

Product/Process Design

Using

Horizontally Structured Modeling

and

Virtual Machining

- **Introduction**
- **Product Design Applications**
- **Manufacturing Applications**
- **Further CAD/CAM Developments**

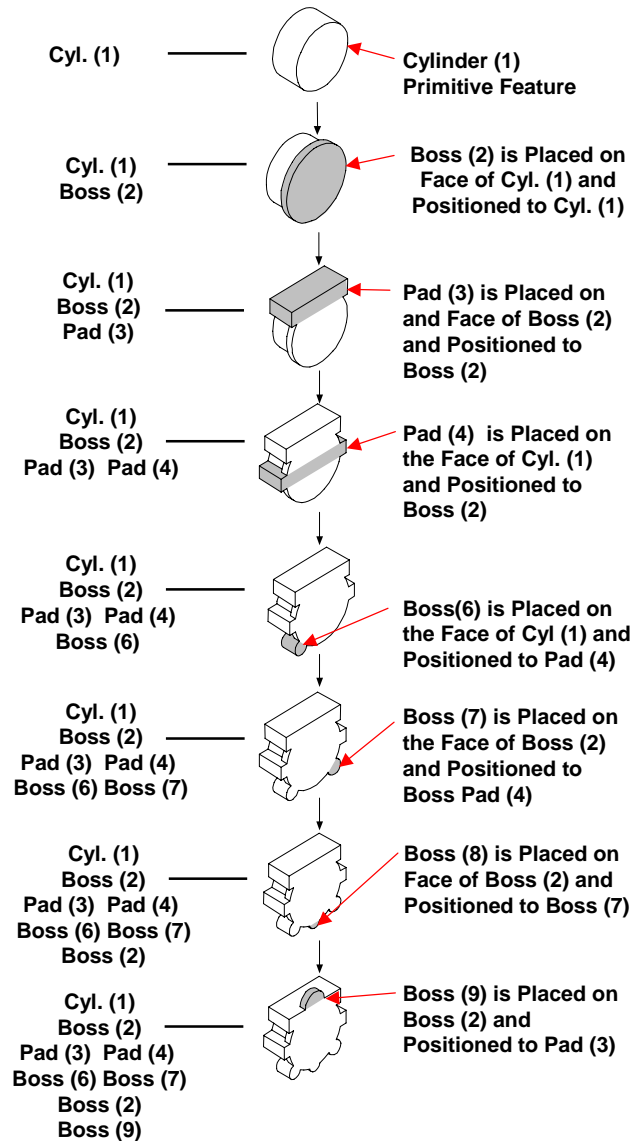
- Introduction
- **Product Design Applications**
- Manufacturing Applications
- Further CAD/CAM Developments

Product Design Applications

Traditional Feature Modeling Process

Documented in Software Training
Materials and Presentations

Feature Dependencies



Definition of Feature Dependency

**A Relationship Between Features that Defines
its Placement and Position to Other Features**

- Structural Features are Not Independent

Method:

- Create/Position Features on features

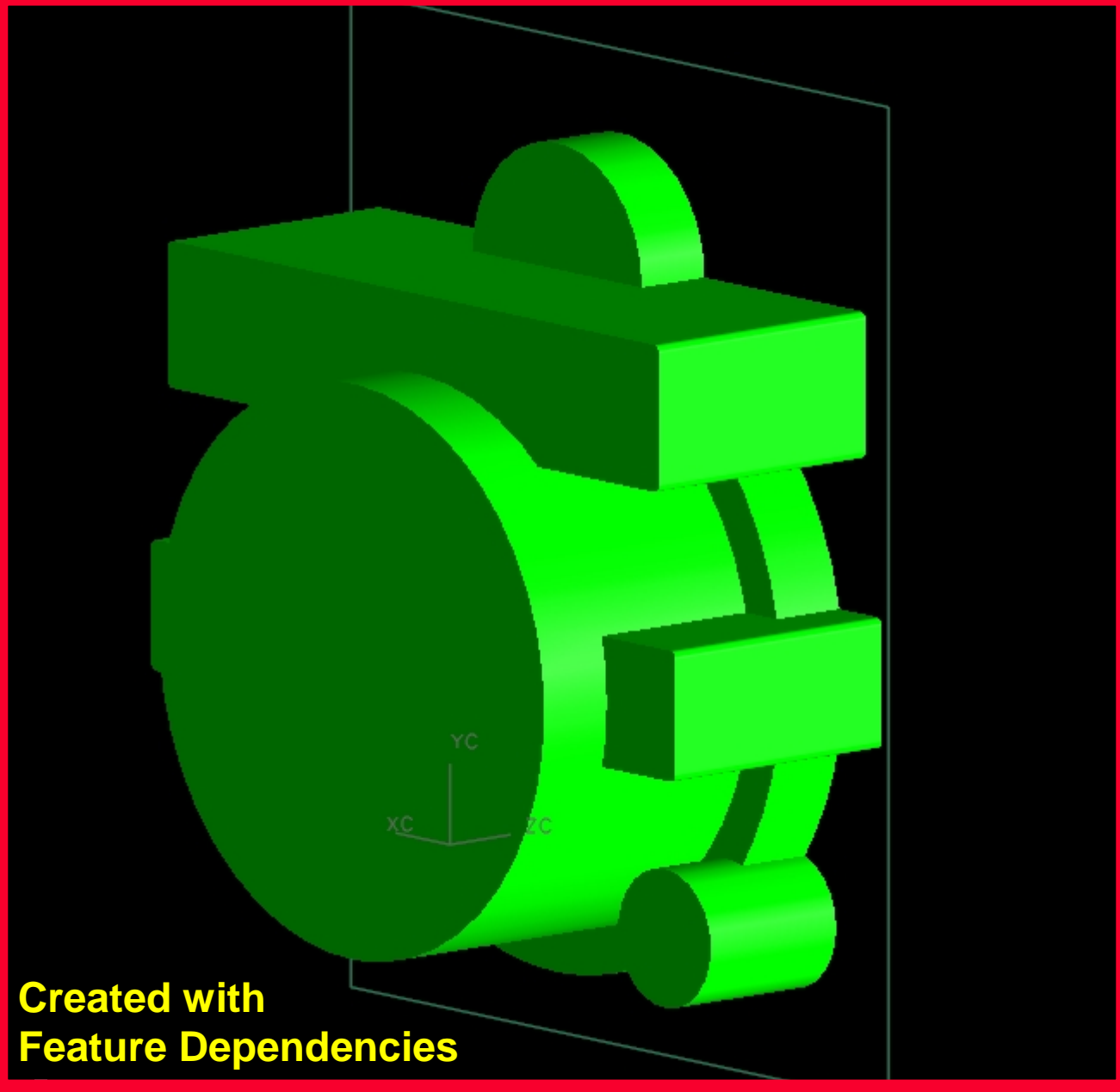
Limitations:

- Parent/Child Feature Dependencies
- Can NOT independently reorder, suppress or Delete features

Vertical Feature Modeling Demo

***Vertically
Structured
CAD Model***

**Recommended
by Commercial
CAD/CAM
Vendors**



**Created with
Feature Dependencies**

Product “Casting” Change

Demo Example

Function

Demonstration of **UNDESIRE**D results when editing a vertically structured model.

Scenario:

Product engineering has determined that the extra RIB material is no longer needed and must be removed.

Show

All

Filter

- RIB(0)
- CYLINDER(3)
- DATUM_PLANE(4)
- RECTANGULAR_PAD(5)
- RECTANGULAR_PAD(6)
- BOSS(7)
- CYLINDER(13)

Display Dimensions

Feature Dependency

Children Parent(s)

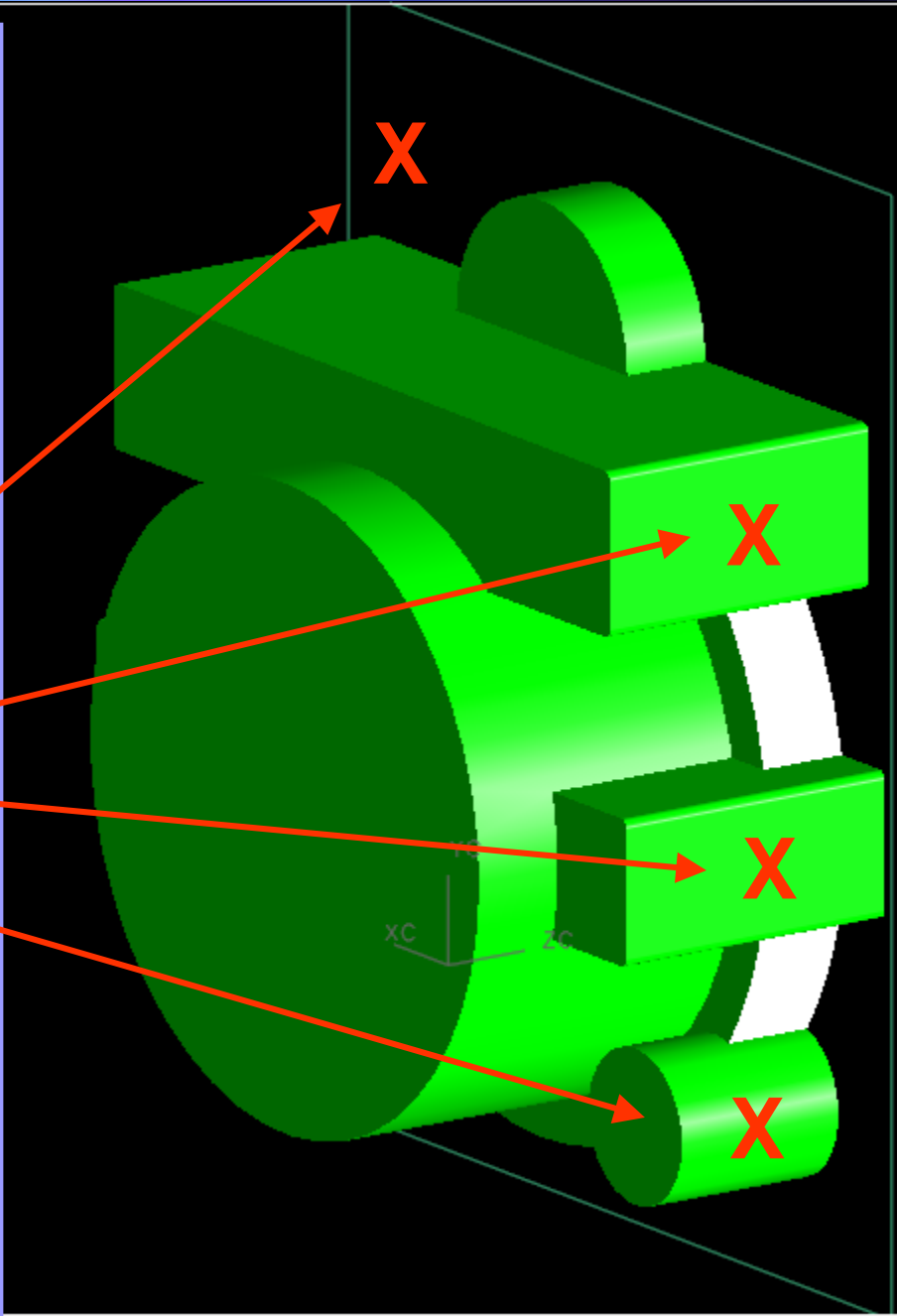
- DATUM_PLANE(4)
- RECTANGULAR_PAD(5)
- RECTANGULAR_PAD(6)
- BOSS(7)

List

Expressions

Update Status Report

Object Dependency Browse



DELETE RIB FEATURE



Model Navigator

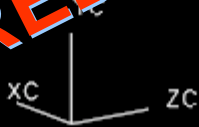
Feature Name

vertical_pumphs

- CYLINDER(3)
- CYLINDER(13)
- CYLINDER(14)



UNDESIRE RESULTS



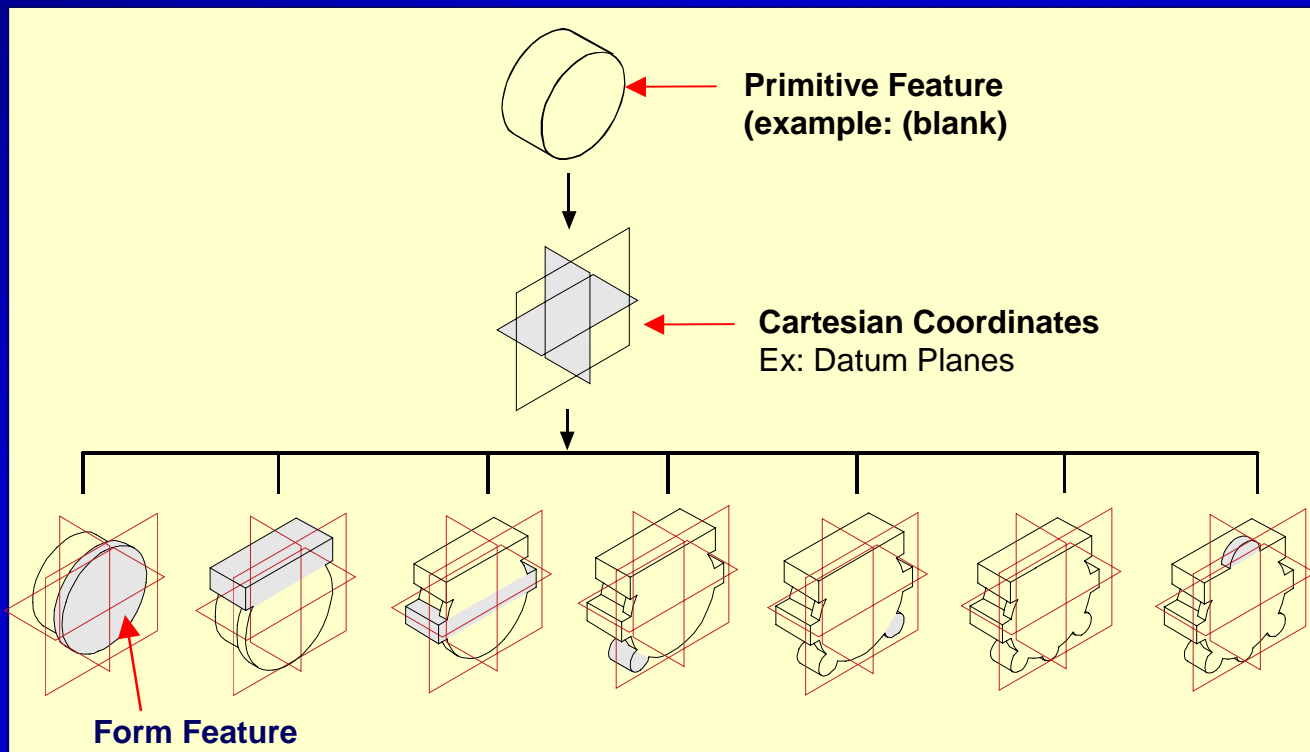
Horizontally Structured CAD/CAM Modeling

Delphi Methodology

- All features are placed on and positioned to datums
- ONLY Parent child relationship between features and datums

Benefits

- Enables easy feature manipulation
- Reorder features, remove features, add features

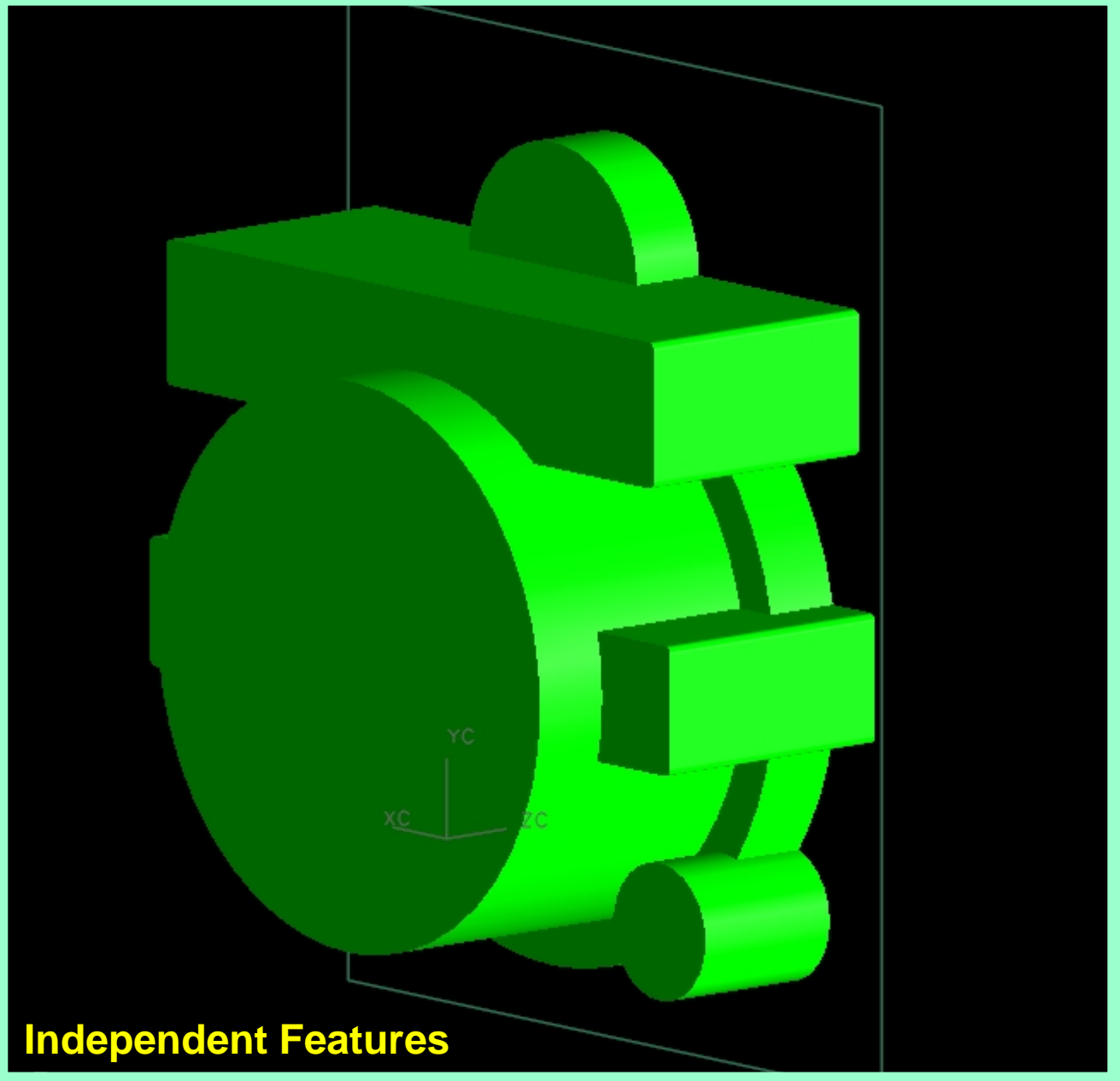


Horizontally - Structured Modeling Demo

Horizontally Structured CAD Model

Process
Developed by

DELPHI
Automotive Systems



Product “Casting” Change

Demo Example

Function

Demonstration of **DESIRED** results when editing a horizontally structured model.

