

USE OF ARRANGEMENTS IN NX

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Premium Partners:



Microsoft

PRESENTATION OUTLINE

- **Mission of Design Process & Technology Group at General Motors Powertrain**
- **How We Design Engines with Large Assemblies – System Design Process**
- **Need for Arrangements in the Design Process**
- **Creating Arrangements**
- **Positioning Components – Use of Wavelinking**
- **Drawings with Multiple Arrangements**
- **Next Steps**
- **Questions**

GM POWERTRAIN Design Process & Technology

- **Accelerate the "Move to Math" within GMPT**
- **Institutionalize Math Methods & Processes to:**
 - **Improve the Engineering Process**
 - **Produce Higher First Time Quality Designs**
 - **Reduce Experimental Material Cost**
 - **Reduced Reliance on Physical Testing**
- **Support the Use of Corporate Common Tools**
- **Develop New Tools to Support the Powertrain Design Process**
- **Train Powertrain Product Engineers & Designers in the Use of These Tools**

How We Design Engines with Large Assemblies – System Design Process

- **System Design Approach**
- **System Design Driven with a Live Powertrain Assembly Structure (PAS)**
- **TcAE Data Management Leveraged**
- **Emphasis on Common Methods & Processes**
- **Focus on Teamwork through Leadership**

Powertrain Assembly Structure (PAS)

<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS54446/005	PAS 2009 XV81 ULTRA V8
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS54447/002	MAINSTREAM MODULE
<input type="checkbox"/> <input type="checkbox"/>  AHS54448/003.0003	IA CYLINDER BLOCK SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54449/003.0003	IA CYLINDER HEAD SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54450/003.0004	IA COVERS AND VENTILATION SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54451/003.0002	IA CRANKTRAIN SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54452/002	IA VALVETRAIN SYSTEM
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS54453/003	IA ACCESSORY DRIVE SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54454/003.0003	IA THERMAL MANAGEMENT SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54455/003.0002	IA OIL SUPPLY SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54456/003.0004	IA OIL RESERVOIR SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54457/003.0002	IA AIR FUEL DELIVERY SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54458/003.0001	IA IGNITION AND CRANKING SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54459/003.0002	IA EXHAUST DISCHARGE SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54460/002	IA CAMSHAFT DRIVE SYSTEM
<input type="checkbox"/> <input type="checkbox"/>  AHS54461/003.0003	IA FRONT COVER SYSTEM
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS54465/003	INSTALLATION MODULE
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS58189/002.0027	IA - VEC BACKGROUND GMT966 FWD
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS70017/002.0008	IA-TRANS BACKGROUND UV8 FWD/AWD
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS74175/001	IA GMT966 VEHICLE LOCATING FILE
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS54468/002	INPLANT MODULE
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS84364/001.0004	IA-ENGINE ASM PLANT TOOLS
<input type="checkbox"/> <input checked="" type="checkbox"/>  AHS87331/001.0001	IA-TRANS ASM PLANT TOOLS UV8 FWD

