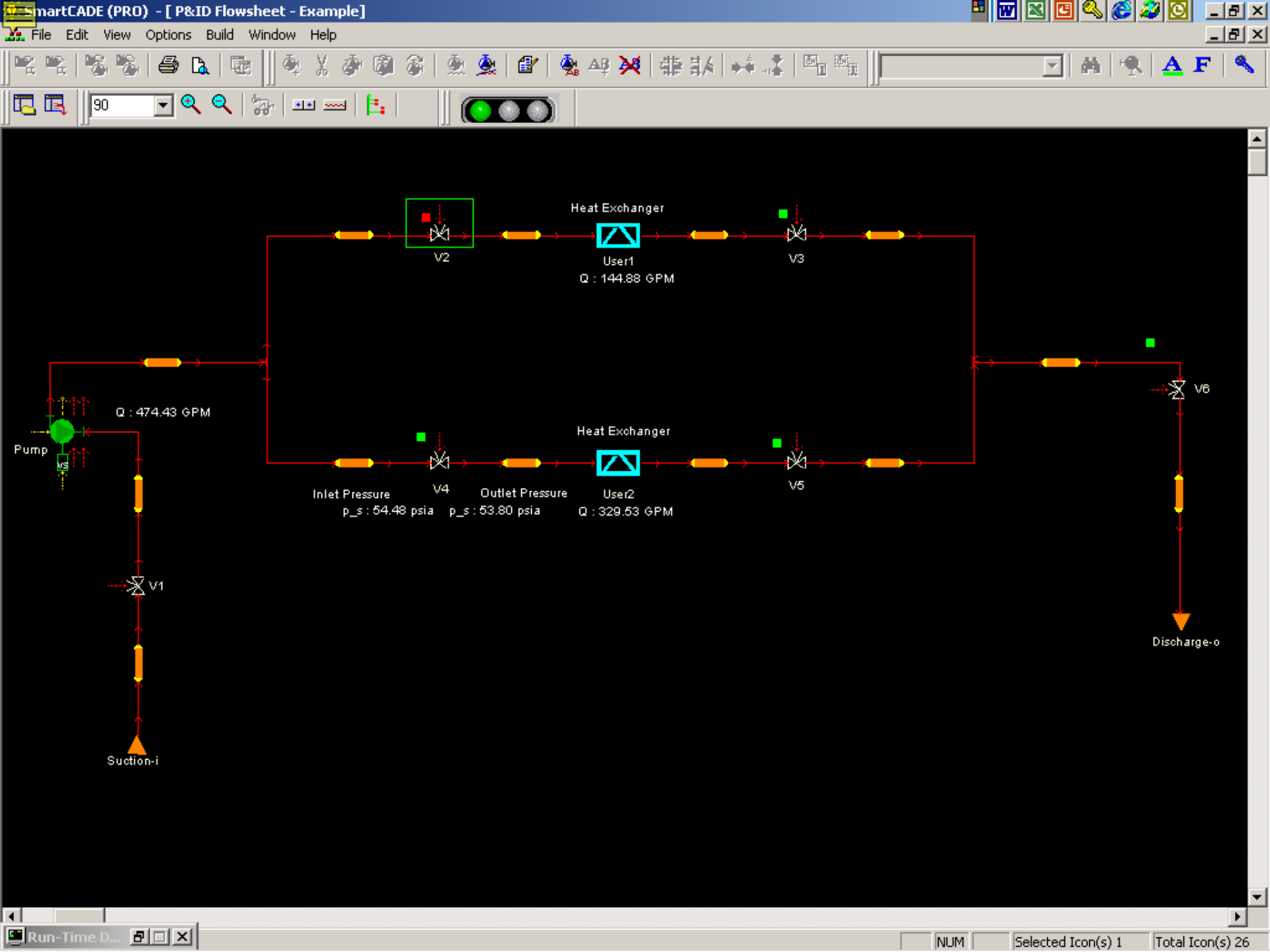
Applications a CAD System

Computer Aided Pipe Flow


SmartCADE (PRO) - [P&ID Flowsheet - Example]
File Edit View Options Build Window Help
90
Heat Exchanger
V2
User1
Q : 307.95 GPM
V3
V6
Q : 615.90 GPM
Pump
Heat Exchanger
Inlet Pressure
p_s : 52.67 psia
V4
Outlet Pressure
p_s : 52.07 psia
User2
Q : 307.95 GPM
V5
V1
Discharge-o
Suction-i
Run-Time D...
NUM
Selected Icon(s) 1
Total Icon(s) 26