Scenario:

Product engineering has determined that the extra RIB material is no longer needed and must be removed.

Show

All

Filter

*

CYLINDER(5)
FIXED_DATUM_PLANE(6)
FIXED_DATUM_PLANE(7)
FIXED_DATUM_PLANE(8)
RIB(9)
BOSS(10)
RECTANGULAR_PAD(12)

Display Dimensions

Feature Dependency

Children Parent(s)

List

Expressions

Update Status Report

Object Dependency Browse

Show

All

Filter

*

CYLINDER(5)
FIXED_DATUM_PLANE(6)
FIXED_DATUM_PLANE(7)
FIXED_DATUM_PLANE(8)
RIB(9)
BOSS(10)
RECTANGULAR_PAD(12)

Display Dimensions

Feature Dependency

Children Parent(s)

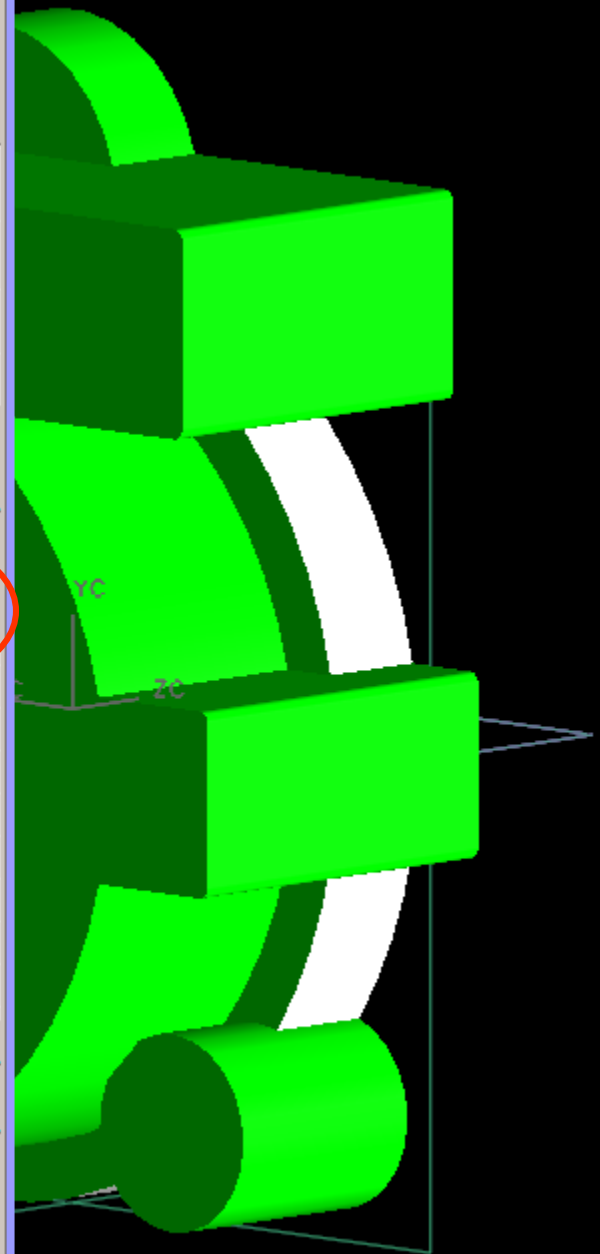
FIXED_DATUM_PLANE(6)
FIXED_DATUM_PLANE(7)
FIXED_DATUM_PLANE(8)

List

Expressions

Update Status Report

Object Dependency Browse












TOP

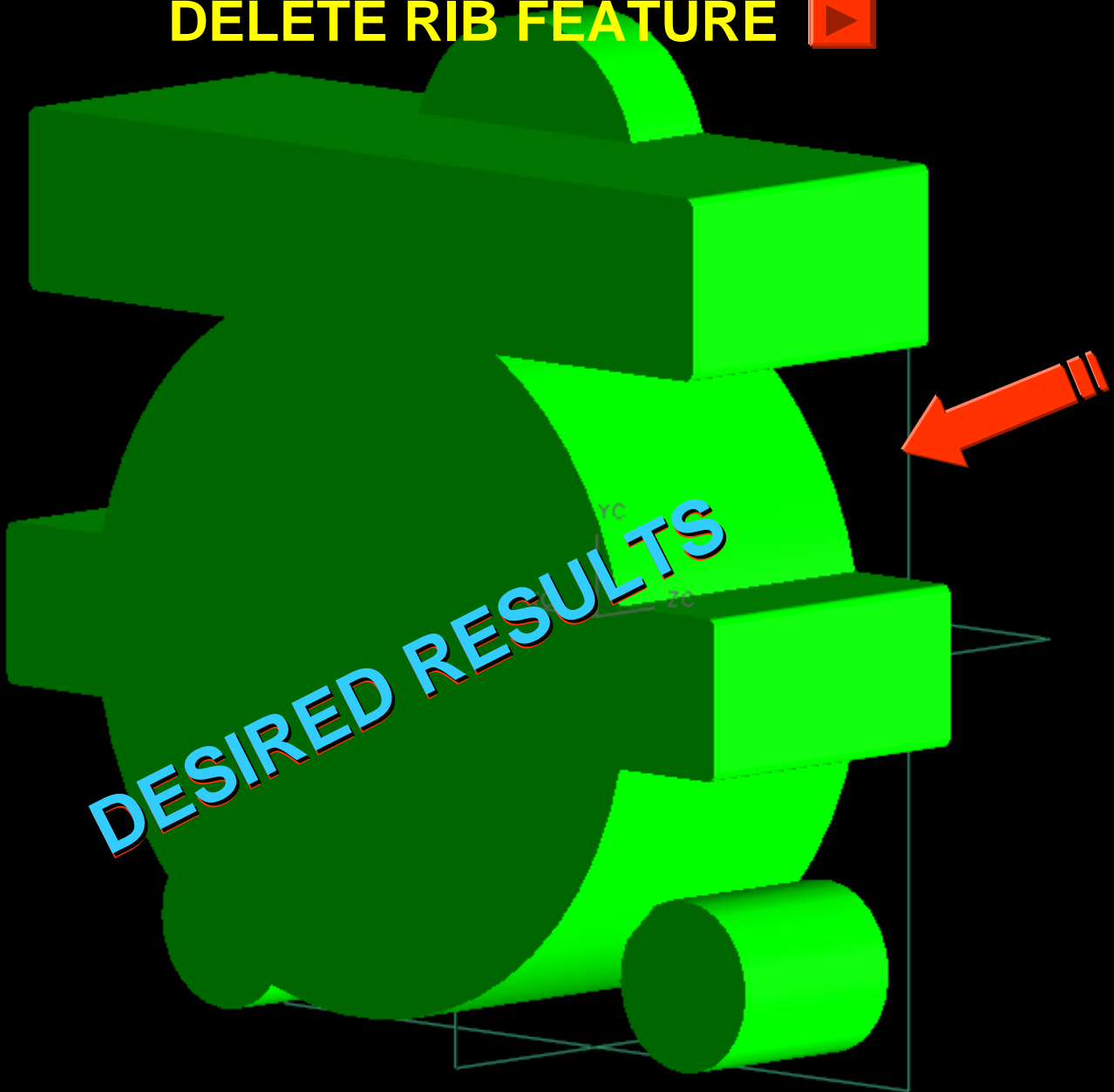
DELETE RIB FEATURE

Model Navigator

Feature Name

horizontal_pmpbs

-  CYLINDER(5)
-  FIXED_DATUM_PLANE(6)
-  FIXED_DATUM_PLANE(7)
-  FIXED_DATUM_PLANE(8)
-  BOSS(10)
-  RECTANGULAR_PAD(12)
-  RECTANGULAR_PAD(13)
-  BOSS(14)
-  BOSS(15)



DESIRED RESULTS



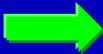
TOP WORK

Product Implementation Benefits

Product Design Activity CAD Operator Functions

Productivity Improvement Delphi Methodology

Total CAD Operators ~70

Create Models	20%		50% reduction
Detail Drawings	30%		- -
Edit Models	50%		90% reduction

- Increased Productivity
- Reduced Cost
- In-Sourced Work

- Introduction
- Product Design Applications
- **Manufacturing Applications**
- Further CAD/CAM Developments

HISTORY of the Process Sheet:

1. 2D CAD/CAM or Manual
2. Non Associative Models
3. Associative In-Process Models

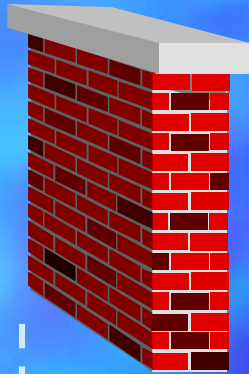
Manufacturing Engineering Integrated CAD/CAM Implementation

Previous Process (1)

Prior to 3D CAD/CAM

Product

3D CAD/CAM
SOLID
MODEL



Manufacturing

RE-CREATE
GEOMETRY
(2D CAD/CAM)

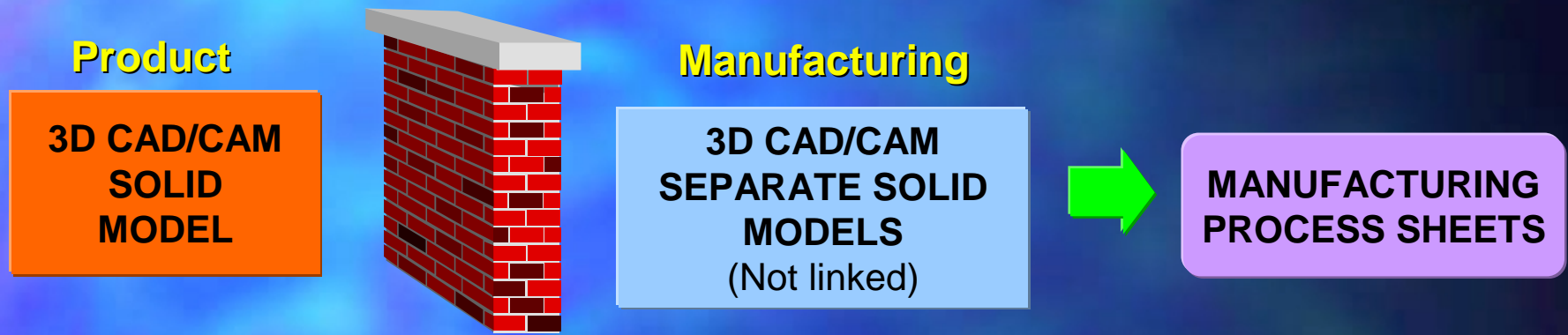


MANUFACTURING
PROCESS SHEETS

- Process Sheets work is done outside in 2D CAD/CAM
 - 3D CAD/CAM Costly
 - Complex to learn/use
 - Resulted in loss of data integrity

Manufacturing Engineering Integrated CAD/CAM Implementation

First 3D CAD/CAM Process (2)



- **Process Sheet work in 3D CAD/CAM**
 - Complex to learn/use
 - Cost disadvantage to Delphi
 - Redundant model creation
- Offered no real advantage
- Alternative method sought

Manufacturing Engineering Integrated CAD/CAM Implementation

New 3D CAD/CAM Process (3) - Virtual Machining

Product

3D CAD/CAM
PRODUCT
MODEL



MANUFACTURING
PROCESS SHEETS

BENEFITS

- Maintain Data Integrity
- Reduced Annual Design Costs 50%
- Reduced Lead Time
- Control of Electronic Data

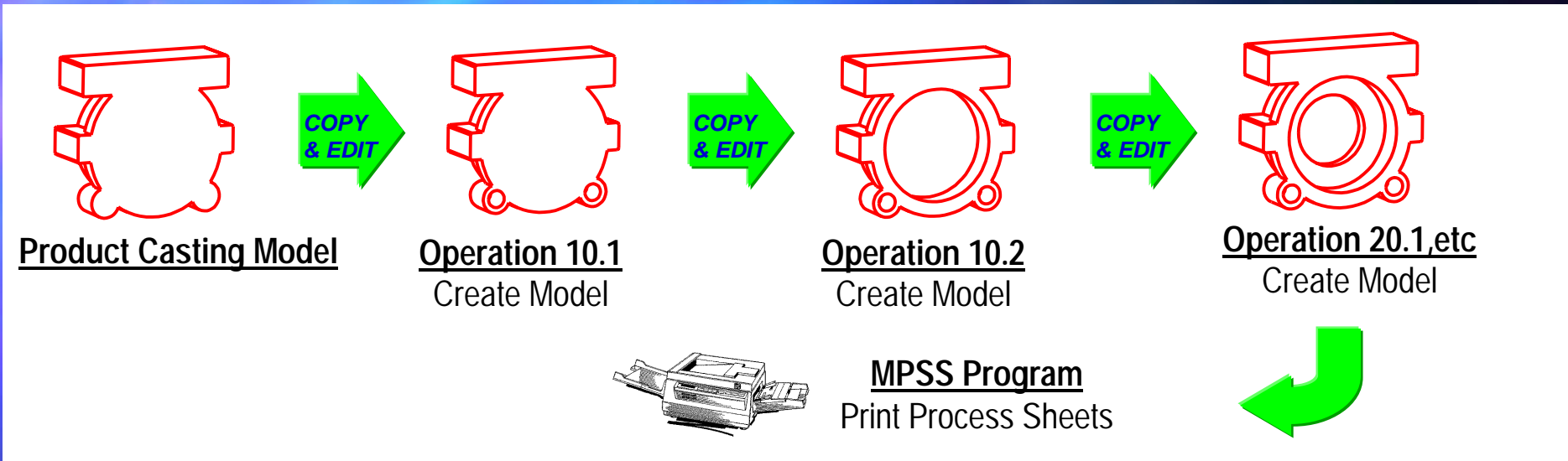
STATUS

- Implemented at all US Locations
- Implementing at Global Locations

Traditional 3D Process Modeling (2)

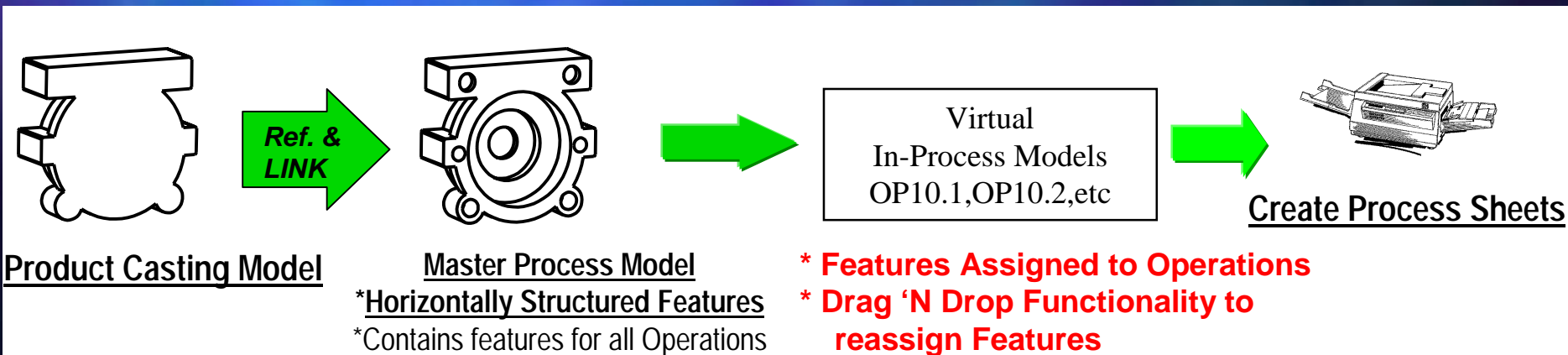
Ex: Multiple Files and Non Associative Solid In-Process Models