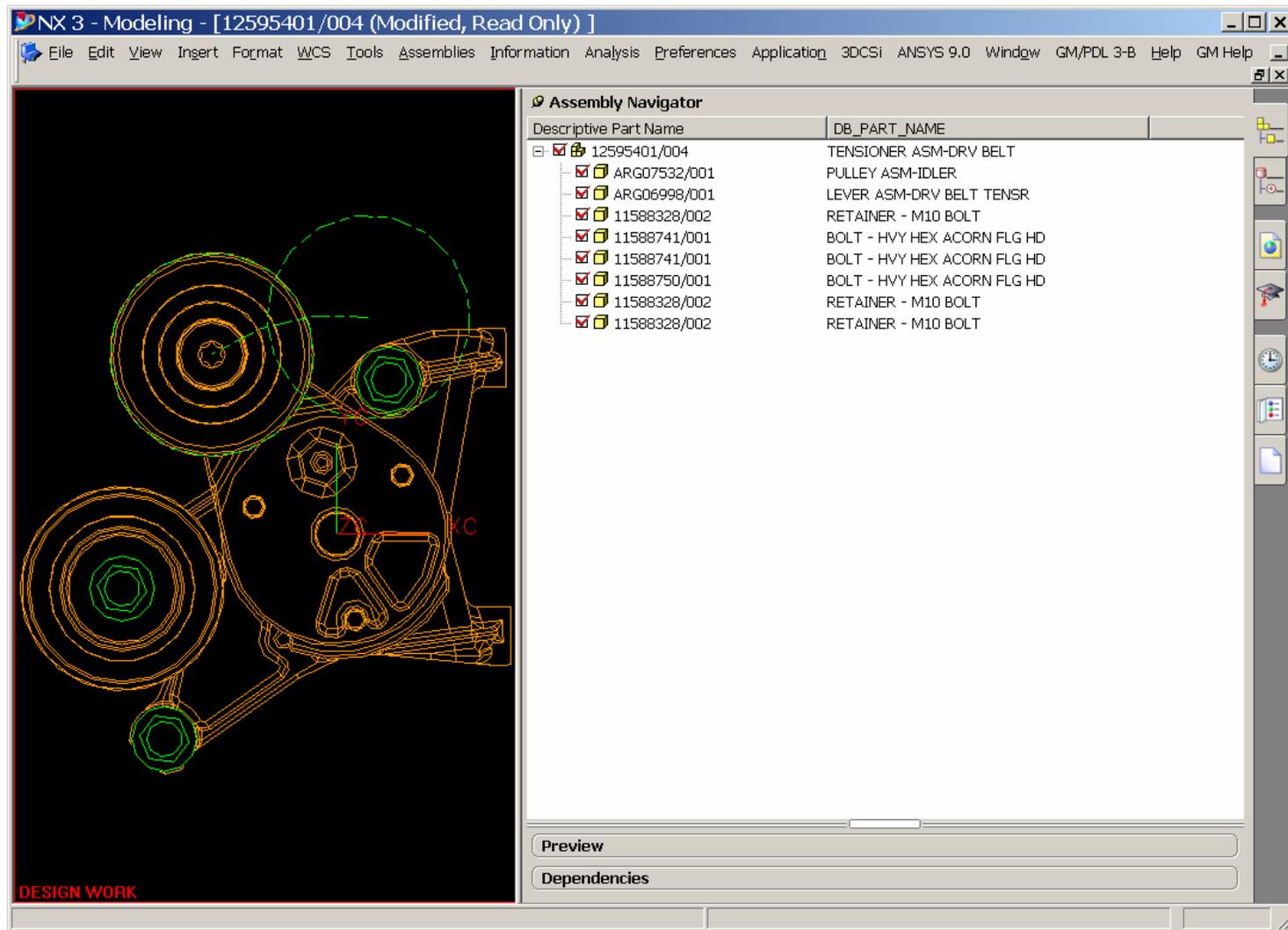
AHS54443/003-IA ACCESSORY DRIVE SYSTEM

The screenshot displays the NX 3 software interface for the assembly 'AHS54453/003 (Modified, Read Only)'. The main window shows a 3D model of the accessory drive system, featuring a green belt looped around several pulleys. A red component is visible at the bottom right, and a yellow pulley is highlighted. The assembly tree on the right lists the following parts:

Descriptive Part Name	DB_PART_NAME
<input checked="" type="checkbox"/> AHS54453/003	IA ACCESSORY DRIVE SYSTEM
<input checked="" type="checkbox"/> 12597206/003	PULLEY-P/S PUMP
<input checked="" type="checkbox"/> 12595401/004	TENSIONER ASM-DRV BELT
<input checked="" type="checkbox"/> 12597198/002	PULLEY ASM-BELT IDLER (UPR)
<input type="checkbox"/> 22535491/003	STUD-GEN BRKT
<input type="checkbox"/> 11588740/001 x 4	BOLT - HVY HEX ACORN FLG HD
<input type="checkbox"/> 12602393/001	BRACKET ASM-GEN
<input type="checkbox"/> 11514597/002 x 2	NUT-M10 HEX FLANGE
<input type="checkbox"/> 11588748/001 x 3	BOLT - HVY HEX ACORN FLG HD
<input type="checkbox"/> 12598553/005.0001	BRACKET-ENG LIFT RR(LH)
<input type="checkbox"/> 12593499/005.0001	BRACKET-ENG LIFT FRT
<input checked="" type="checkbox"/> 12597207/004 (altrep: 12597207.GEO_FIN002)	BELT-W/PMP & A/C CMPR & GEN & P/
<input type="checkbox"/> 12560892/002	STUD-A/C COMP
<input type="checkbox"/> 11589349/002	BOLT
<input type="checkbox"/> 11588742/001	BOLT - HVY HEX ACORN FLG HD
<input type="checkbox"/> 11588729/001 x 2	BOLT - HVY HEX ACORN FLG HD
<input type="checkbox"/> 11588940/001 x 4	BOLT ASM-HEX HD W/CONICAL WASHER
<input checked="" type="checkbox"/> 12595400/003	PULLEY-W/PMP

At the bottom left of the 3D model, the text 'BACK WORK' is displayed. The status bar at the bottom indicates that the part 'TENSIONER_ASM-DRV_BELT' is selected.