SmartCADE (PRO) - [P&ID Flowsheet - Example]
File Edit View Options Build Window Help
90
Heat Exchanger
V2
User1
Q : 144.88 GPM
V3
V6
Q : 474.43 GPM
Pump
Heat Exchanger
Inlet Pressure
p_s : 54.48 psia
V4
Outlet Pressure
p_s : 53.80 psia
User2
Q : 329.53 GPM
V5
V1
Discharge-o
Suction-i
Run-Time D...
NUM
Selected Icon(s) 1
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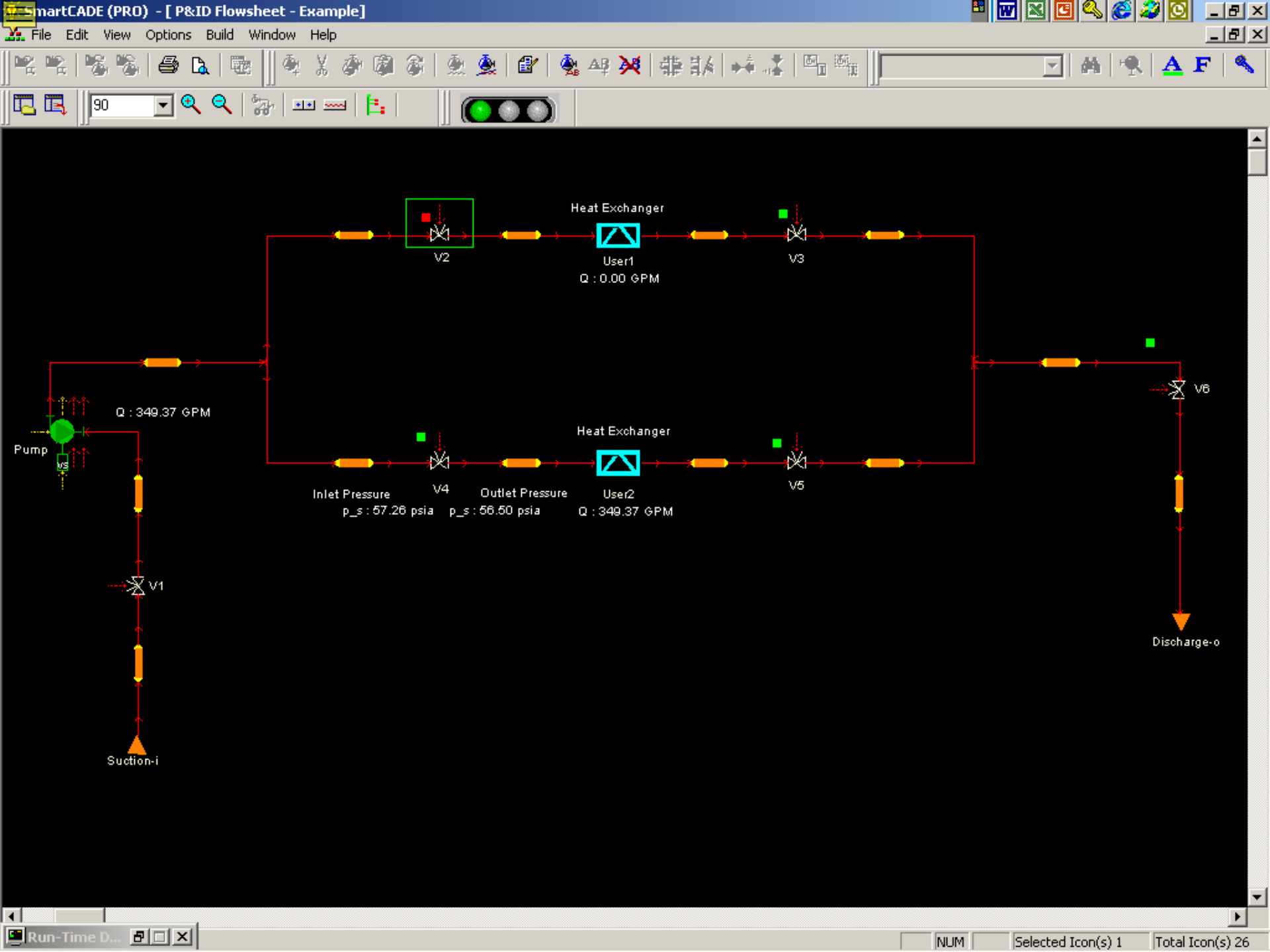
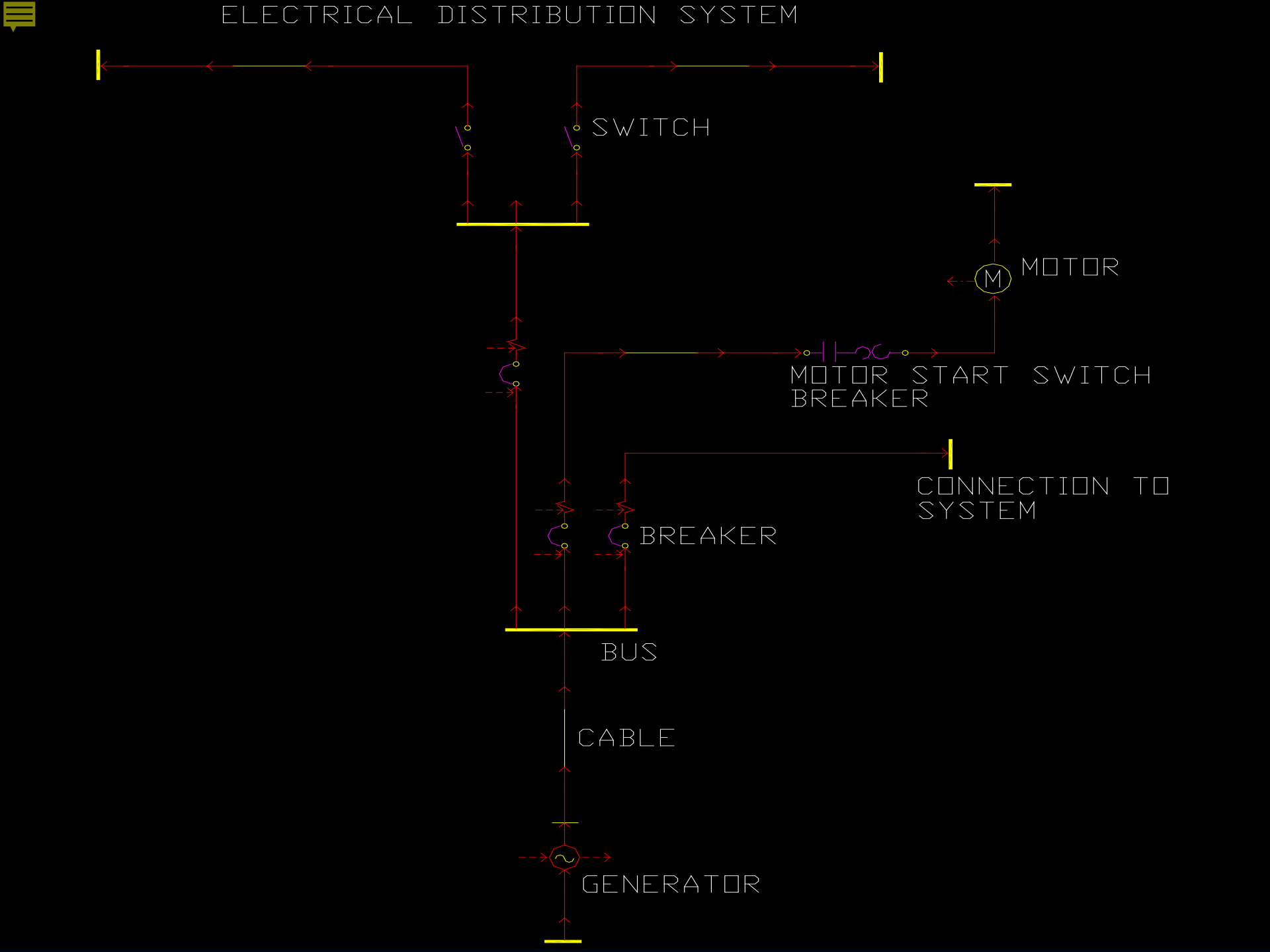