Manufacturing Process Modeling



Virtual Machining (3)- (requires horizontal modeling)

Ex: Single File with Associative Solid In-Process Models



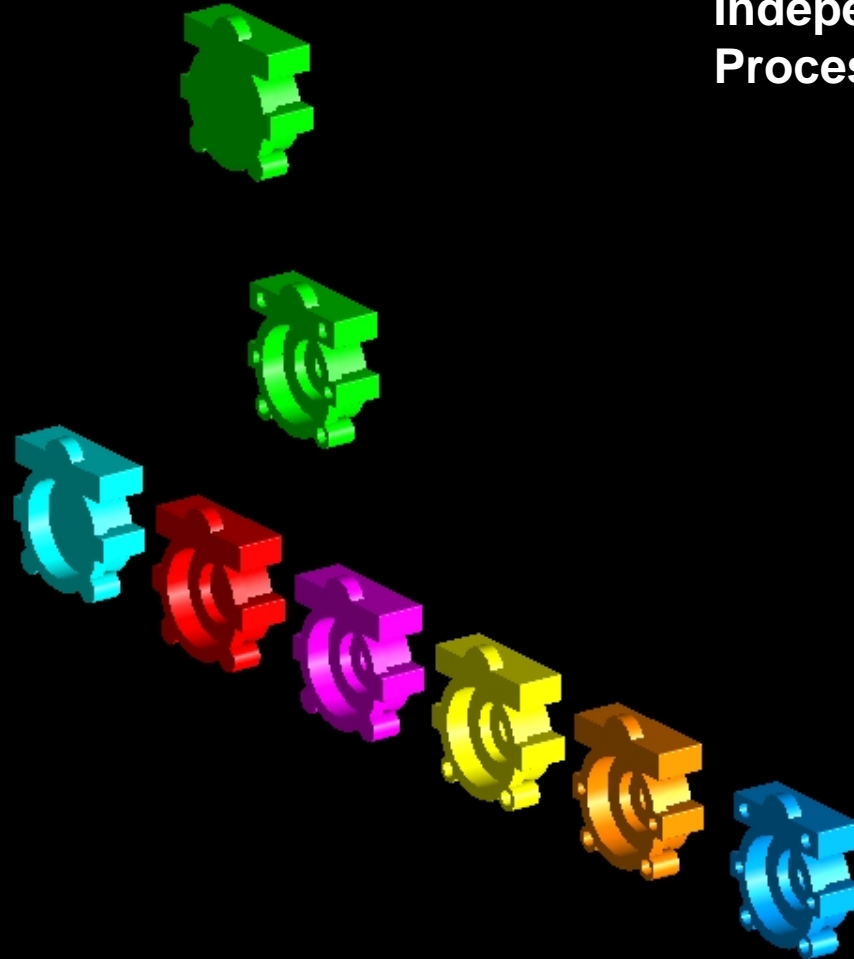
Virtual Manufacturing Process Modeling Demo

Virtual Machining Process Modeling

Developed by

DELPHI
Automotive Systems

Independent
Process Modeling



PART 1

Manufacturing Change

Demo Example

PART 1

Demonstration of how product model changes update the manufacturing process models and process sheets.

Scenario:

The size of the Casting BOSS changes.

What is a Process Sheet?

A QS9000 required set of process documentation depicting either a part being machined or assembled. This information is displayed on the manufacturing line for the operators reference.

CAPS
PART



DELPHI
Automotive Systems

SHT 1 OF 1

OP NO 001

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF

OPER.	STATION	DESCRIPTION
010	--	BORE MAJOR CENTER DIAMETER
020	--	BORE INTERMEDIATE DIAMETER
030	--	BORE MINOR DIAMETER
040	--	DRILL (2) HOLES IN LOWER BOSSES
050	--	DRILL (2) HOLES IN CENTER PADS
060	--	DRILL (2) HOLES IN UPPER PAD

Example of a Process Sheet

SO 2899-A DEC-98

See OP001 SHT 1 for LEC

REF PART NO.	--	CHART NO.	--	LEC	001	DATE	300C00	OPEN OP	--	THRU	--	MATL	--	SHT	1	OF	1	
OP NAME	SUMMARY SHEET							PART NO.	12345678			VERSION	MA	OP NO.	001			
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET																	
DELPHI SAGINAW STEERING SYSTEMS				PLANT	MDC	DEPT	--											

CAPS PART



DELPHI
Automotive Systems

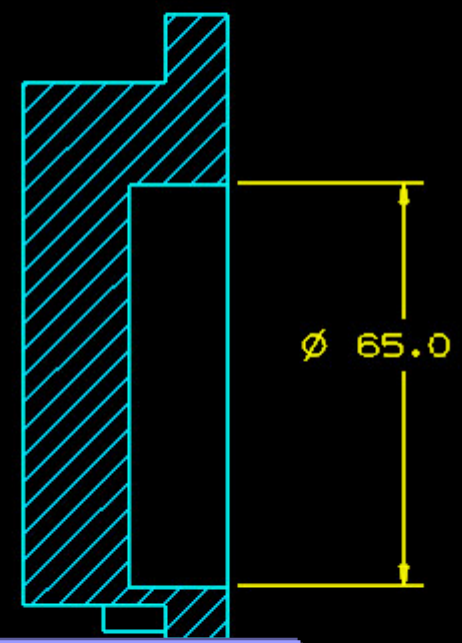
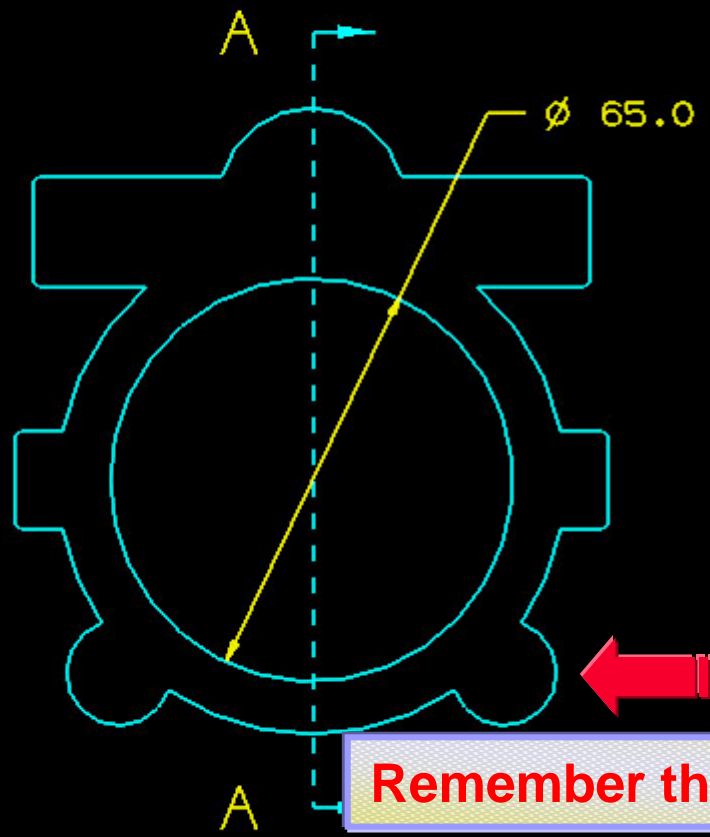
SHT 1 OF 1

OP NO 010

REFER TO DIVISIONAL PROCEDURE NO. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



Remember the size of this BOSS

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. . .	CHART NO. . .	LEC	DATE	OPEN OP	THRU 9	MATL	. .	SHT 1 OF 1
OP NAME BORE MAJOR CENTER DIAMETER				PART NO.		VERSION		OP NO.
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		010
DELPHI SAGINAW STEERING SYSTEMS			PLANT MDC	DEPT . .				

CAPS
PART



DELPHI
Automotive Systems

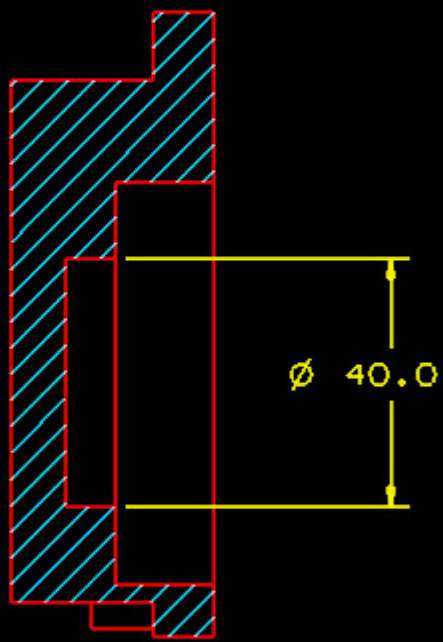
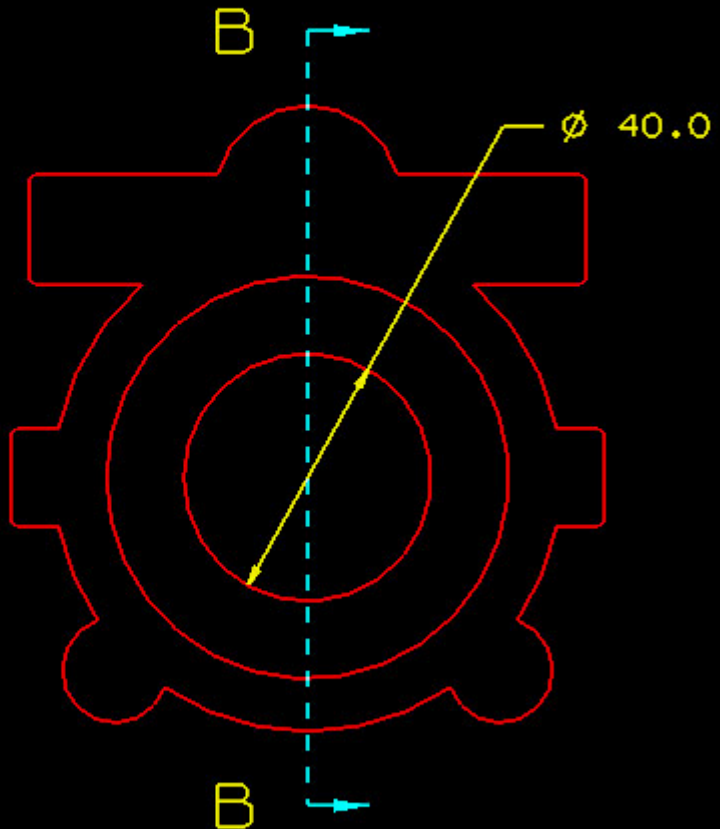
SHT 1 OF 1

OP NO 020

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION B - B

SD 2899-A DEC-98

See OP001 SHT 1 for LEC

REF PART NO. . .	CHART NO. . .	LEC	DATE	OPEN OP	11	THRU	19	MATL	. .	SHT	1	OF	1
OP NAME BORE INTERMEDIATE DIAMETER				PART NO.				VERSION		OP NO.			
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678				MA		020			
DELPHI SAGINAW STEERING SYSTEMS				PLANT MDC		DEPT . .							

CAPS
PART
DELPHI
Automotive Systems

SHT 1 OF 1

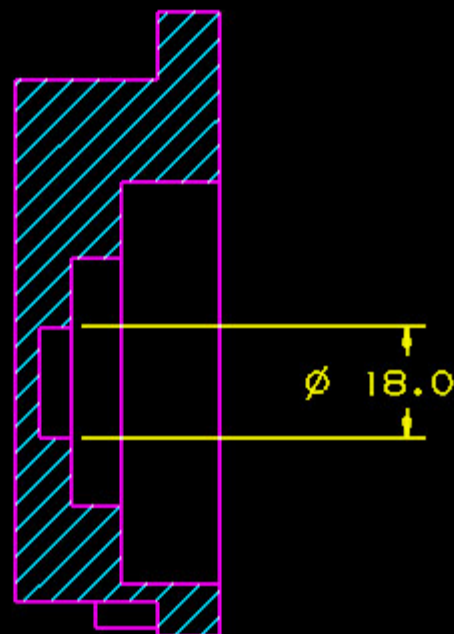
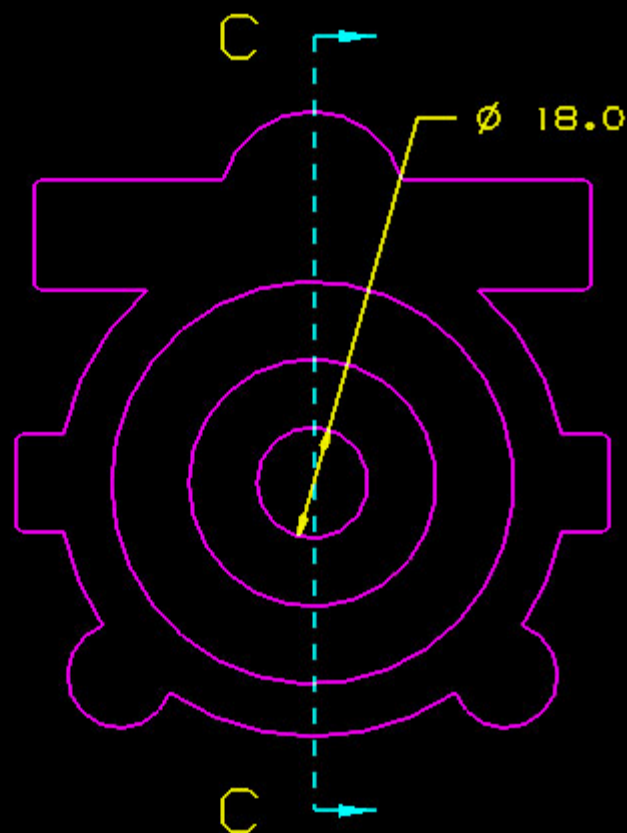
OP NO 030

REFER TO DIVISIONAL PROCEDURE No. 102

SD 2899-A DEC-98

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION C - C

See OP001 SHT 1 for LEC

REF PART NO. . .	CHART NO. . .	LEC	DATE	OPEN OP	21 THRU 29	MATL	. .	SHT 1 OF 1
OP NAME BORE MINOR DIAMETER				PART NO.		VERSION		OP NO.
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		030
DELPHI SAGINAW STEERING SYSTEMS			PLANT	MDC	DEPT	. .		

SH030.1 (DWG) -WBK

CAPS
PART

0303000
REVISIONS
DATE

DELPHI
Automotive Systems

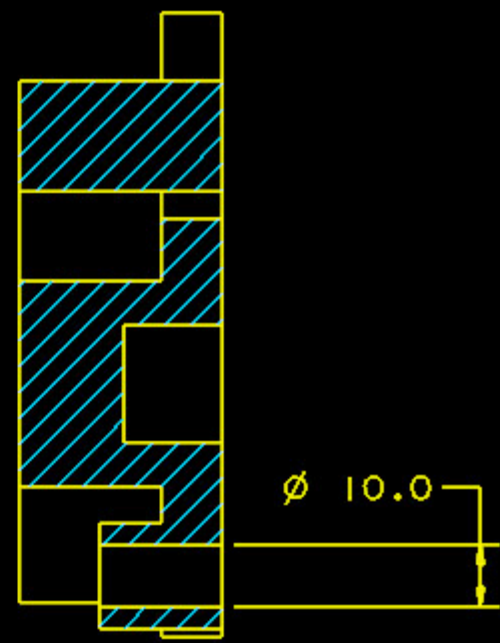
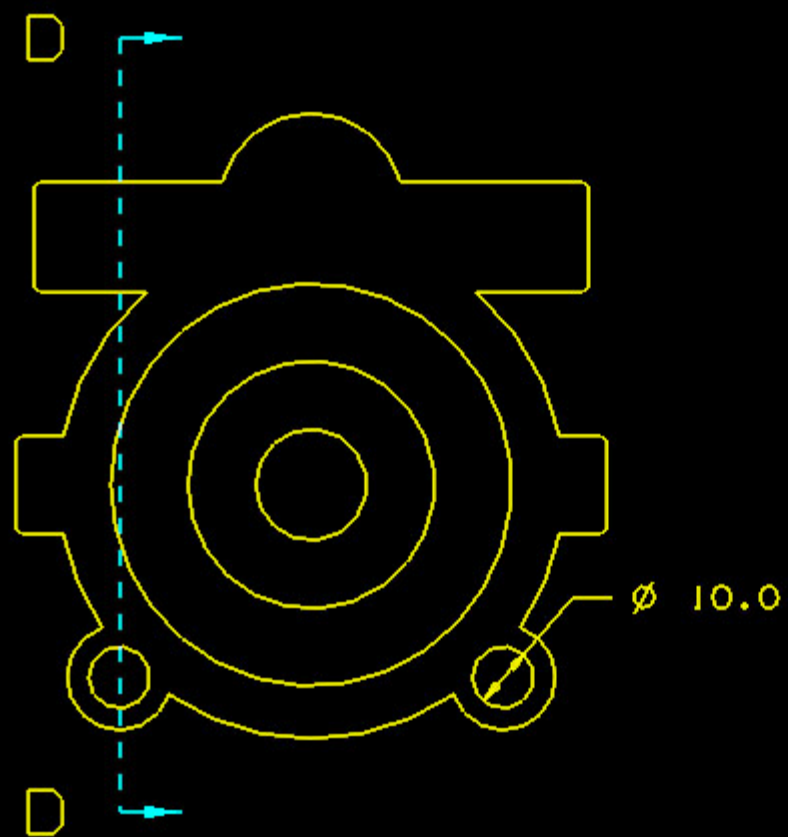
SHT 1 OF 1

OP NO 040

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION D - D

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO.	..	CHART NO.	..	LEC	DATE	OPEN OP	31	THRU	39	MATL	..	SHT	1	OF	1
OP NAME	DRILL (2) HOLES IN LOWER BOSSES					PART NO.	12345678					VERSION	MA 040		
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET														
DELPHI SAGINAW STEERING SYSTEMS				PLANT	MDC	DEPT	..								