12595401/004-TENSIONER ASM-DRV BELT



Need for Arrangements in the Design Process

- Tensioner Asm – has a movable Lever & Pulley Asm
- It is necessary to show in “**As Shipped State**” within the UG Master File & on the Drawing
- Necessary to show in “**Installed State** ” within the Engine Asm File
- There is an “**Optional As Shipped State**” that must be shown on the Drawing
- This makes it an ideal candidate for use of this functionality.

Requirements for Arrangements

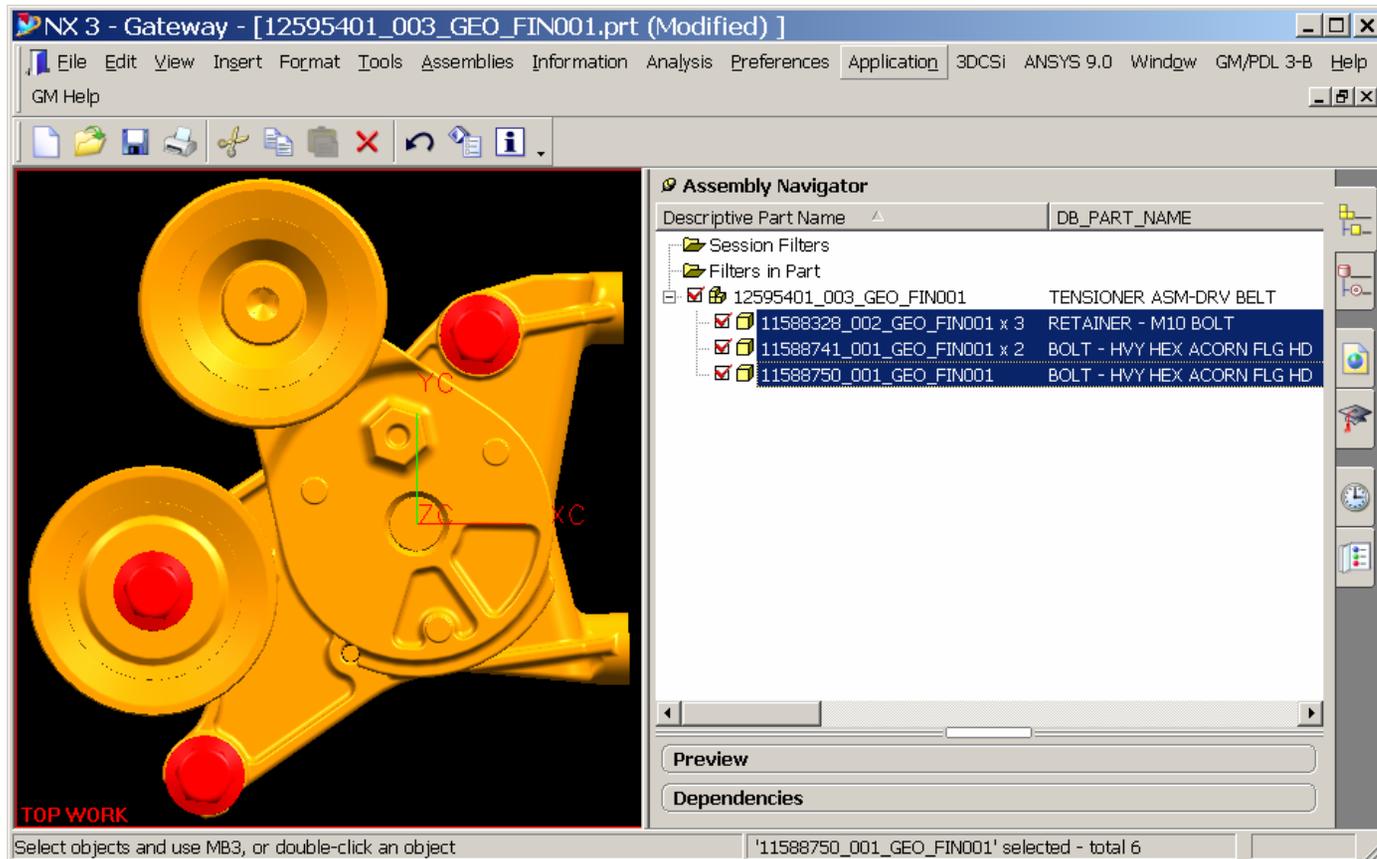
- There must be an assembly (since **Arrangements** merely Repositions the components).
- It is still necessary to create **ALTREPs** for those parts that have DEFORMATION upon assembly
- Every part file has an Arrangement and a Default
- Important to save the part file with the intended **Arrangement**
- The Default **Arrangement** should be the one that defines the **UGMaster**