SmartCADE (PRO) - [P&ID Flowsheet - Example]
File Edit View Options Build Window Help
90
Heat Exchanger
V2
User1
Q : 0.00 GPM
V3
V6
Q : 349.37 GPM
Pump
Heat Exchanger
Inlet Pressure
p_s : 57.26 psia
V4
Outlet Pressure
p_s : 56.50 psia
User2
Q : 349.37 GPM
V5
V1
Discharge-o
Suction-i
Run-Time D...
NUM
Selected Icon(s) 1
Total Icon(s) 26

CAD Design in Modern Day Products

Applications of a CAD System

Electrical Load Analysis


ELECTRICAL DISTRIBUTION SYSTEM
SWITCH
MOTOR
M
MOTOR START SWITCH
BREAKER
CONNECTION TO
SYSTEM
BREAKER
BUS
CABLE
GENERATOR

CAD Design in Modern Day Products

Applications of a CAD System

Computer Aided Pipe Flexibility

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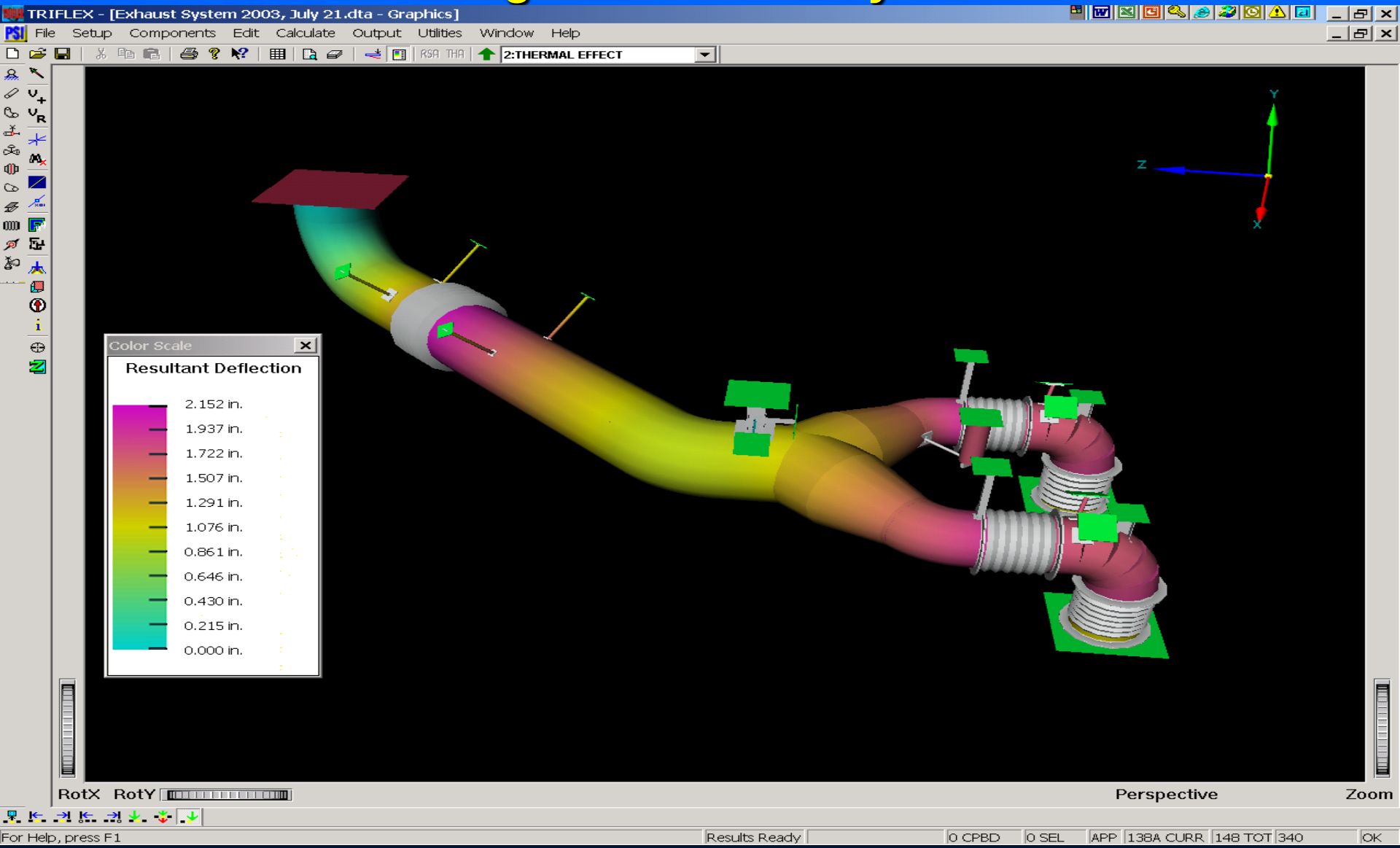