CAPS
PART



DELPHI
Automotive Systems

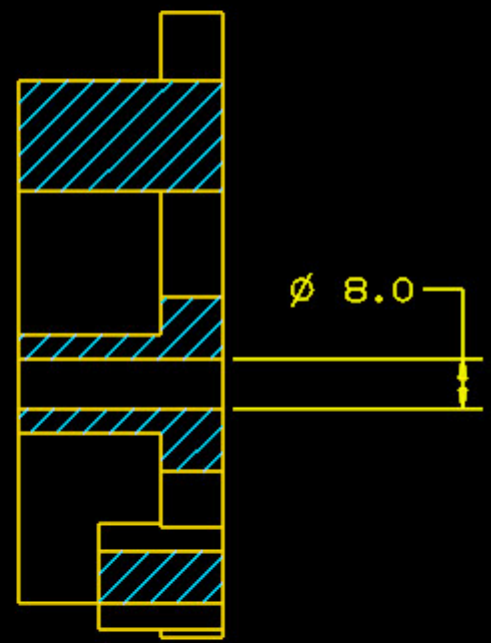
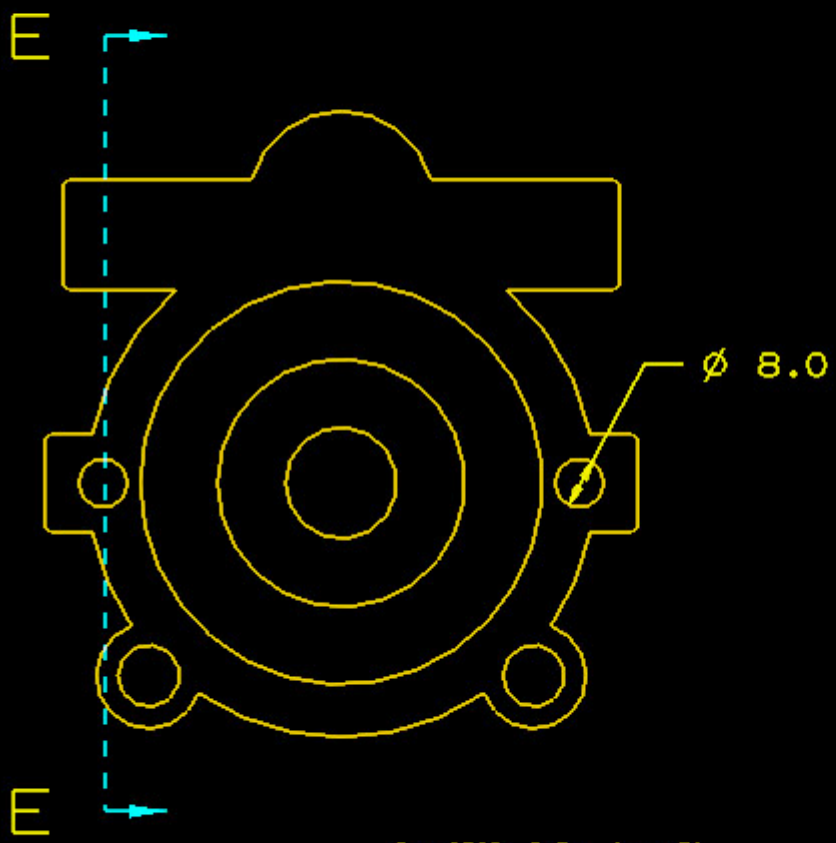
SHT 1 OF 1

OP NO 050

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION E-E

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. ..	CHART NO. ..	LEC	DATE	OPEN OP	41	THRU	49	MATL	..	SHT	1	OF	1
OP NAME				DRILL (2) HOLES IN CENTER PADS				PART NO.		VERSION		OP NO.	
PART NAME				VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		050	
DELPHI SAGINAW STEERING SYSTEMS				PLANT MDC		DEPT ..							

CAPS
PART



DELPHI
Automotive Systems

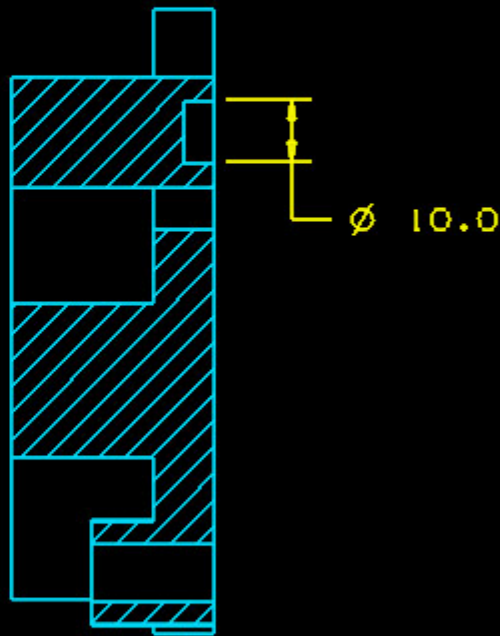
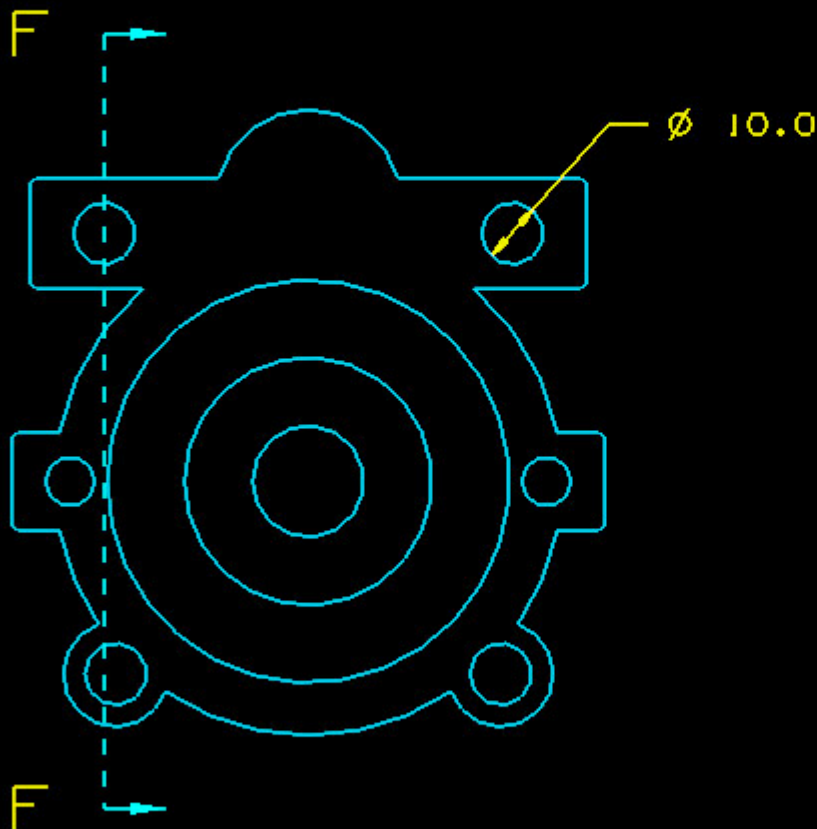
SHT 1 OF 1

OP NO 060

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION F - F

See OP001 SHT 1 for LEC

SO 2899-A DEC-98

REF PART NO.	..	CHART NO.	..	LEC	DATE	OPEN OP	51	THRU	59	MATL	..	SHT	1	OF	1	
OP NAME	DRILL (2) HOLES IN UPPER PADS						PART NO.	12345678			VERSION	MA	OP NO.	060		
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET															
DELPHI SAGINAW STEERING SYSTEMS				PLANT	MDC	DEPT	..									

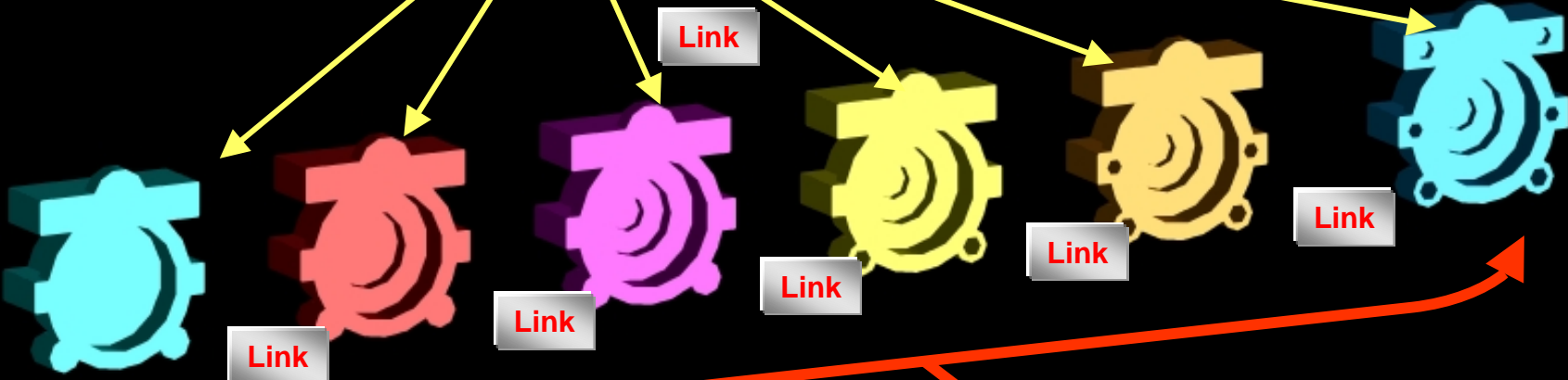
Product Casting



MASTER

Process Model

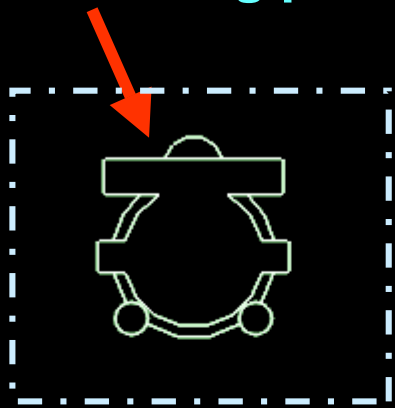
Contains all Machined Geometry



Process Models

- Created from the MASTER
- Linked to the MASTER and Each Other

Product Casting.prt



Change Work Part

Displayed Part

Choose loaded part

- vmds_cast
- vmds_concurrent
- vmds_study

Part name

vmds_cast

Select Owner

Select Component

OK Back Cancel



Production CASTING Change



Work Layer

Displayed Part: vmds_study.prt Work Part: vmds_cast.prt

Model Navigator

Feature Name

- vmds_cast
 - ✓ CYLINDER(0)
 - ✓ FIXED_DATUM_PLANE(13)
 - ✓ FIXED_DATUM_PLANE(14)
 - ✓ FIXED_DATUM_PLANE(15)
 - ✓ BOSS(16)
 - ✓ BOSS(17)
 - ✓ RECTANGULAR_PAD(18)
 - ✓ RECTANGULAR_PAD(19)
 - ✓ BOSS(20)
 - ✓ BOSS(21)

Feature Dialog
Reattach

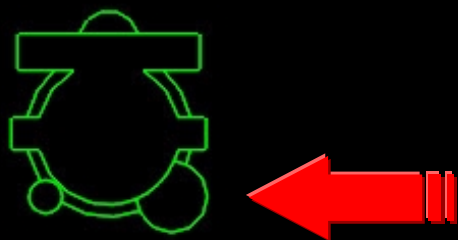
OK Back Cancel

Boss Feature

Production CASTING Change

TOP WORK

**Production CASTING
Change UPDATES ALL
Process Models
and Process Sheets**



OP10

OP20

OP30

OP40

OP50

OP60

CAPS
PART



DELPHI
Automotive Systems

SHT 1 OF 1

OP NO 001

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF

OPER.	STATION	DESCRIPTION
010	--	BORE MAJOR CENTER DIAMETER
020	--	BORE INTERMEDIATE DIAMETER
030	--	BORE MINOR DIAMETER
040	--	DRILL (2) HOLES IN LOWER BOSSES
050	--	DRILL (2) HOLES IN CENTER PADS
060	--	DRILL (2) HOLES IN UPPER PAD

CASTING Change UPDATED Process Sheet

SD 2899-A DEC-98

See OP001 SHT 1 for LEC

REF PART NO.	--	CHART NO.	--	LEC	001	DATE	300000	OPEN OP	--	THRU	--	MATL	--	SHT	1	OF	1	
OP NAME	SUMMARY SHEET							PART NO.	12345678			VERSION	MA	OP NO.	001			
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET																	
DELPHI SAGINAW STEERING SYSTEMS				PLANT	MDC	DEPT	--											

CAPS PART



DELPHI
Automotive Systems

SHT 1 OF 1

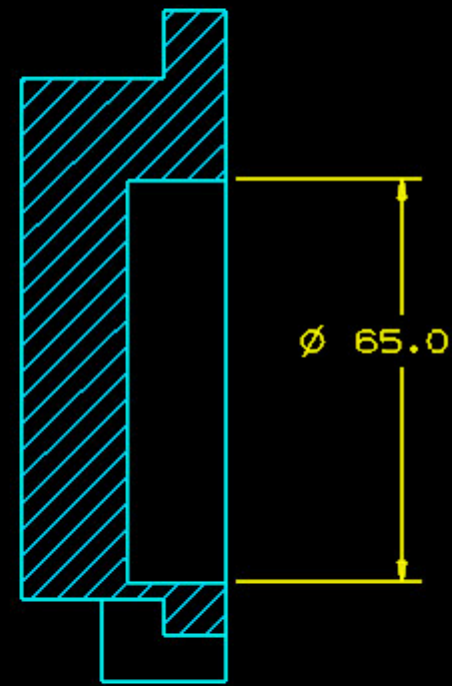
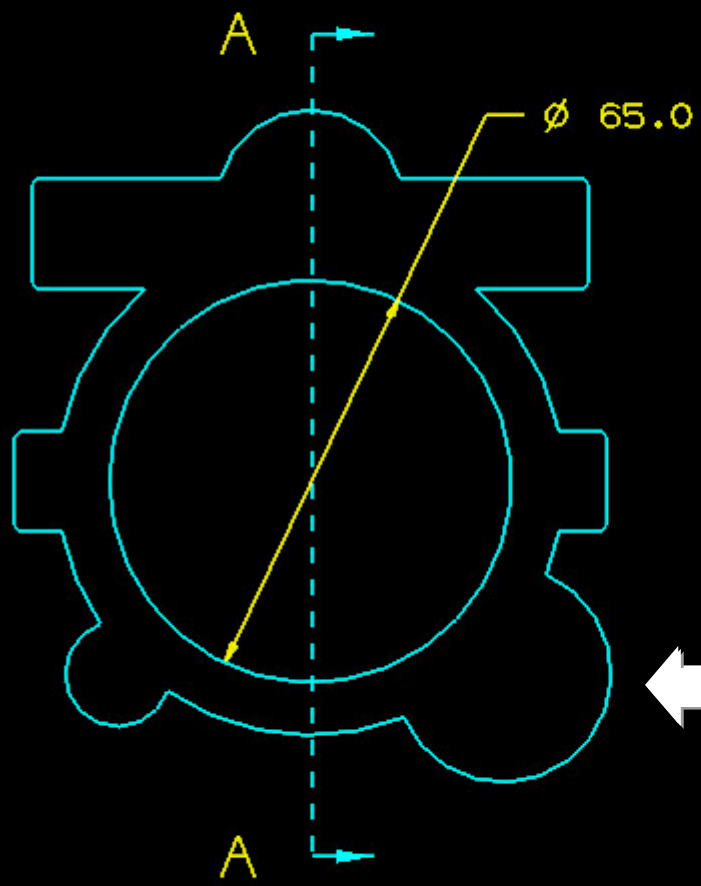
OP NO 010

REFER TO DIVISIONAL PROCEDURE NO. 102

SD 2899-A DEC-98

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION A - A

See OP001 SHT 1 for LEC

REF PART NO.	CHART NO.	LEC	DATE	OPEN OP	THRU	MATL	SHT	OF
OP NAME	BORE MAJOR CENTER DIAM			PART NO.	12345678		VERSION	OP NO.
PART NAME	VIRTUAL CONCURRENT PR						MA	010
DELPHI STEERING SYSTEMS								