Process Relies on Three Key NX Technologies

- Use of **Arrangements** to create the alternative positions
- Use of **WAVE Geometry Linker** to "link" the "**Installed State**" Tensioner Asm to the **ALTREP** of the Accessory Drive Belt for a particular Accessory Drive System
- Use of **Exploded Views** within Drafting to enable the depiction of multiple **Arrangements** on the same Drawing

Creating Arrangements

- The first order of business, in this case, is to create a “true” assembly structure.



Creating a “True” Assembly Structure.

The screenshot displays the NX 3 software interface for a file named [12595401_003_GEO_FIN001.prt (Modified)]. The 'Assemblies' menu is open, showing options such as 'Components', 'Exploded Views', 'Sequencing', and 'Reports'. The 'Components' sub-menu is expanded, highlighting 'Create New...'. The main workspace shows a 3D model of a yellow mechanical assembly with green fasteners. A red box highlights a specific feature on the model. The right-hand side of the interface features a table with the following data:

DB_PART_NAME	
	TENSIONER ASM-DRV BELT
001 x 3	RETAINER - M10 BOLT
001 x 2	BOLT - HVY HEX ACORN FLG HD
001	BOLT - HVY HEX ACORN FLG HD

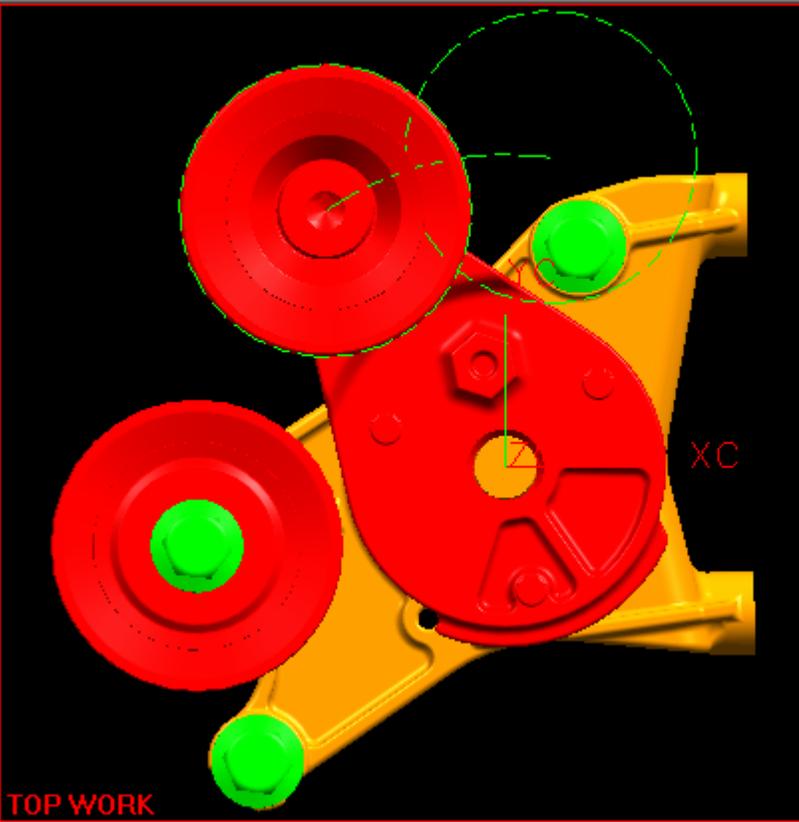
At the bottom of the interface, there are buttons for 'Preview' and 'Dependencies', and a status bar that reads 'Select objects and use MB3, or double-click an object'.