Computer Aided Pipe Flexibility
Thermal Effect

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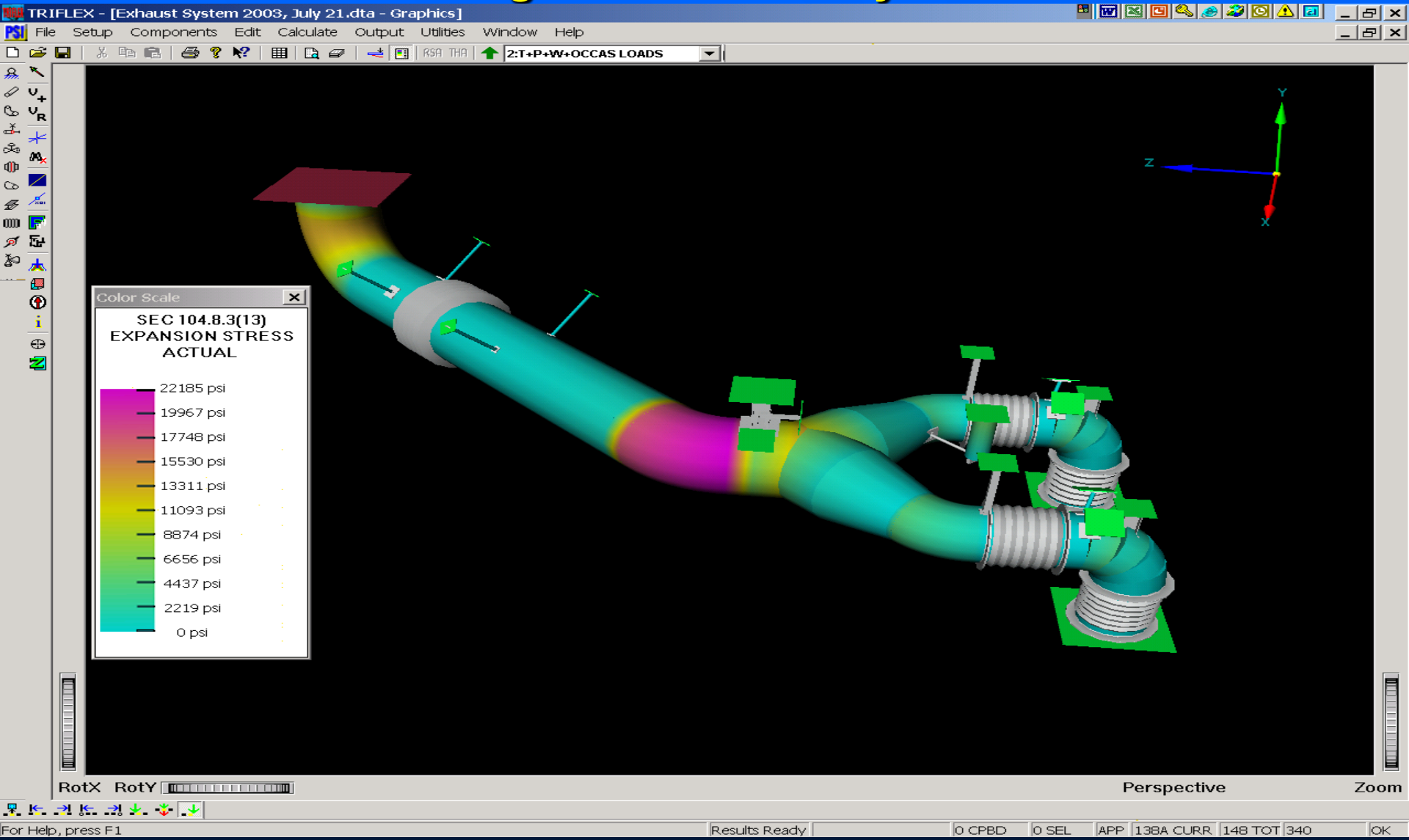

Computer Aided Pipe Flexibility
Thermal Pressure and Weight

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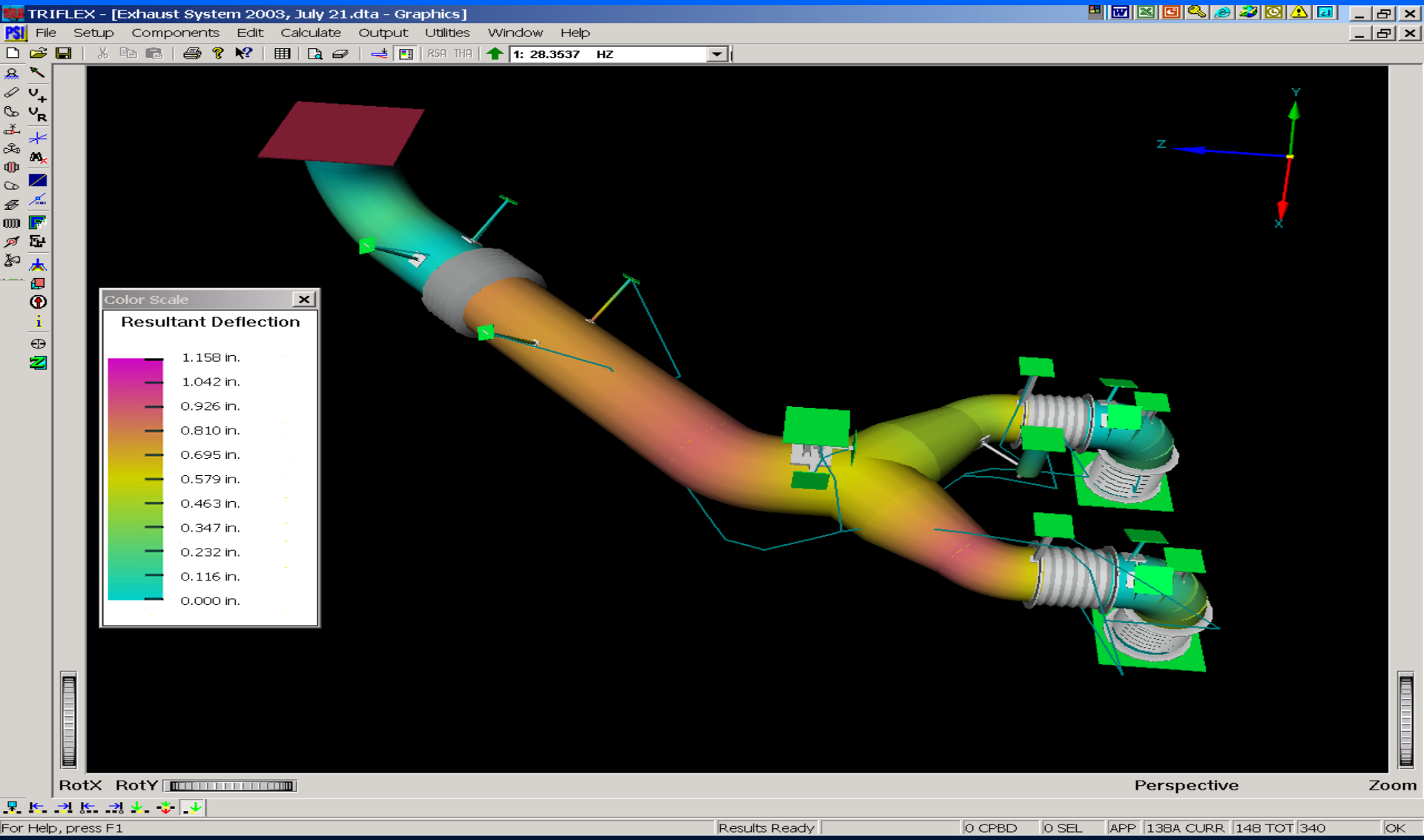