UPDATED

SH010.1 (DWG) -WRBK

CAPS PART



DELPHI Automotive Systems

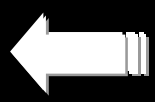
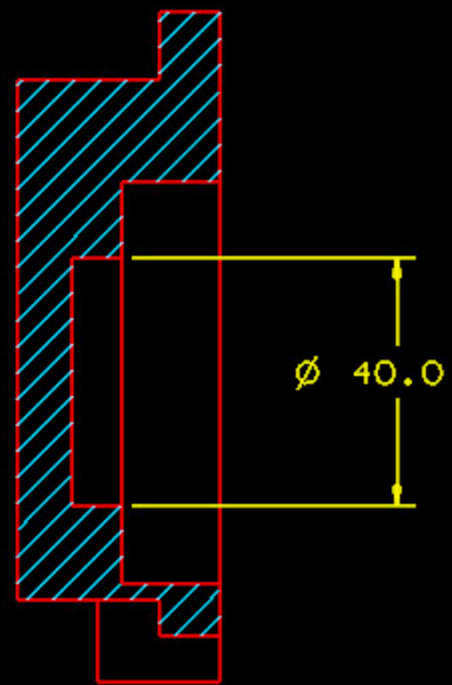
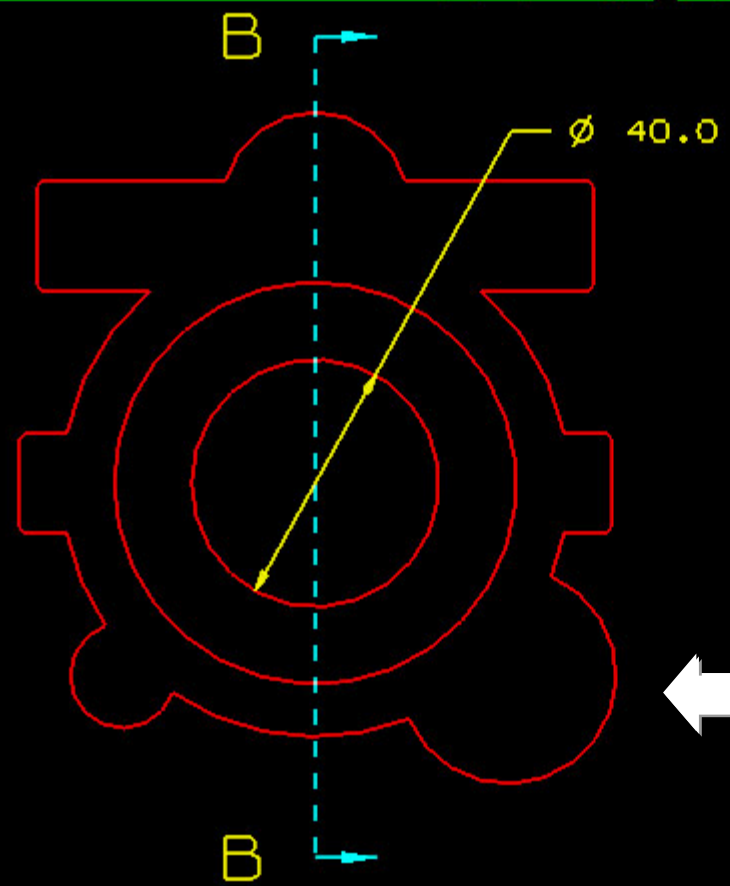
SHT 1 OF 1

OP NO 020

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION B-B

See OP001 SHT 1 for LEC

SO 2899-A DEC-98

REF PART NO. ..	CHART NO. ..	LEC	DATE	OPEN OP	11	THRU	19	MATL	..	SHT	1	OF	1
OP NAME BORE INTERMEDIATE DIAMETER				PART NO.				VERSION		OP NO.			
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678				MA		020			
DELPHI SAGINAW STEERING SYSTEMS				PLANT MDC		DEPT ..							

CAPS PART



DELPHI
Automotive Systems

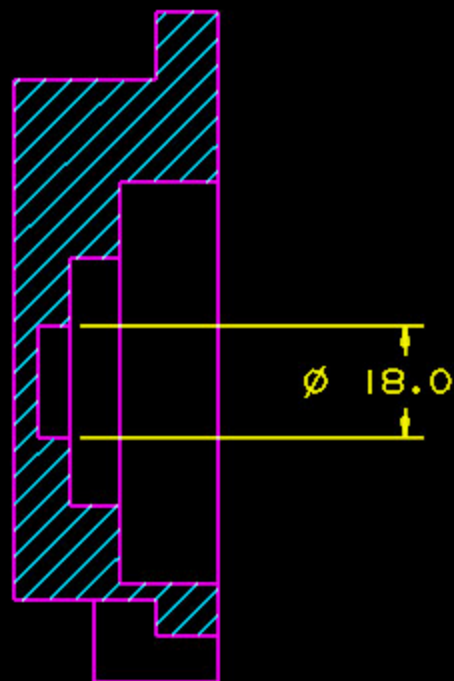
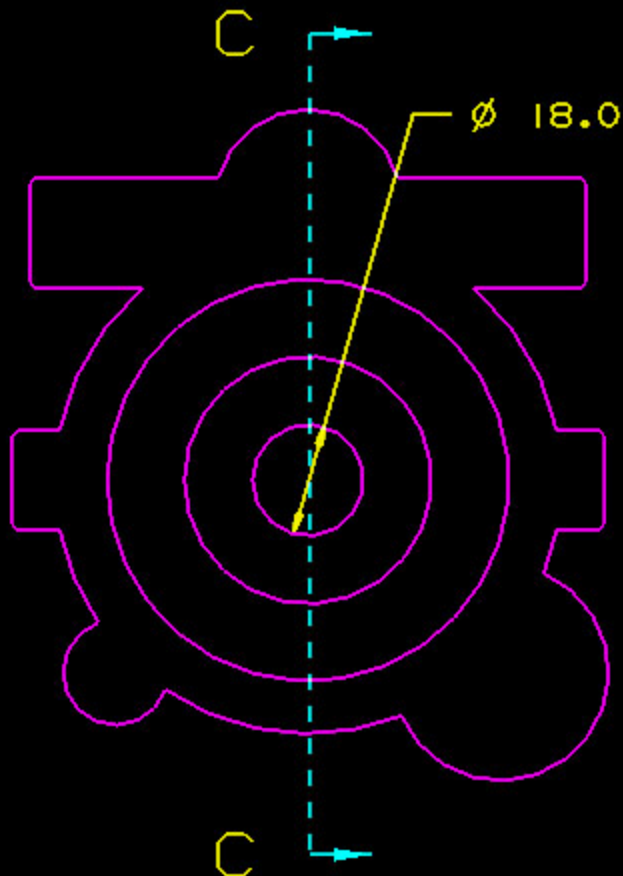
SHT 1 OF 1

OP NO 030

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION C - C

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. . .	CHART NO. . .	LEC	DATE	OPEN OP 21 THRU 29	MATL . .	SHT 1 OF 1
OP NAME BORE MINOR DIAMETER				PART NO. 12345678		VERSION MA
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				OP NO. 030		
DELPHI SAGINAW STEERING SYSTEMS			PLANT MDC	DEPT . .		

CAPS PART

0.003000
REVISIONS
DATE

DELPHI
Automotive Systems

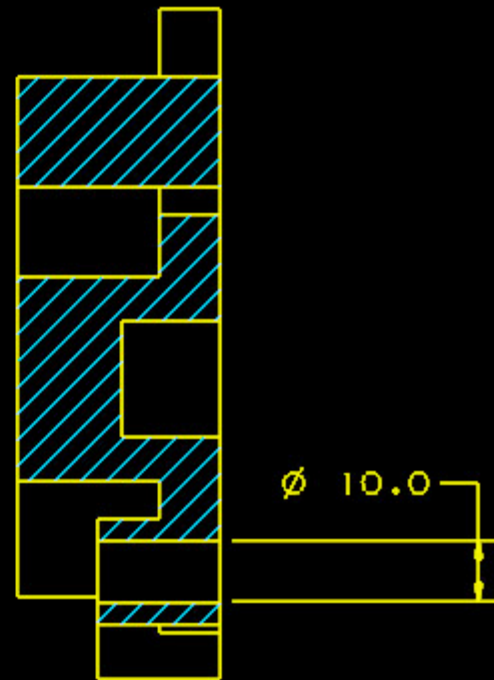
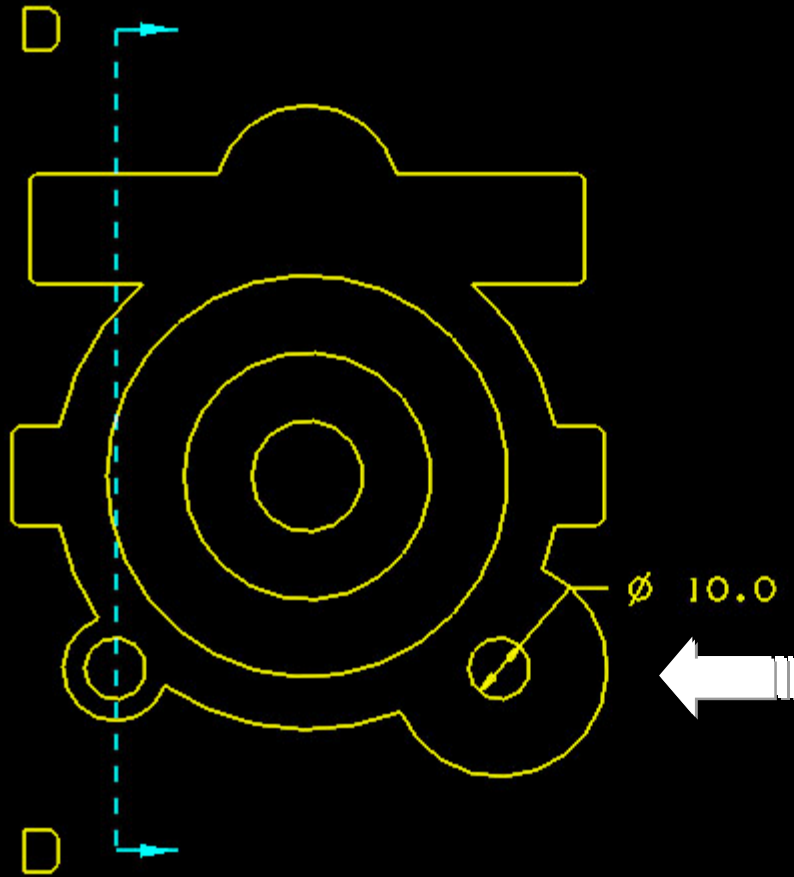
SHT 1 OF 1

OP NO 040

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION D - D

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. ..	CHART NO. ..	LEC	DATE	OPEN OP 31	THRU 39	MATL ..	SHT 1 OF 1
OP NAME DRILL (2) HOLES IN LOWER BOSSES				PART NO. 12345678		VERSION MA	OP NO. 040
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				PLANT MDC		DEPT ..	
DELPHI SAGINAW STEERING SYSTEMS							

CAPS
PART

0.0000
REVISIONS
DATE

DELPHI
Automotive Systems

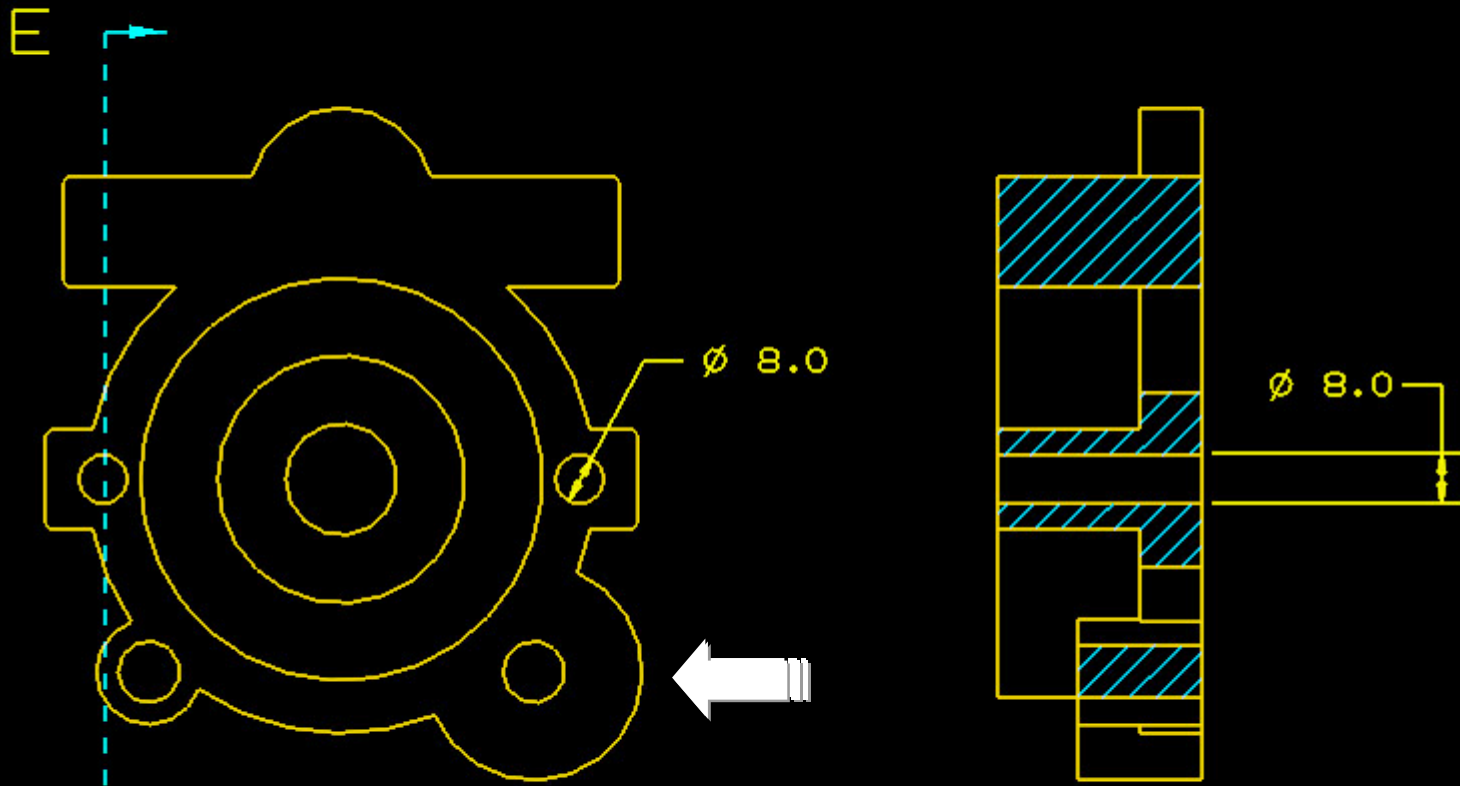
SHT 1 OF 1

OP NO 050

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION E - E

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO.	..	CHART NO.	..	LEC	DATE	OPEN OP	41	THRU	49	MATL	..	SHT	1	OF	1
OP NAME	DRILL (2) HOLES IN CENTER PADS					PART NO.	12345678			VERSION	MA	OP NO.	050		
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET					PLANT	MDC	DEPT	..						
DELPHI SAGINAW STEERING SYSTEMS															

CAPS PART

000000
REVISIONS
DATE

DELPHI
Automotive Systems

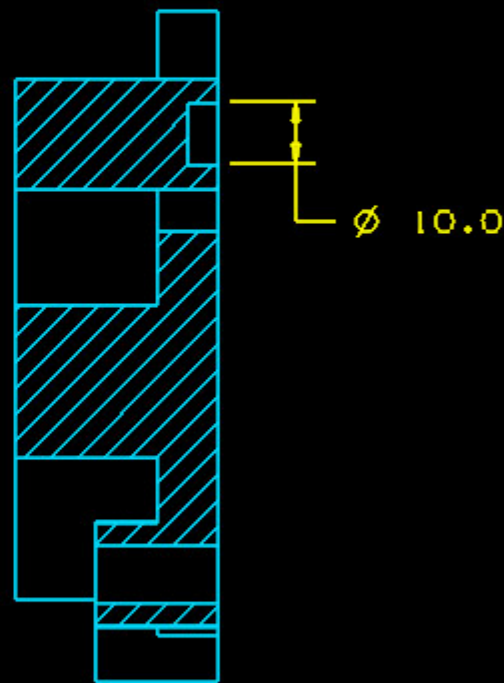
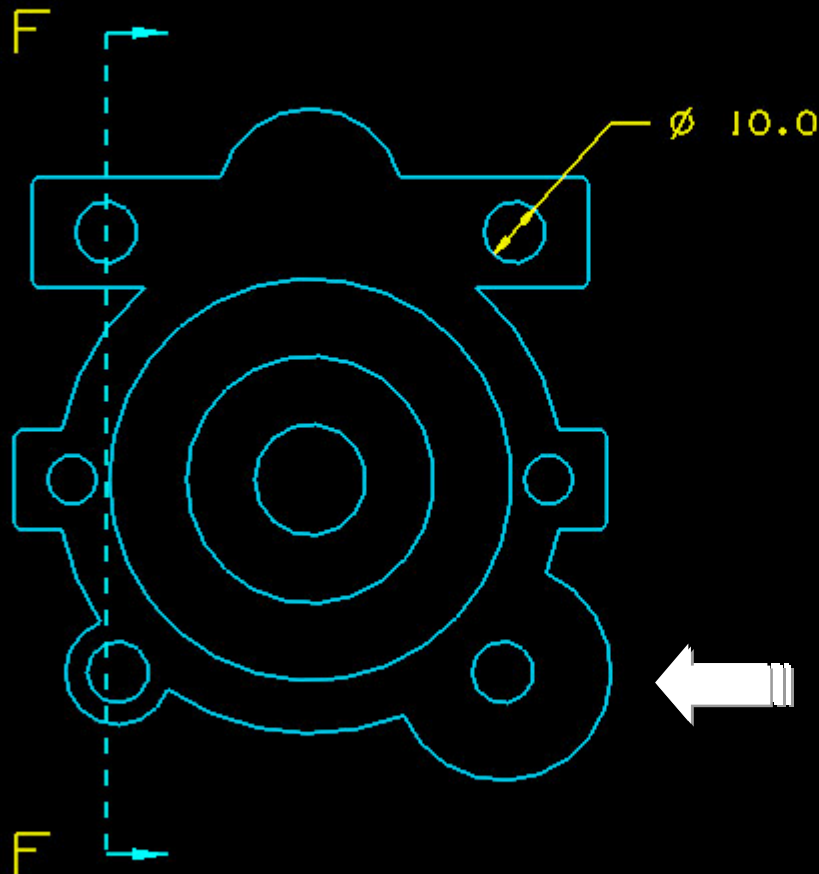
SHT 1 OF 1

OP NO 060

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	WF

SYM	REVISIONS	BY	CHK	DATE	WF



SECTION F - F

See OP001 SHT 1 for LEC

REF PART NO. ..	CHART NO. ..	LEC	DATE	OPEN OP	51 THRU 59	MATL	..	SHT 1 OF 1
OP NAME DRILL (2) HOLES IN UPPER PADS				PART NO.		VERSION		OP NO.
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		060
DELPHI SAGINAW STEERING SYSTEMS			PLANT MDC	DEPT	..			