“True” Assembly Structure Created

Assembly Structure after New Components Created

NX 3 - Gateway - [12595401_004_GEO_FIN001.prt (Modified)]

File Edit View Insert Format Tools Assemblies Information Analysis Preferences Application 3DCSi ANSYS 9.0 Window GM/PDL 3-B
Help GM Help



Assembly Navigator

Descriptive Part Name	DB_PART_NAME
<input checked="" type="checkbox"/> 12595401_004_GEO_FIN001	TENSIONER ASM-DRV BELT
└─ <input checked="" type="checkbox"/> 11588328_002_GEO_FIN001 x 3	RETAINER - M10 BOLT
└─ <input checked="" type="checkbox"/> 11588741_001_GEO_FIN001 x 2	BOLT - HVY HEX ACORN FLG HD
└─ <input checked="" type="checkbox"/> 11588750_001_GEO_FIN001	BOLT - HVY HEX ACORN FLG HD
└─ <input checked="" type="checkbox"/> ARG06998_001_GEO_FIN001	LEVER ASM-DRV BELT TENSUR
└─ <input checked="" type="checkbox"/> ARG07532_001_GEO_FIN001	PULLEY ASM-IDLER

Preview
Dependencies

Creating the Arrangements

- System creates your first arrangement when you add or create the first component
- Add the column “Arrangement” to the Assembly Navigator
- Create all new Arrangements by copying the first
- Rename each Arrangement
- Make each Arrangement the “Active Arrangement” and reposition the components to suit that Arrangement
- Make the Default Arrangement Active and save the part file

Positioning Components-Use of Wavelinking

- ALTREP (Installed State) of the Accessory Drive Belt is driven by a completely constrained Sketch
- All pulley locations are constrained, except for the position of the movable Tensioner Pulley
- Tensioner Pulley location is determined by the belt length chosen for a particular Accessory Drive System

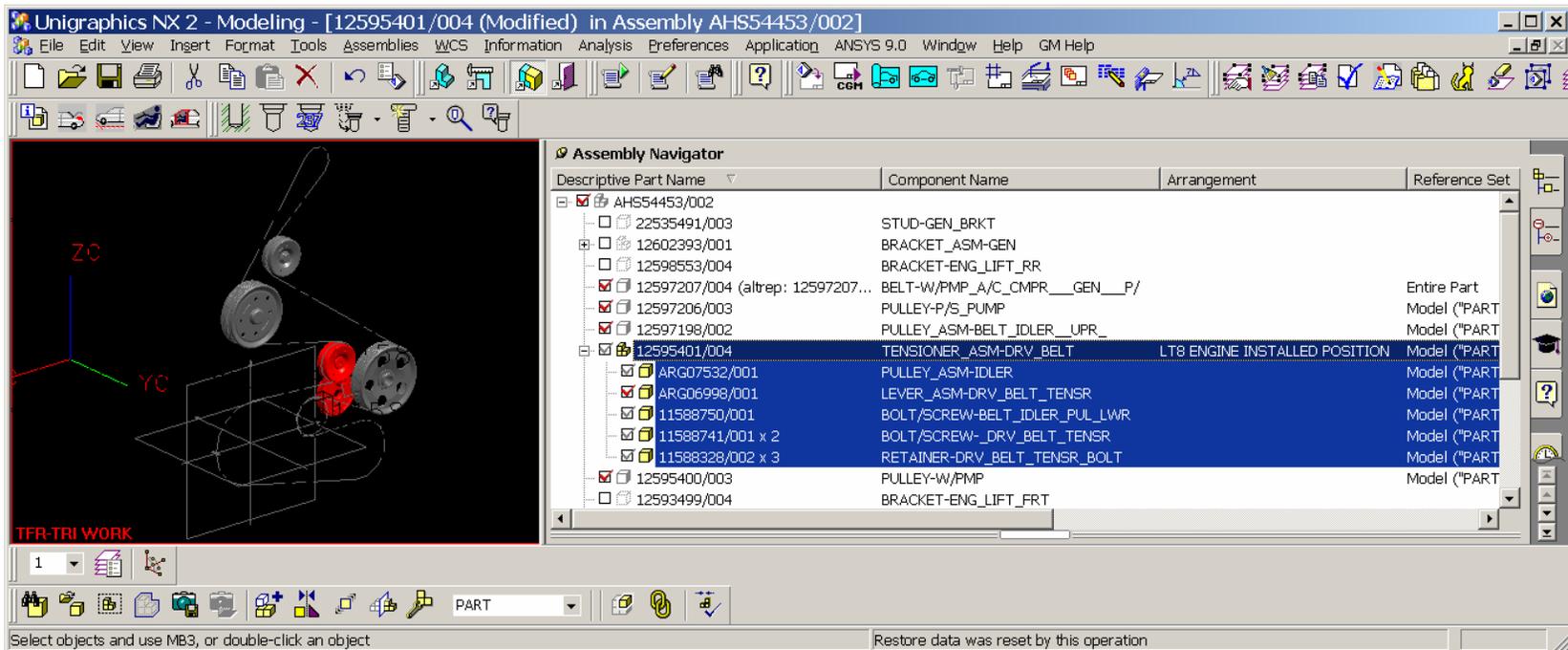
The screenshot displays the Unigraphics NX 2 Modeling environment. The main window shows a 2D sketch of a belt system with various pulleys and a tensioner. The sketch is labeled "TOP WORK" and includes a coordinate system with X and Z axes. The Assembly Navigator shows the current assembly structure, including the part "12597207/004 (altre... BELT-W/PMP & A/C CMPR & GEN & P/". The Expressions dialog box is open, showing a list of expressions used in the model, including:

- EFF_CRANK'5'0=(165.00-0.99)/2
- EFF_CRANK'6'0=(159.00-0.99)/2
- EFF_HEIGHT'5'0=2.290
- EFF_HEIGHT'6'0=2.60
- Perimeter_p0=2865
- p1'5'0=120.0/2
- p1'6'0=70.000/2
- p2'5'0=p1'5'0+EFF_HEIGHT'5'0
- p2'6'0=p1'6'0+EFF_HEIGHT'6'0

The Expressions dialog box also includes a "List by" dropdown set to "Name", a "Filter" input field, a "Filter Action" dropdown set to "Include", and a "Save Current Filter" button. The bottom of the dialog box contains the text "Choose existing expression to edit or enter a new expression".

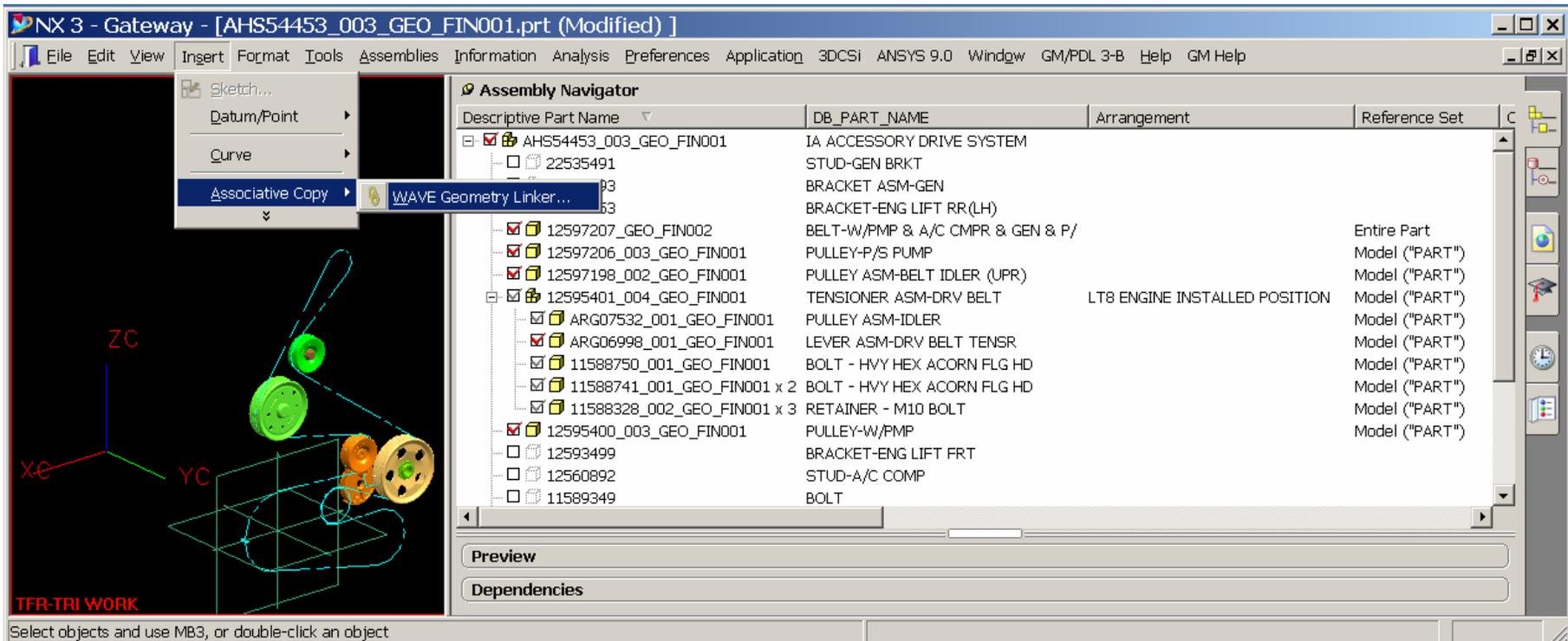
Wavelinking ALTREP Sketch into Tensioner ASM