Computer Aided Pipe Flexibility Vibration

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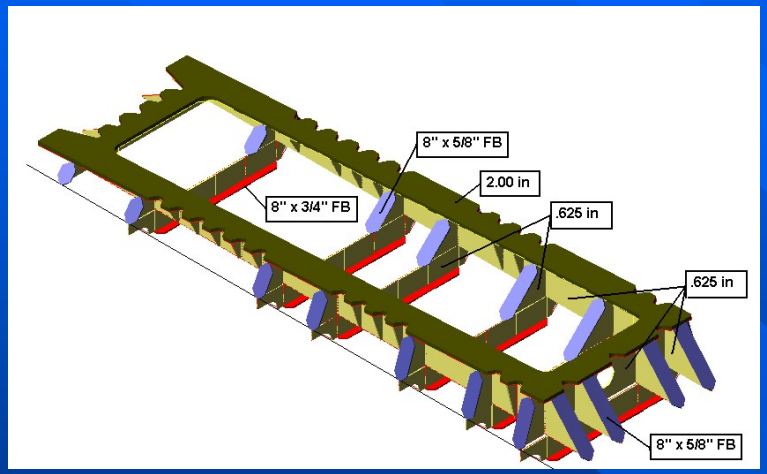
Applications of a CAD System

Weight

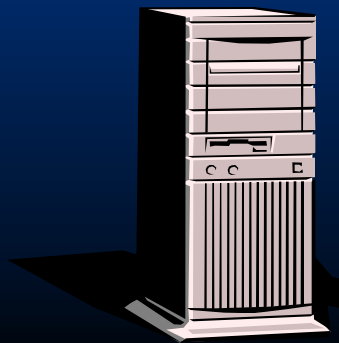
CAD



Extract Entity Attributes
Center of Gravity, Area, Lengths

Weight Database
Description, Unit Weight, Weight Class

Weight Reporting Database Main Frame



CAD Design in Modern Day Products

Applications of a CAD System

Ability to Interface with Vendor Data

Wheelbarrows 269

Light Duty Wheelbarrows

Utility Model—Light duty wheelbarrow for industrial grounds-keeping and hauling of small parts.
All steel construction with 20 gauge tray that has a rolled under flange and smooth wrinkle free corners. Seamless tubular handle and legs. Rust resistant graphite bearing tire never needs oiling. Shipped K.D.

Contractors Model—Has kiln dried hardwood handles and wedges with smooth varnish finish. Handles are bolted to a leakproof, one piece, heavy gauge steel tray.
Specially designed nose piece provides extra rigidity and better dump gripping.
Rolls on sealed ball bearing, 3ply pneumatic tired wheel.
Wheelbarrow is shipped knocked down.

Cap. Cu. Ft. Heaped	Tray Size LxWxD	Wheel Size	No.	NET EACH
UTILITY MODEL WITH SEMI-PNEUMATIC WHEEL				
3	32"x25"x9"	...10"x1.75"	2802T14	$31.08
CONTRACTORS MODEL WITH PNEUMATIC WHEEL				
5⅛	36"x28"x11"	...16"x4.00"	2323T14	$120.30
6	38⅛"x28⅛"x13"	...16"x4.00"	2323T16	129.70

Utility Model

Contractors Model

Seamless Pressed Tray Barrows

One piece tray of deep drawn, 16 gauge sheet steel. Tray will not leak. No seams rivets or welds. Glide rings let shovel glide over bolt-heads without sagging. Shipped K.D.
Wide spread legs of channel steel prevent tipping. Legs fully braced and riveted. Shoes resist wear. Reinforced edge. Perfect rolled edge adds stability and strength. No sharp edges to injure personnel. Rounded nose for fast, controlled pouring. Strong steel braces.

Steel Frame Model—A single length of strong steel rectangular tubing. Serves as wheel mount and guard. Has extra long handles.
Wood Frame Model—Hardwood handles. Wrap-around steel wheel guard. Risers for balance and proper wheeling.
Steel Wheels—For heaviest loads. Plain bearing, 16"x1¾". Pneumatic Wheels—Ball bearing, 16"x4.00"-8. Semi-Pneumatic Wheels—Oil lube. Zero pressure; puncture proof, 15"x4.00".