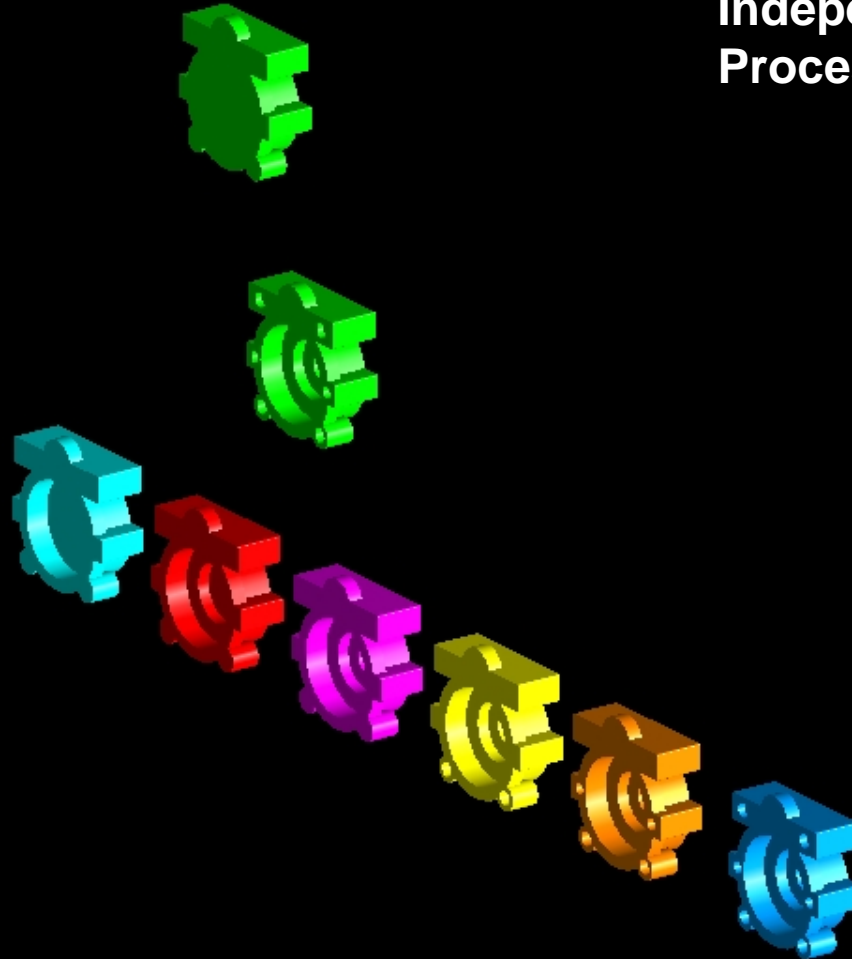
SD 2699-A DEC-98

Virtual Machining Process Modeling

Developed by

DELPHI
Automotive Systems

Independent
Process Modeling



PART 2

Manufacturing Change

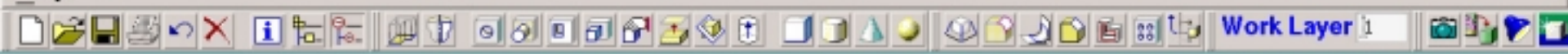
Demo Example

PART 2

Demonstration of how process changes update ALL process models and process sheets.

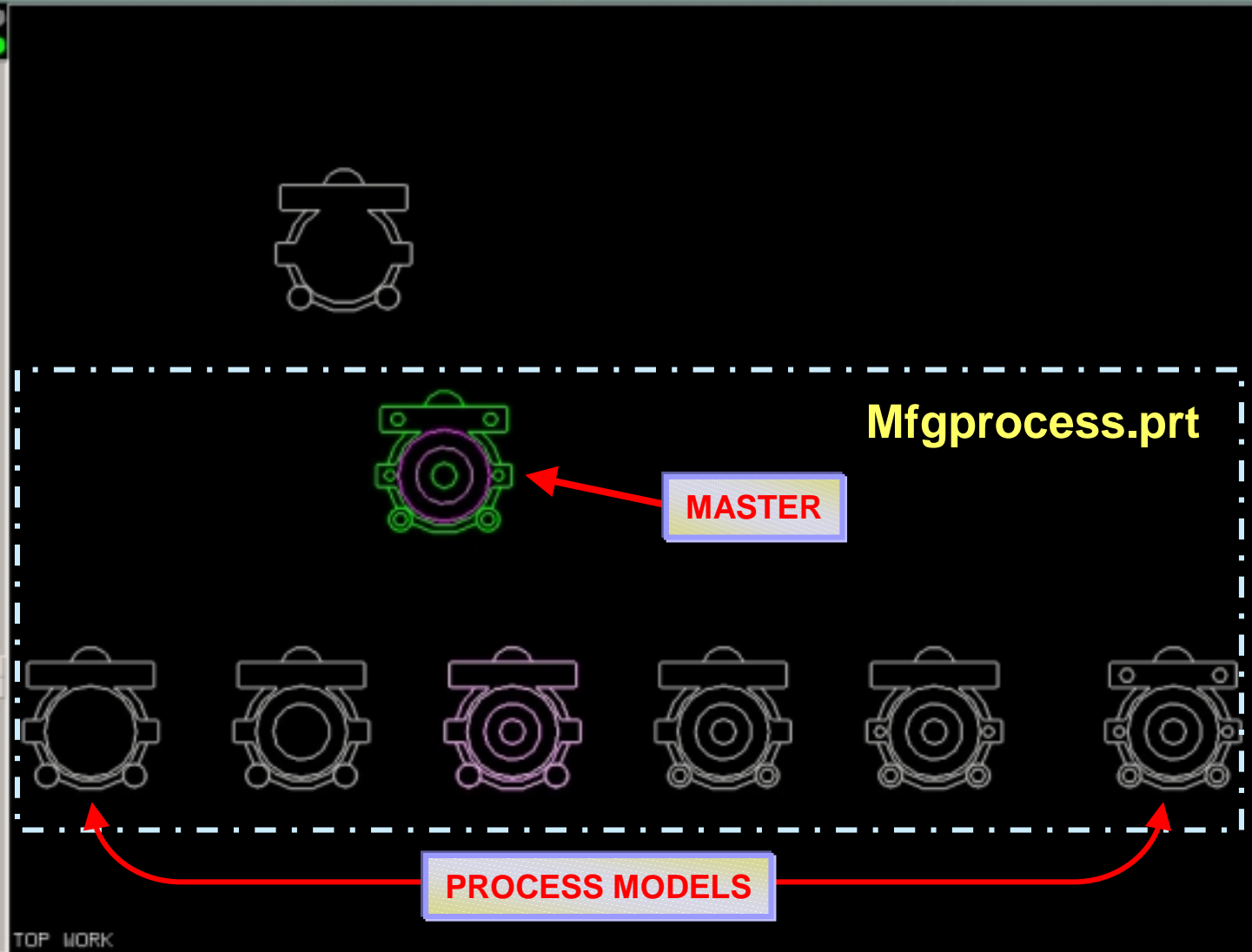
Scenario:

A HOLE that is currently located in Operation 60 now needs to be machined in Operation 20.

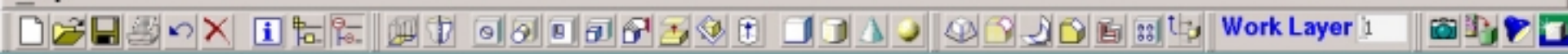


Displayed Part: vmds_study.prt Work Part: vmds_concurrent.prt

- Model Navigator**
- Feature Name
- vmds_concurrent
 - LINKED_BODY(0)
 - FIXED_DATUM_PLANE(1)
 - FIXED_DATUM_PLANE(2)
 - FIXED_DATUM_PLANE(3)
 - OP10_SIMPLE_HOLE(4)**
 - OP10_EXTRACT_BODY(5)
 - OP20_SIMPLE_HOLE(6)
 - OP20_EXTRACT_BODY(7)
 - OP30_SIMPLE_HOLE(8)
 - OP30_EXTRACT_BODY(9)
 - OP40_F10_SIMPLE_HOLE(10)
 - OP40_F10_OFFSET_CURVE(11)
 - OP40_SIMPLE_HOLE(12)
 - OP40_EXTRACT_BODY(13)
 - OP50_SIMPLE_HOLE(14)
 - OP50_SIMPLE_HOLE(15)
 - OP50_EXTRACT_BODY(16)
 - OP60_SIMPLE_HOLE(17)
 - OP60_SIMPLE_HOLE(18)
 - OP60_EXTRACT_BODY(19)
 - PROD_EXTRACT_BODY(20)



SIMPLE_HOLE(4) : OP10_SIMPLE_HOLE



Displayed Part: vmds_study.prt Work Part: vmds_concurrent.prt

Sequence Change

- Model Navigator
- LINKED_BODY(0)
 - FIXED_DATUM_PLANE(1)
 - FIXED_DATUM_PLANE(2)
 - FIXED_DATUM_PLANE(3)
 - OP10_SIMPLE_HOLE(4)
 - OP10_EXTRACT_BODY(5)
 - OP20_SIMPLE_HOLE(6)
 - OP20_EXTRACT_BODY(7)
 - OP30_SIMPLE_HOLE(8)
 - OP30_EXTRACT_BODY(9)
 - OP40_F10_SIMPLE_HOLE(10)
 - OP40_F10_OFFSET_CURVE(11)
 - OP40_SIMPLE_HOLE(12)
 - OP40_EXTRACT_BODY(13)
 - OP50_SIMPLE_HOLE(14)
 - OP50_SIMPLE_HOLE(15)
 - OP50_EXTRACT_BODY(16)
 - OP60_SIMPLE_HOLE(18)**
 - OP60_EXTRACT_BODY(19)
 - PROD_EXTRACT_BODY(20)



MASTER Hole Feature



Move HOLE to OP20

Move HOLE Feature



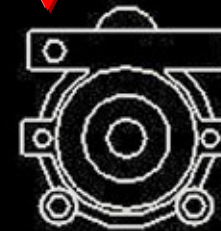
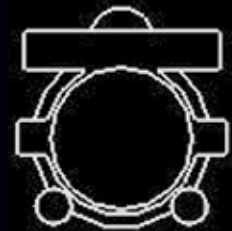
OP20

OP60

TOP WORK

EXTRACT_BODY(16) : OP50_EXTRACT_BODY

**MASTER Change
UPDATES ALL
Process Models
and Process Sheets**



OP10

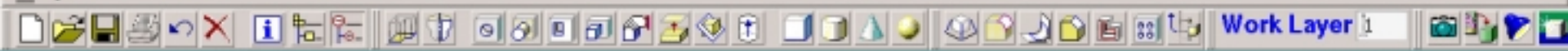
OP20

OP30

OP40

OP50

OP60



Displayed Part: vmds_study.prt Work Part: vmds_concurrent.prt (Modified)

- Model Navigator
- Feature Name
- vmds_concurrent
 - LINKED_BODY(0)
 - FIXED_DATUM_PLANE(1)
 - FIXED_DATUM_PLANE(2)
 - FIXED_DATUM_PLANE(3)
 - OP10_SIMPLE_HOLE(4)
 - OP10_EXTRACT_BODY(5)
 - OP60_SIMPLE_HOLE(8)
 - OP20_SIMPLE_HOLE(7)
 - OP20_EXTRACT_BODY(8)
 - OP30_SIMPLE_HOLE(9)
 - OP30_EXTRACT_BODY(10)
 - OP40_F10_SIMPLE_HOLE(11)
 - OP40_F10_OFFSET_CURVE(12)
 - OP40_SIMPLE_HOLE(13)
 - OP40_EXTRACT_BODY(14)
 - OP50_SIMPLE_HOLE(15)
 - OP50_SIMPLE_HOLE(16)
 - OP50_EXTRACT_BODY(17)
 - OP60_SIMPLE_HOLE(18)
 - OP60_EXTRACT_BODY(19)
 - PROD_EXTRACT_BODY(20)

HOLE moved to OP20



EXTRACT_BODY(10) : OP30_EXTRACT_BODY

CAPS
PART



DELPHI
Automotive Systems

SHT 1 OF 1

OP NO 001

REFER TO DIVISIONAL PROCEDURE No. 102

SD 2899-A DEC-98

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF

Manufacturing Process Sheet

<u>OPER.</u>	<u>STATION</u>	<u>DESCRIPTION</u>
010	--	BORE MAJOR CENTER DIAMETER
020	--	BORE INTERMEDIATE DIAMETER AND (1) HOLE IN UPPER LEFT PAD
030	--	BORE MINOR DIAMETER
040	--	DRILL (2) HOLES IN LOWER BOSSES
050	--	DRILL (2) HOLES IN CENTER PADS
060	--	DRILL (1) HOLE IN UPPER PAD

UPDATED Process Sheet HOLE now drilled in OP20

See OP001 SHT 1 for LEC

REF PART NO.	--	CHART NO.	--	LEC	001	DATE	300C00	OPEN OP	--	THRU	--	MATL	--	SHT	1	OF	1	
OP NAME	SUMMARY SHEET							PART NO.	12345678		VERSION	MA	OP NO.	001				
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET							DELPHI (SAG)NAW STEERING SYSTEMS	PLANT	MDC	DEPT	--						

CAPS PART



DELPHI
Automotive Systems

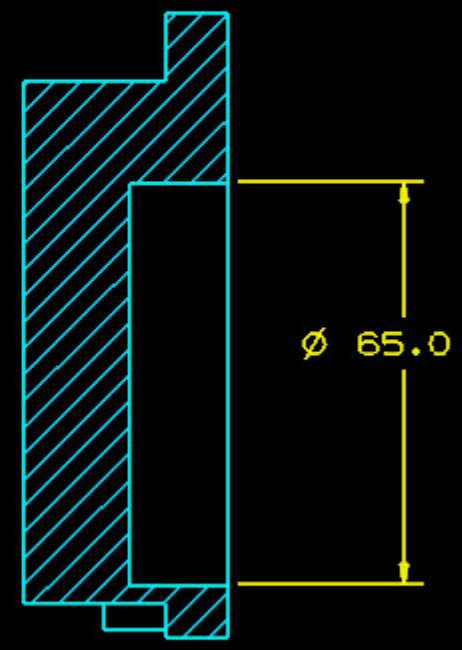
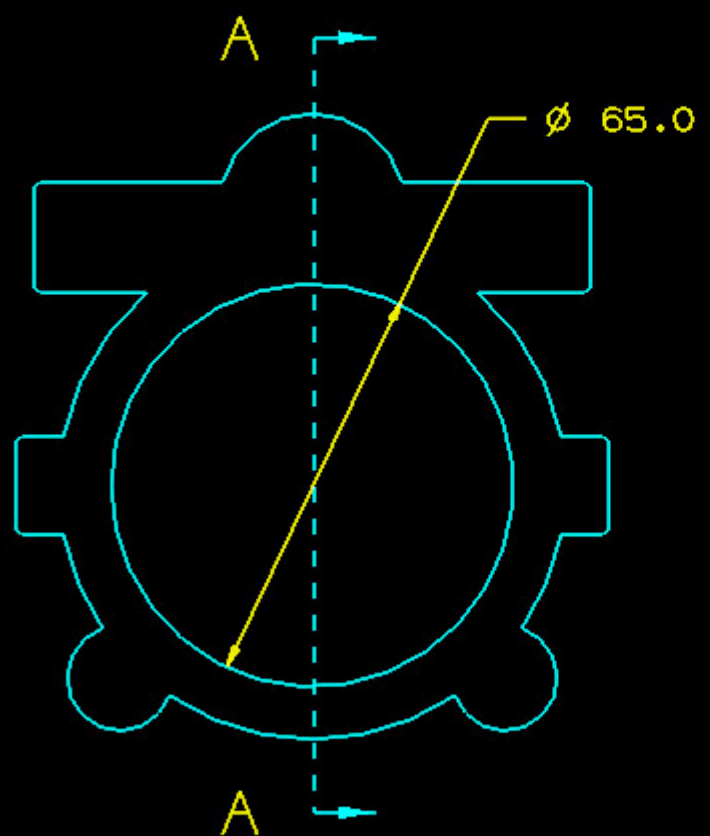
SHT 1 OF 1