- IA ACCESSORY DRIVE SYSTEM the “Displayed Part”, Tensioner Asm the “Work Part”
- Make “LT8 ENGINE INSTALLED POSITION” the Active Arrangement for the Tensioner Asm



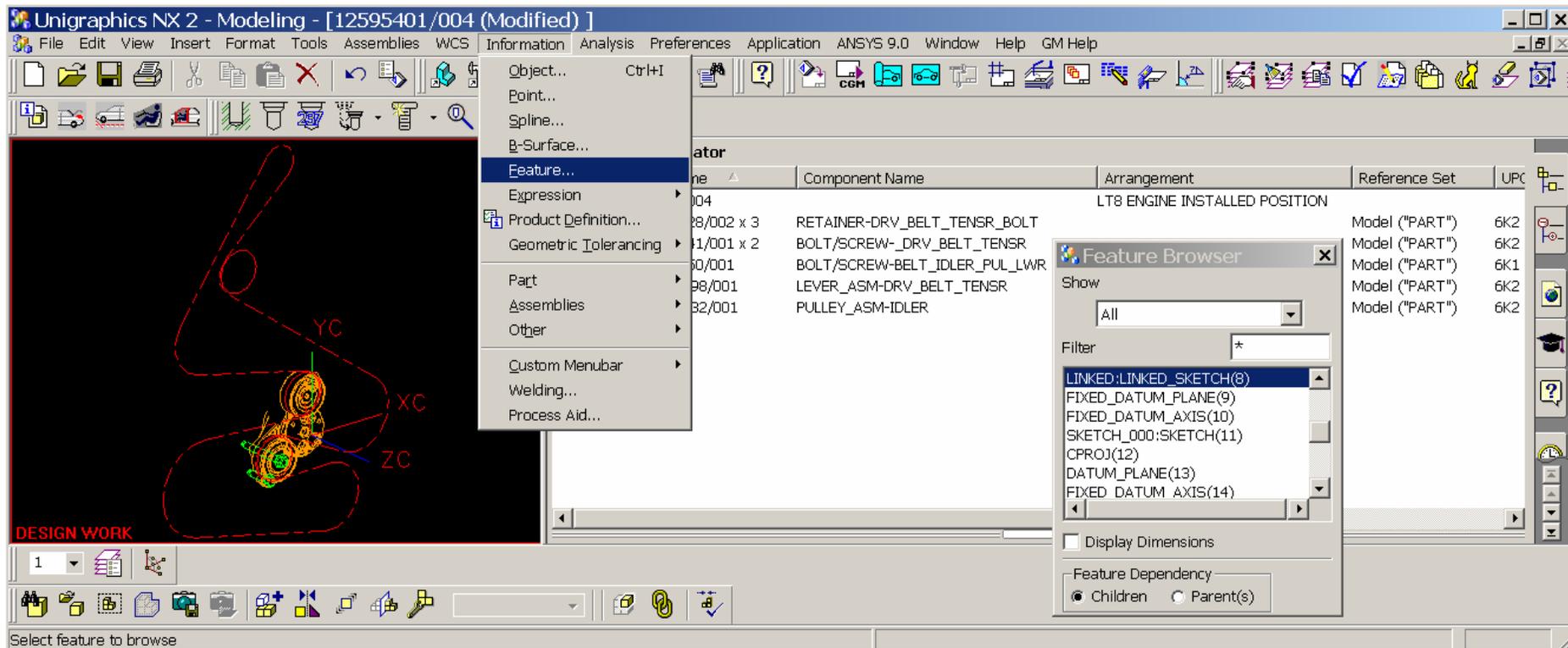
Wavelinking ALTREP Sketch into Tensioner ASM

- “Wavelink” the Sketch from the ALTREP of the Accessory Drive Belt into the Tensioner Asm using Insert > Associative Copy > WAVE Geometry Linker > Sketch/String.