Cap. Cu. Ft. Heaped	Overall LxWxH	Steel No.	Steel NET EA.	Pneumatic No.	Pneumatic NET EA.	Semi-Pneumatic No.	Semi-Pneumatic NET EA.
STEEL FRAME MODEL							
4½	62"x27¾"x26"	2766T1	$125.10	2766T9	$140.42	2766T3	$140.42
5	62"x27¼"x26¾"	2766T4	131.06	2766T5	125.83	2766T8	146.36
WOOD FRAME MODEL							
4½	62"x27¾"x26"	2767T1	$120.25	2767T2	$115.02	2767T3	$135.58
5	62"x27¼"x26¾"	2767T4	127.40	2767T5	122.17	2767T6	142.73

Steel Frame Model

Wood Frame Model

Leakproof Folded Tray Barrows

Perfectly designed to put 80% of the load on the wheel. Durable 16-ga. steel tray with double lapped welded corners. Rolled tray rim is reinforced with butt-welded steel rod. Tray front is fully braced to frame and all-welded steel channel legs are fully braced. Ideal for wet or dry material handling. Choice of self-lube bearing wheels: 4.00x8 4-ply pneumatic, or 16x4.00 puncture proof semi-pneumatic.

Meets U.S. Government Spec. KKK-291E Dec. 21, 1976. Shipped K.D.
Steel Frame Model—Handle, frame and wheel guard are one continuous length of 1" standard steel pipe. "U" shaped wheel guard permits easy dumping.
Wood Frame Model—Selected straight, even grained smoothed hardwood. Tray wedges and cross brace of same material. Steel wheel guard for easy dumping.

Cap. Cu. Ft. Heaped	Overall LxWxH	Pneumatic No.	Pneumatic NET EA.	Semi-Pneumatic No.	Semi-Pneumatic NET EA.
STEEL FRAME MODEL					
5.00	59"x27⅛"x28⅛"	2768T1	$140.02	2768T2	$155.75
5.78	59½"x27¼"x28¼"	2768T3	151.56	2768T4	177.28
WOOD FRAME MODEL					
5.00	61½"x27¼"x28¼"	2769T2	$122.72	2769T3	$161.06
5.78	62"x27¼"x29½"	2769T4	136.59	2769T5	172.60

Steel Frame Model

Wood Frame Model

Large Capacity Bulk Load Barrows

Balanced design permits easy tilting of heaviest loads. All welded 14-ga. steel tray bolted to tubular steel frame. Shipped knocked down.
Tray rim reinforced with continuous butt welded ⅝" rod. Length, 67". Width, 33". Height, 39".

Cap., Cu. Ft. Heaped Lvl.	Type	Wheel Size	No.	NET EA.
9.90	Steel	16"x2"	2786T1	$230.50
9.90	Pneumatic	16"x4.00-8	2786T2	223.38
9.90	Semi-Pneumatic	16"x4.00	2786T3	250.13

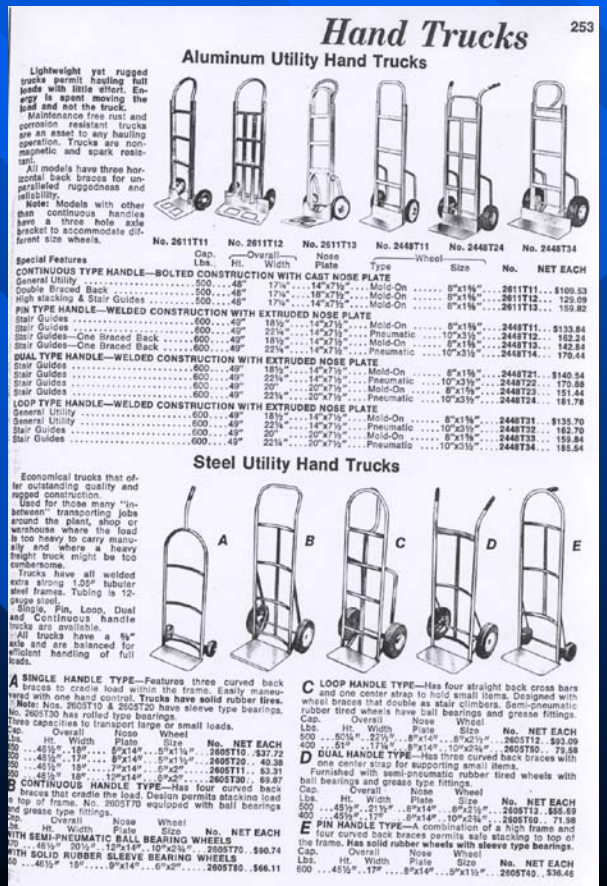
E-Z Fill Folding Clean Up Cart

Versatile cart performs clean up duties all year round and folds compactly to one fifth the size of conventional carts when not in use.
Sides, back, and front are rolled edge galvanized steel with a heavy duty ⅜" aluminum frame and a solid ½" steel axle. Green cart has a capacity of 160 pounds or 4.7 cu. ft. (level) and 6.5 cu. ft. (heaped). Rubber tired 10" dia. wheels with nylon bushings. Ship. wt., 39 lbs.
No. 2262T14. NET EACH $65.42

Big Boy Wheelbarrows

Two large wheels provide perfect balance and prevent accidental dumping. Designed for roofers. Braces have flat pads to protect roof. Curved steel plate in front of wheelbarrow also protects roof. Tray is 18 gauge steel. Designed for use on level terrain.
Wheels are 16"x4.80", mounted on 1" axle.

Cap. Cu. Ft.	Overall L x W x H	Pneumatic No.	Pneumatic NET EACH	Semi-Pneumatic No.	Semi-Pneumatic NET EACH
6	66"x26½"x31"	2262T12	$192.11	2262T14	$257.89



Hand Trucks 253

Aluminum Utility Hand Trucks

Lightweight yet rugged trucks permit hauling full loads with little effort. Energy is spent moving the load and not the truck.
Maintenance free rust and corrosion resistant trucks are an asset to any hauling operation. Trucks are non-magnetic and spark resistant.
All models have three horizontal back braces for unparalleled ruggedness and reliability.
Note: Models with other than continuous handles have a three hole axle bracket to accommodate different size wheels.