OP NO 010

REFER TO DIVISIONAL PROCEDURE NO. 102

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION A - A

See OP001 SHT 1 for LEC

SD 28999-A DEC-98

REF PART NO. --	CHART NO. --	LEC	DATE	OPEN OP	THRU 9	MATL	--	SHT 1	OF 1
OP NAME BORE MAJOR CENTER DIAMETER				PART NO.		VERSION		OP NO.	
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		010	
DELPHI SAGINAW STEERING SYSTEMS			PLANT	MDC	DEPT	--			

PAPER.VIEW@3

SX@12

TOP@11

List All In Part

View Selection

Out-Of-Date

Out-Of-Date Automatic

All

Reset

OK

Apply

Cancel

Delphi Automotive Systems

SHT 1 OF 1

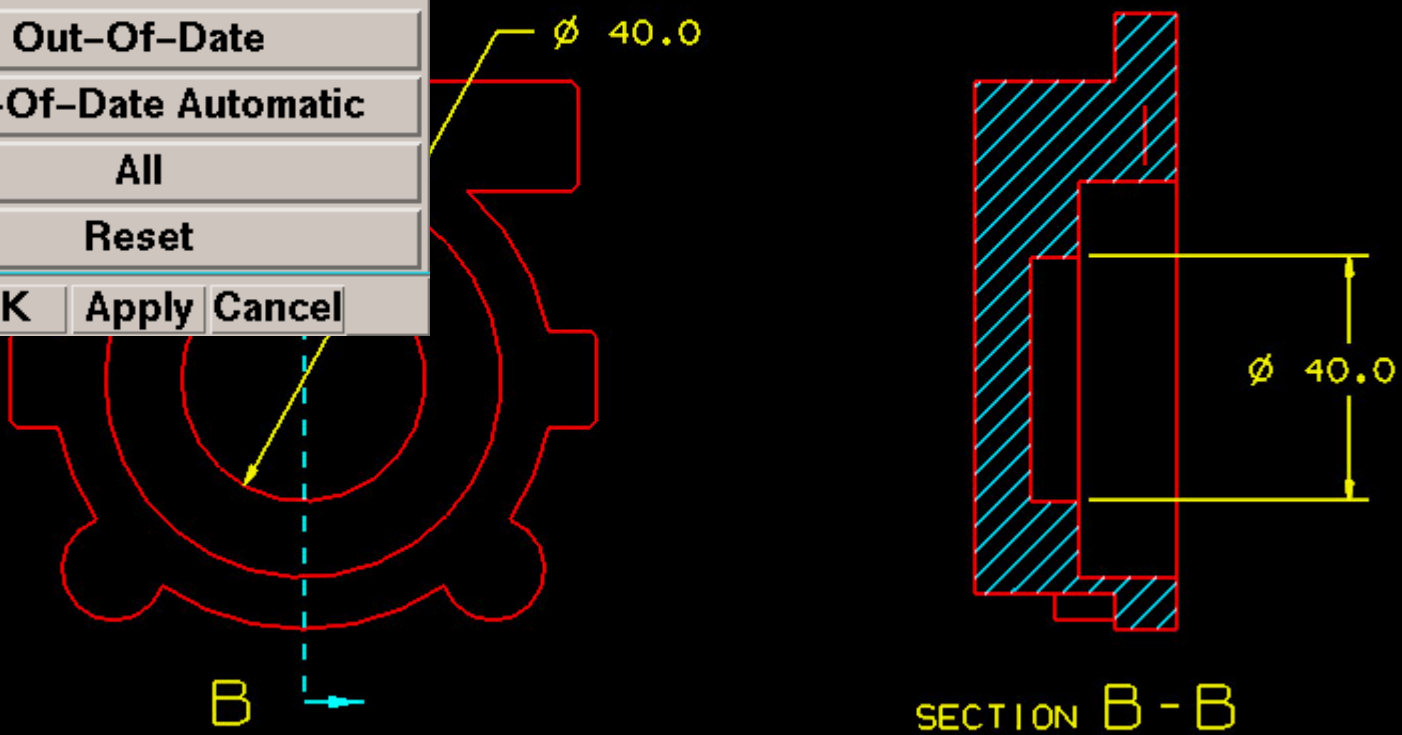
OP NO 020

BY	CHK	DATE	MF

STN	REVISIONS	BY	CHK	DATE	MF

REFER TO DIVISIONAL PROCEDURE NO. 102

SD 2899-A DEC-98



Drawing is OUT OF DATE

REF PART NO.	CHART NO.	LEC	VERSION	OP NO.
			MA	020

DELPHI SAGINAW STEERING SYSTEMS

1 2 3 4 5 6 7 8

SH020_1 (DWG) WORK (OUT-OF-DATE)

CAPS
PART



DELPHI
Automotive Systems

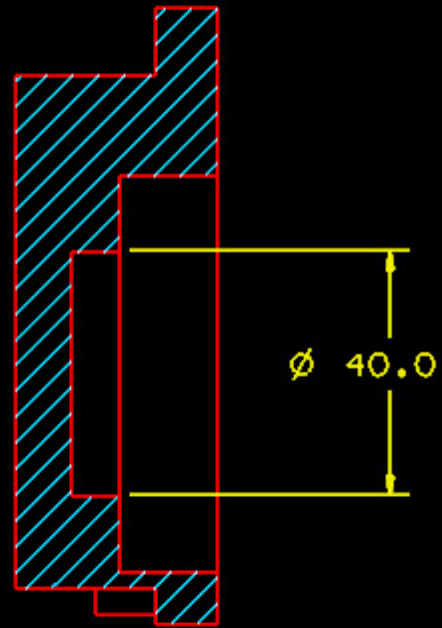
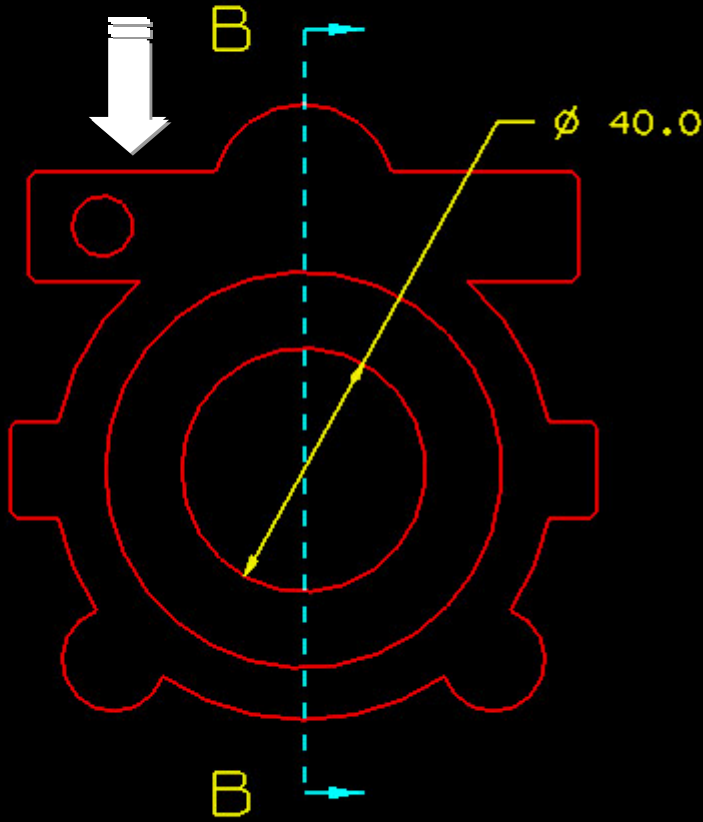
SHT 1 OF 1

OP NO 020

REFER TO DIVISIONAL PROCEDURE No. 102

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION B-B

See OPO01 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. --	CHART NO. --	LEC	DATE	OPEN OP 11 THRU 19	MATL --	SHT 1 OF 1
OP NAME BORE INTERMEDIATE DIAM	PART NO. 12345678			VERSION MA	OP NO. 020	
PART NAME VIRTUAL CONCURRENT PRO	DEPT --					

UPDATED

SHT 20.1 (DWG) WORK

CAPS
PART



DELPHI
Automotive Systems

SHT 1 OF 1

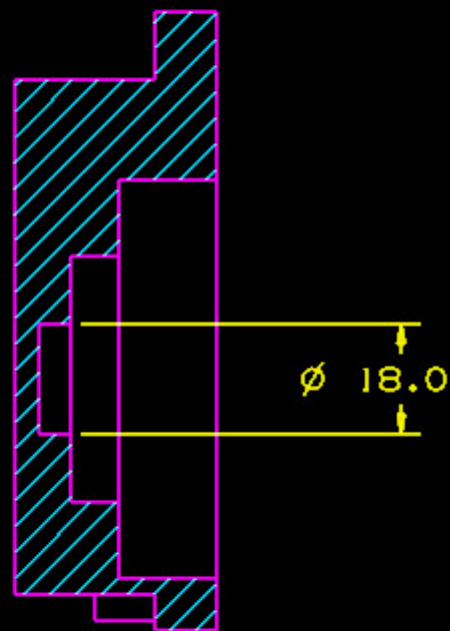
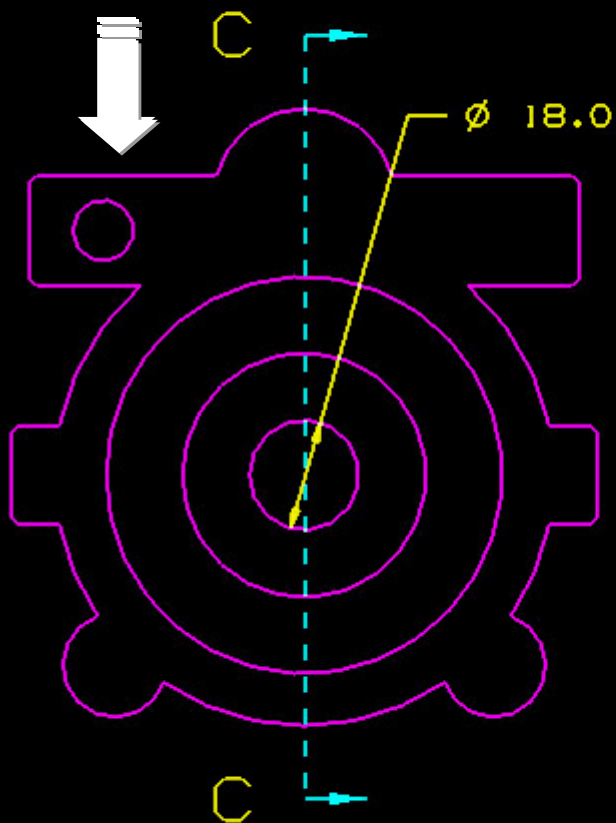
OP NO 030

REFER TO DIVISIONAL PROCEDURE NO. 102

SD 2899-A DEC-98

STM	REVISIONS	BY	CHK	DATE	MF

STM	REVISIONS	BY	CHK	DATE	MF



SECTION C - C

See OP001 SHT 1 for LEC

REF PART NO. --	CHART NO. --	LEC	DATE	OPEN OP 21 THRU 29	MATL --	SHT 1 OF 1
OP NAME BORE MINOR DIAMETER				PART NO.	VERSION	OP NO.
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678	MA	030
DELPHI (SAGINAW) STEERING SYSTEMS			PLANT MDC	DEPT --		

SH030_1 (DWG) WORK

CAPS PART



DELPHI
Automotive Systems

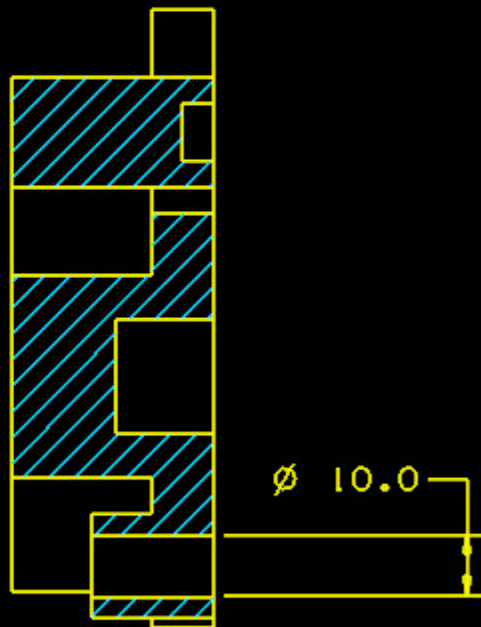
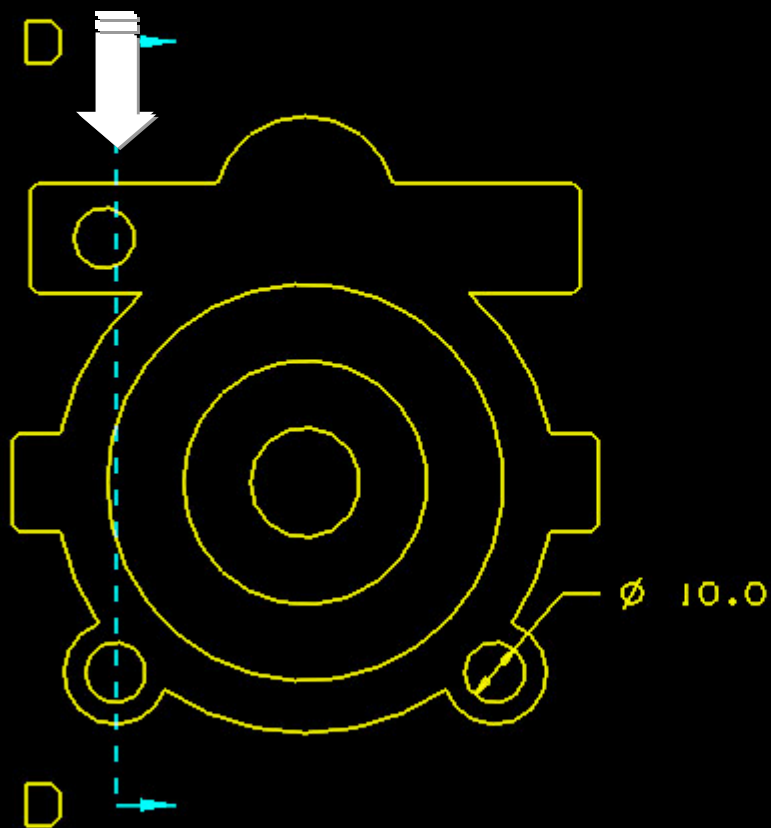
SHT 1 OF 1

OP NO 040

REFER TO DIVISIONAL PROCEDURE NO. 102

STM	REVISIONS	BY	CHK	DATE	MF

STM	REVISIONS	BY	CHK	DATE	MF



SECTION D-D

See OP001 SHT 1 for LEC

SD 2899-A DEC-98

REF PART NO. --	CHART NO. --	LEC	DATE	OPEN OP	31 THRU 39	MATL	--	SHT 1 OF 1
OP NAME DRILL 121 HOLES IN LOWER BOSSES				PART NO.		VERSION		OP NO.
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		040
DELPHI SAGINAW STEERING SYSTEMS			PLANT	MDC	DEPT	--		