No. 2611T11 No. 2611T12 No. 2611T13 No. 2448T11 No. 2448T24 No. 2448T34

Special Features	Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate Type	Wheel Size	Wheel No.	NET EACH
CONTINUOUS TYPE HANDLE—BOLTED CONSTRUCTION WITH CAST NOSE PLATE							
General Utility	500	48"	17¼"	14"x7½"	Mold-On	8"x1⅝"	2611T11 $109.53
Double Braced Back	500	48"	17¼"	18"x7½"	Mold-On	8"x1⅝"	2611T12 129.09
High stacking & Stair Guides	500	48"	17¼"	14"x7½"	Mold-On	6"x1⅝"	2611T13 159.82
PIN TYPE HANDLE—WELDED CONSTRUCTION WITH EXTRUDED NOSE PLATE							
Stair Guides	600	49"	18½"	14"x7½"	Mold-On	8"x1⅝"	2448T11 $133.84
Stair Guides—One Braced Back	600	49"	22¼"	14"x7½"	Pneumatic	10"x3½"	2448T12 162.24
Stair Guides—One Braced Back	600	49"	18½"	14"x7½"	Mold-On	8"x1⅝"	2448T13 142.84
	600	49"	22¼"	14"x7½"	Pneumatic	10"x3½"	2448T14 170.44
DUAL TYPE HANDLE—WELDED CONSTRUCTION WITH EXTRUDED NOSE PLATE							
Stair Guides	600	49"	18½"	14"x7½"	Mold-On	8"x1⅝"	2448T21 $140.54
Stair Guides	600	49"	22¼"	14"x7½"	Pneumatic	10"x3½"	2448T22 170.88
Stair Guides	600	49"	20"	20"x7½"	Mold-On	8"x1⅝"	2448T23 151.44
	600	49"	22¼"	20"x7½"	Pneumatic	10"x3½"	2448T24 181.78
LOOP TYPE HANDLE—WELDED CONSTRUCTION WITH EXTRUDED NOSE PLATE							
General Utility	600	49"	18½"	14"x7½"	Mold-On	8"x1⅝"	2448T31 $135.70
General Utility	600	49"	22¼"	14"x7½"	Pneumatic	10"x3½"	2448T32 162.70
Stair Guides	600	49"	20"	20"x7½"	Mold-On	8"x1⅝"	2448T33 159.84
Stair Guides	600	49"	22¼"	20"x7½"	Pneumatic	10"x3½"	2448T34 185.54

Steel Utility Hand Trucks

Economical trucks that offer outstanding quality and rugged construction.
Used for those many "in-between" transporting jobs around the plant, shop or warehouse where the load is too heavy to carry manually and where a heavy freight truck might be too cumbersome.
Trucks have all welded extra strong 1.05# tubular steel frames. Tubing is 12-gauge steel.
Single, Pin, Loop, Dual and Continuous handle trucks are available.
All trucks have a ⅝" axle and are balanced for efficient handling of full loads.

A B C D E

A SINGLE HANDLE TYPE—Features three curved back braces to cradle load within the frame. Easily maneuvered with one hand control. Trucks have solid rubber tires.
Note: Nos. 2605T10 & 2505T20 have sleeve type bearings.
No. 2605T30 has rolled type bearings.
Three capacities to transport large or small loads.

Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate	Wheel Size	No.	NET EACH
400	46½"	18"	6"x14"	.5"x1¼"	2605T10	$37.72
500	46½"	17"	8"x14"	.5"x1¼"	2505T20	40.38
600	46½"	18"	7"x14"	.5"x2"	2605T11	53.31
600	46½"	18"	10"x14"	.6"x2"	2605T30	59.87

B CONTINUOUS HANDLE TYPE—Has four curved back braces that cradle the load. Design permits stacking load on top of frame. No. 2605T70 equipped with ball bearings and grease type fittings.

Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate	Wheel Size	No.	NET EACH
WITH SEMI-PNEUMATIC BALL BEARING WHEELS						
500	46½"	20½"	.12"x14"	.10"x2½"	2605T70	$90.74
WITH SOLID RUBBER SLEEVE BEARING WHEELS						
600	46½"	18"	.9"x14"	.6"x2"	2605T80	$66.11

C LOOP HANDLE TYPE—Has four straight back cross bars and one center strap to hold small items. Designed with wheel braces that double as stair climbers. Semi-pneumatic rubber tired wheels have ball bearings and grease fittings.

Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate	Wheel Size	No.	NET EACH
500	50¼"	22½"	.8"x14"	.8"x2½"	2605T12	$93.09
400	51"	17¾"	.8"x14"	.10"x2¾"	2605T50	79.98

D DUAL HANDLE TYPE—Has three curved back braces with one center strap for supporting small items.
Furnished with semi-pneumatic rubber tired wheels with ball bearings and grease type fittings.

Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate	Wheel Size	No.	NET EACH
500	45½"	21½"	.8"x14"	.8"x2½"	2605T13	$55.59
400	45½"	17"	.8"x14"	.10"x2¾"	2505T60	71.98

E PIN HANDLE TYPE—A combination of a high frame and four curved back braces permits safe stacking to top of the frames. Has solid rubber wheels with sleeve type bearings.

Cap. Lbs.	Overall Ht.	Overall Width	Nose Plate	Wheel Size	No.	NET EACH
600	45½"	17"	.8"x14"	.9"x1½"	2505T40	$36.46

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Applications of a CAD System

Facilitates the Use of Integrated Product Teams

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LESSONS LEARNED

- Choose a fully Developed CAD System for a Project
- Anticipate Significant Cost to Tailor a CAD System to your application
- Use a Proven CAD System
- Allow Significant Time for Design Development

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CONTUSIONS

3D CAD Lends Itself to Complicated Designs

2D CAD Lends Itself to Less Complicated Designs

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What Does the Future Bring?