SH040_1 (DWG) WORK

CAPS
PART



DELPHI
Automotive Systems

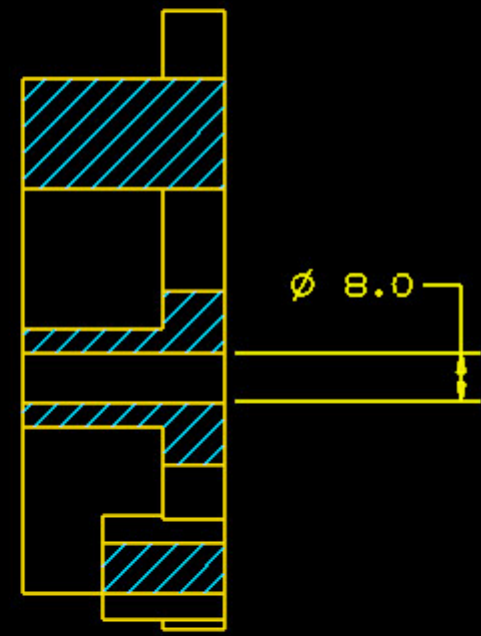
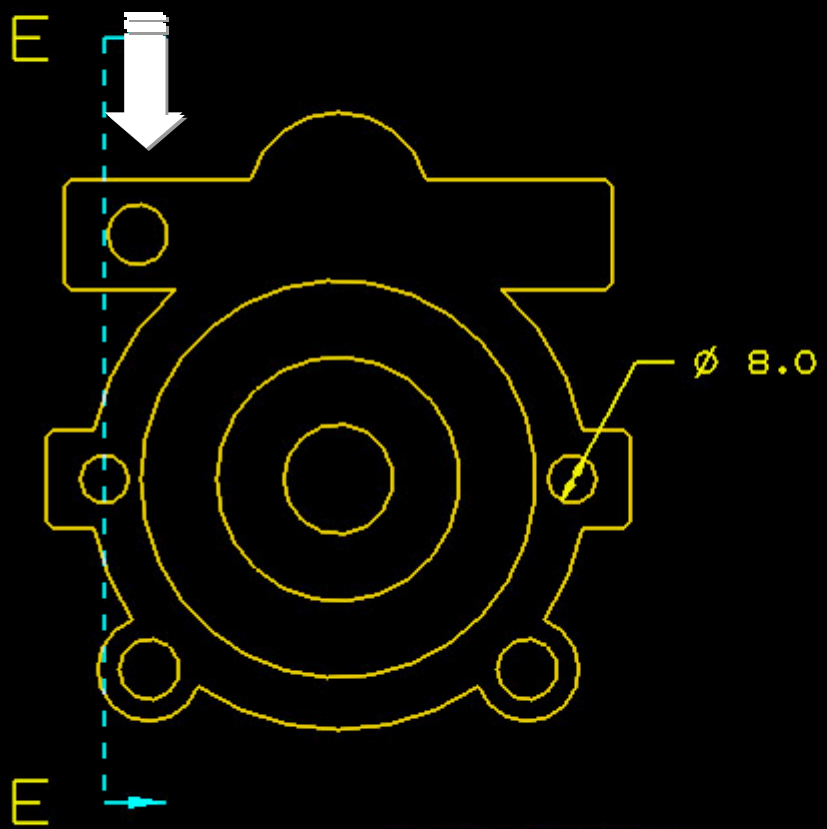
SHT 1 OF 1

OP NO 050

REFER TO DIVISIONAL PROCEDURE NO. 102

STM	REVISIONS	BY	CHK	DATE	MF

STM	REVISIONS	BY	CHK	DATE	MF



SECTION E - E

SD 2899-A DEC-98

See OP001 SHT 1 for LEC

REF PART NO. --	CHART NO. --	LEC	DATE	OPEN OP	41 THRU 49	MATL	--	SHT	1	OF	1
OP NAME DRILL 121 HOLES IN CENTER PADS				PART NO.		VERSION		OP NO.			
PART NAME VIRTUAL CONCURRENT PROCESS SHEET				12345678		MA		050			
DELPHI (SAG)NAW STEERING SYSTEMS				PLANT MDC		DEPT --					

CAPS
PART



DELPHI
Automotive Systems

SHT 1 OF 1

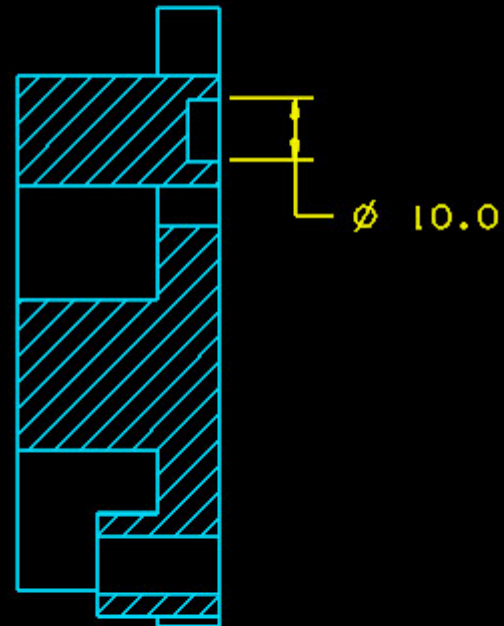
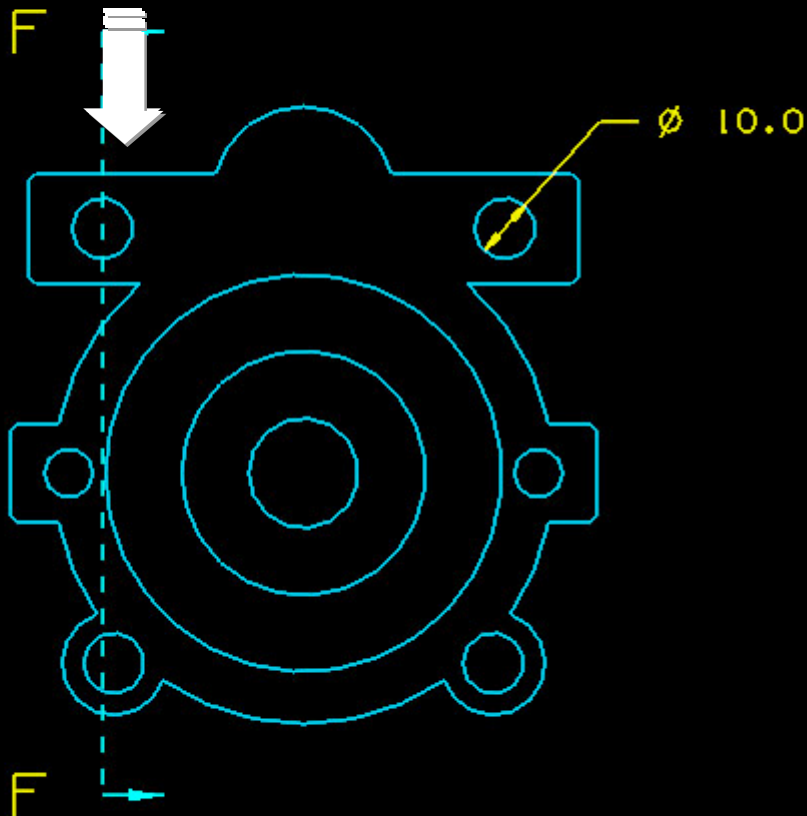
OP NO 060

REFER TO DIVISIONAL PROCEDURE No. 102

SD 2899-A DEC-98

SYM	REVISIONS	BY	CHK	DATE	MF

SYM	REVISIONS	BY	CHK	DATE	MF



SECTION F - F

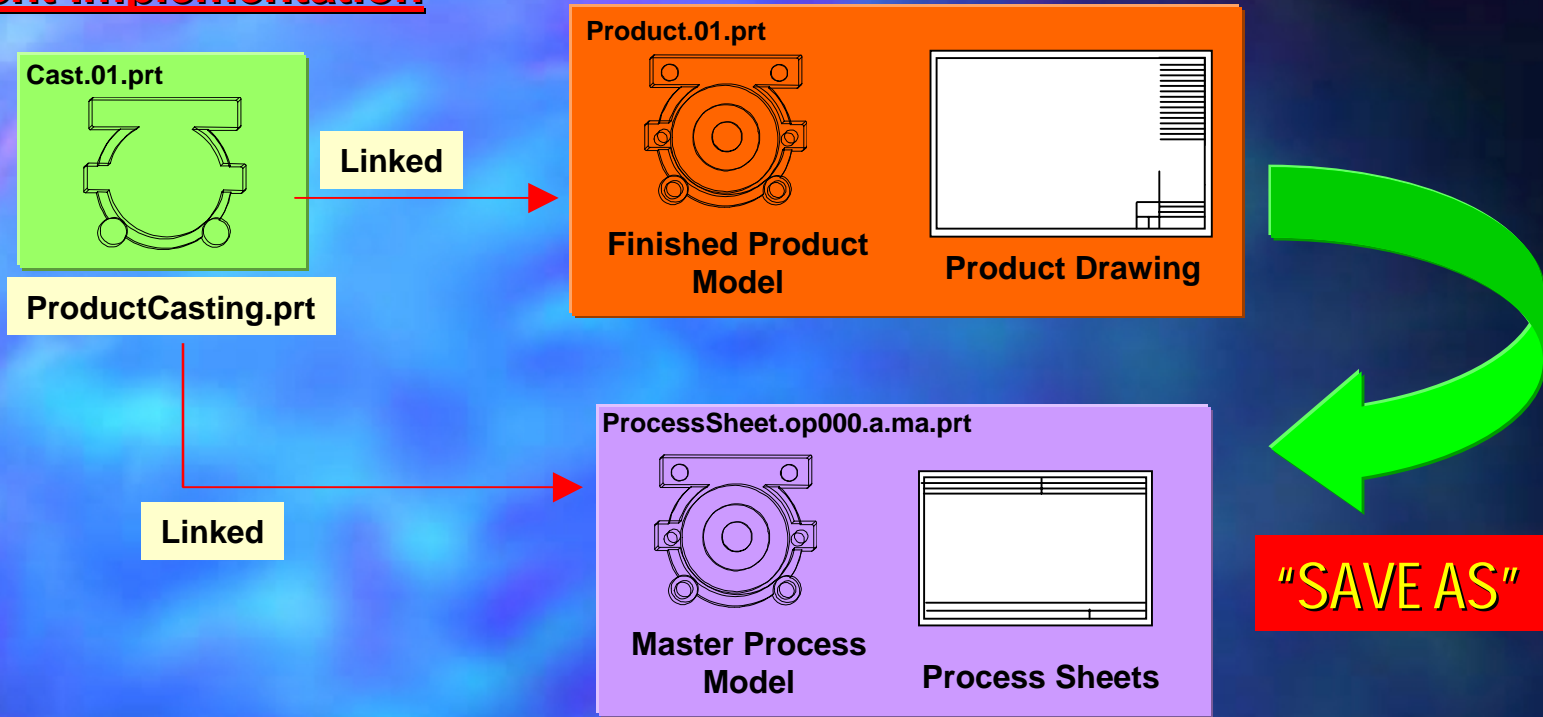
See OPO01 SHT 1 for LEC

REF PART NO.	CHART NO.	LEC	DATE	OPEN OP	51 THRU 59	MATL	SHT 1 OF 1
OP NAME	DRILL 121 HOLES IN UPPER PADS			PART NO.	12345678		VERSION
PART NAME	VIRTUAL CONCURRENT PROCESS SHEET			DEPT	MA		OP NO.
DELPHI (SAGINAW) STEERING SYSTEMS				PLANT	MDC		060

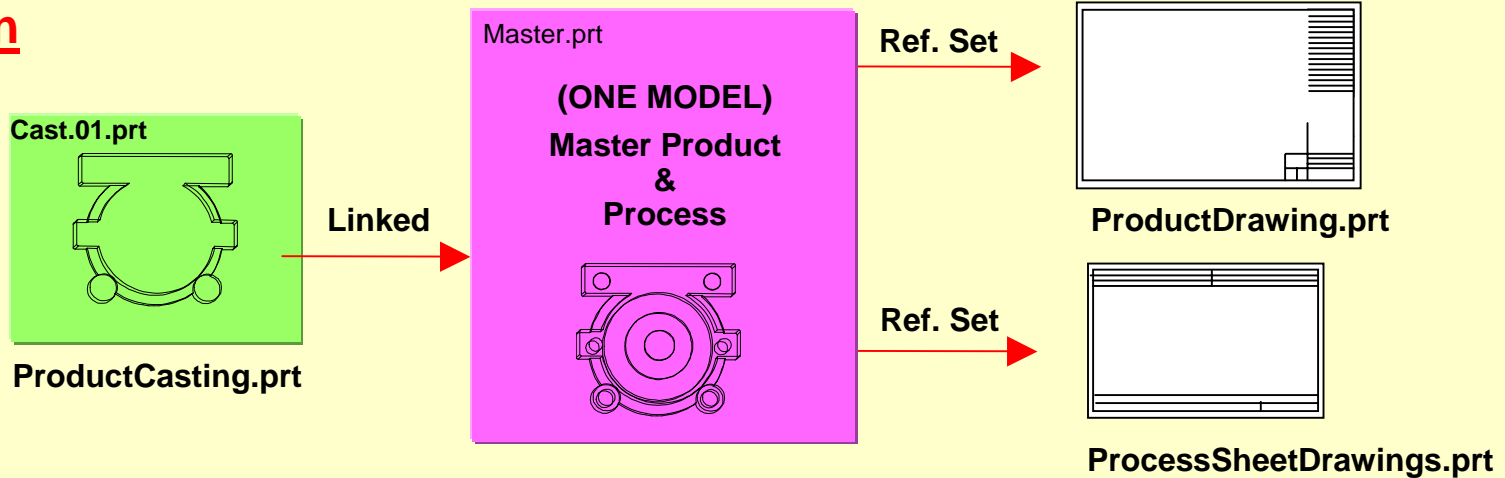
SH060_1 (DWG) WORK

Associated Master Product and Process Model

Current Implementation

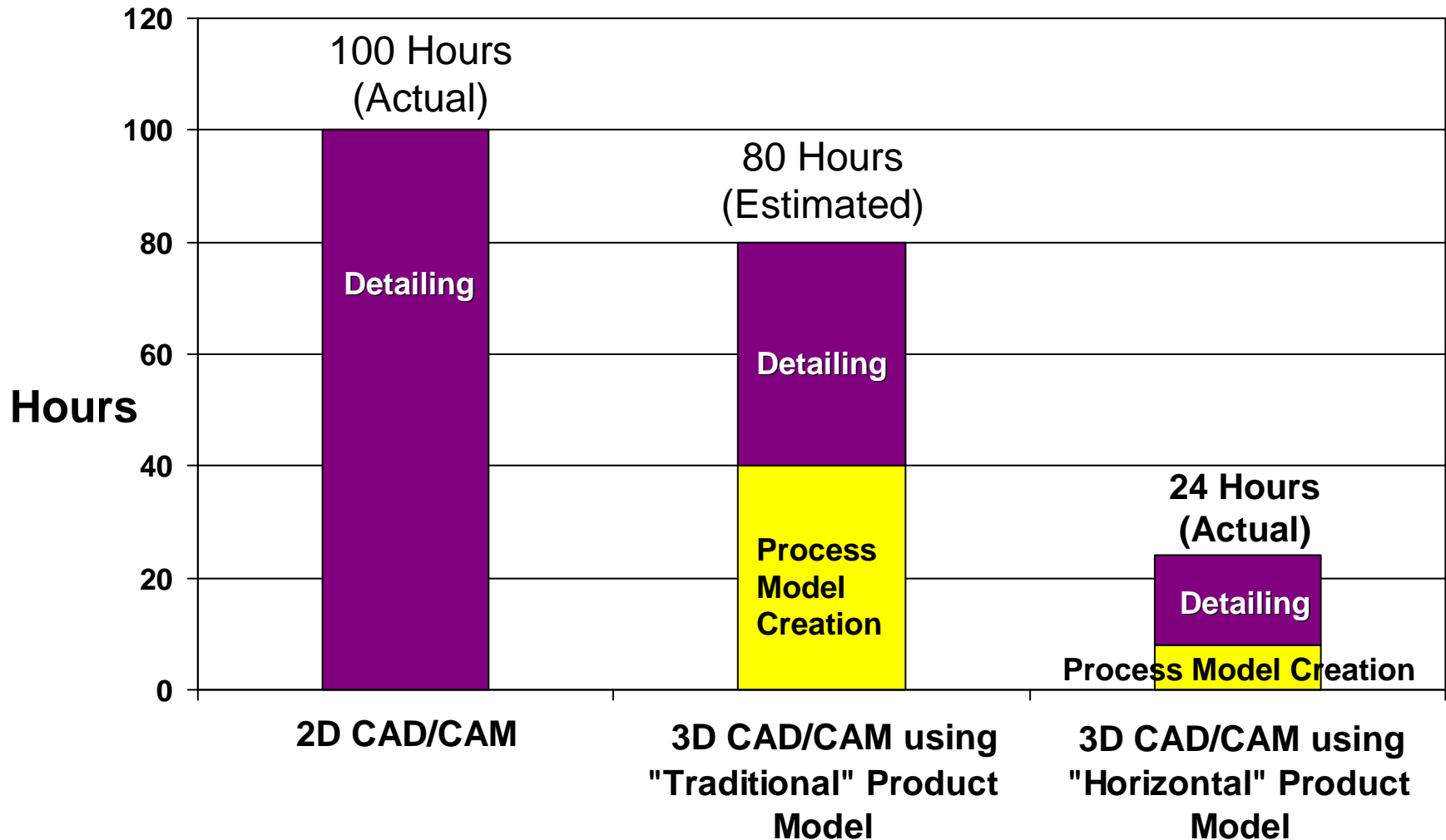


Vision



Virtual Machining Comparison

Process Sheet Creation Time for EPS Epsilon Housing Machining



Savings for revisions in line with horizontal modeling

- Introduction
- Product Design Applications
- Manufacturing Applications
- **Further CAD/CAM Developments**

Further CAD/CAM Development (Work progressing at Delphi)