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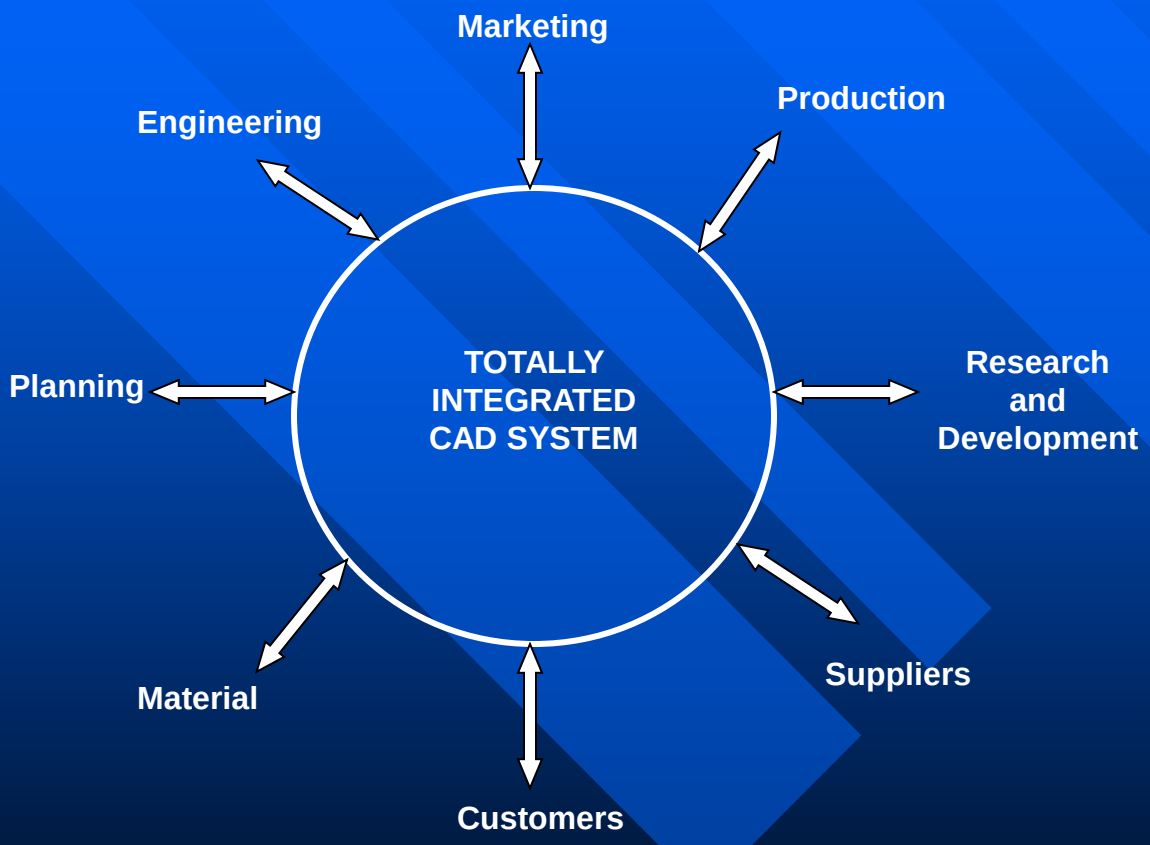
What Does the Future Bring?

- Expanded Use of the Databases
- Elimination of Paper Designs
- Complete Integration of CAD and CAE
- Virtual Reality and More

CAD Design in Modern Day Products

What Does the Future Bring?



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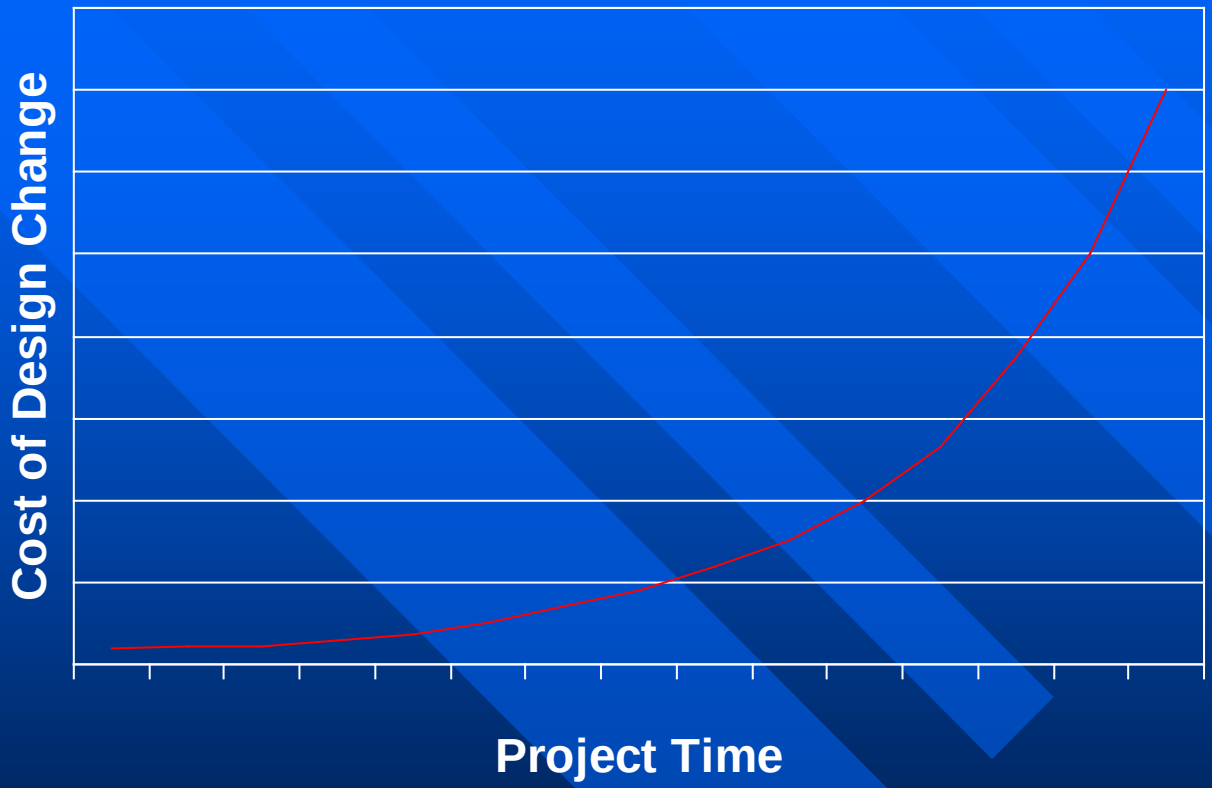

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