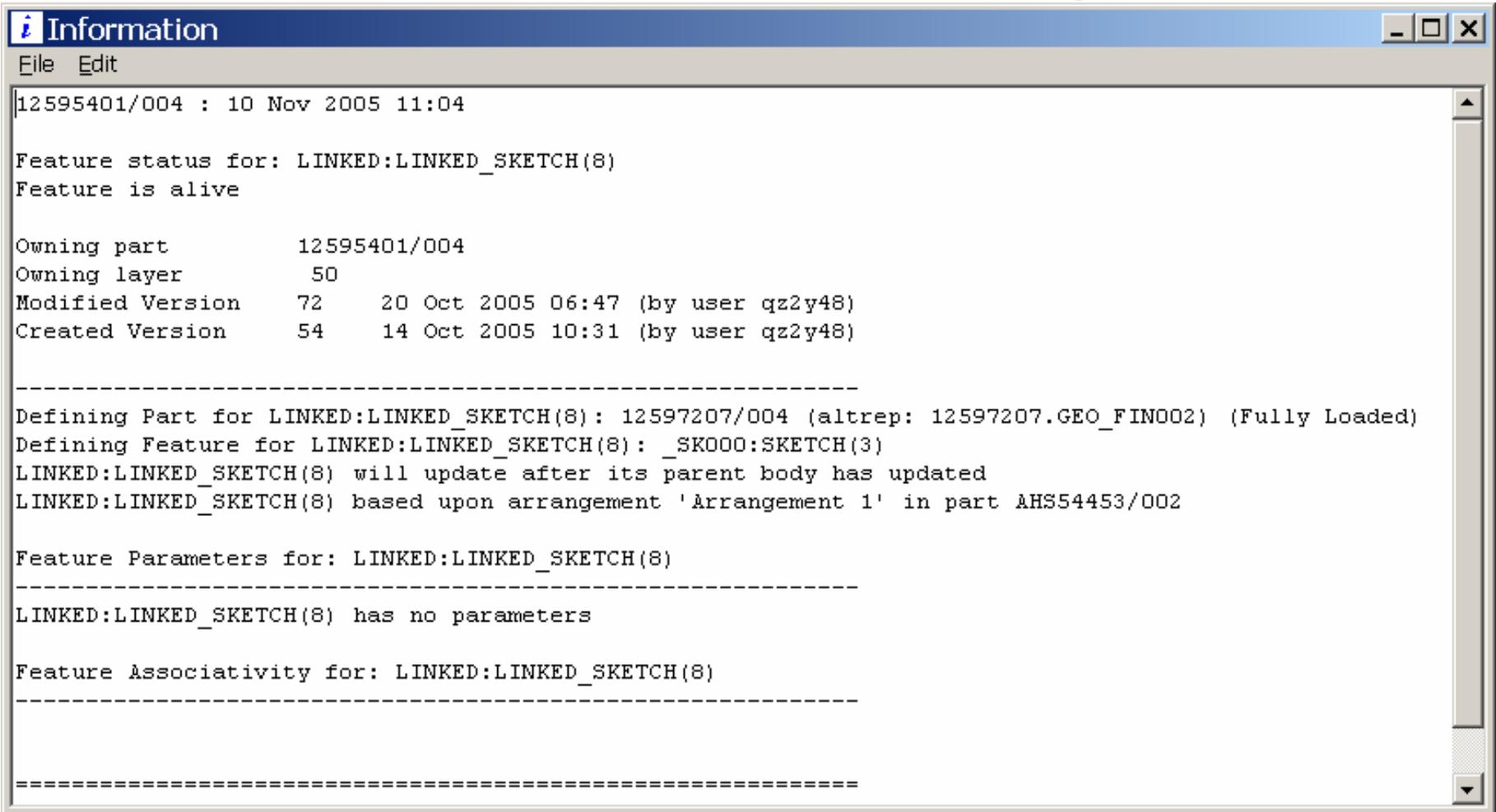
Tensioner Asm the “Displayed Part”

- Verify the “Linked Sketch” Feature just created using Information > Feature. Select the Sketch. Select OK or Apply.



Tensioner Asm the “Displayed Part”

- The Info Window returns the following information



```
Information
File Edit

12595401/004 : 10 Nov 2005 11:04

Feature status for: LINKED:LINKED_SKETCH(8)
Feature is alive

Owning part      12595401/004
Owning layer     50
Modified Version 72      20 Oct 2005 06:47 (by user qz2y48)
Created Version  54      14 Oct 2005 10:31 (by user qz2y48)

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Defining Part for LINKED:LINKED_SKETCH(8): 12597207/004 (altrep: 12597207.GEO_FIN002) (Fully Loaded)
Defining Feature for LINKED:LINKED_SKETCH(8): _SK000:SKETCH(3)
LINKED:LINKED_SKETCH(8) will update after its parent body has updated
LINKED:LINKED_SKETCH(8) based upon arrangement 'Arrangement 1' in part AHS54453/002

Feature Parameters for: LINKED:LINKED_SKETCH(8)

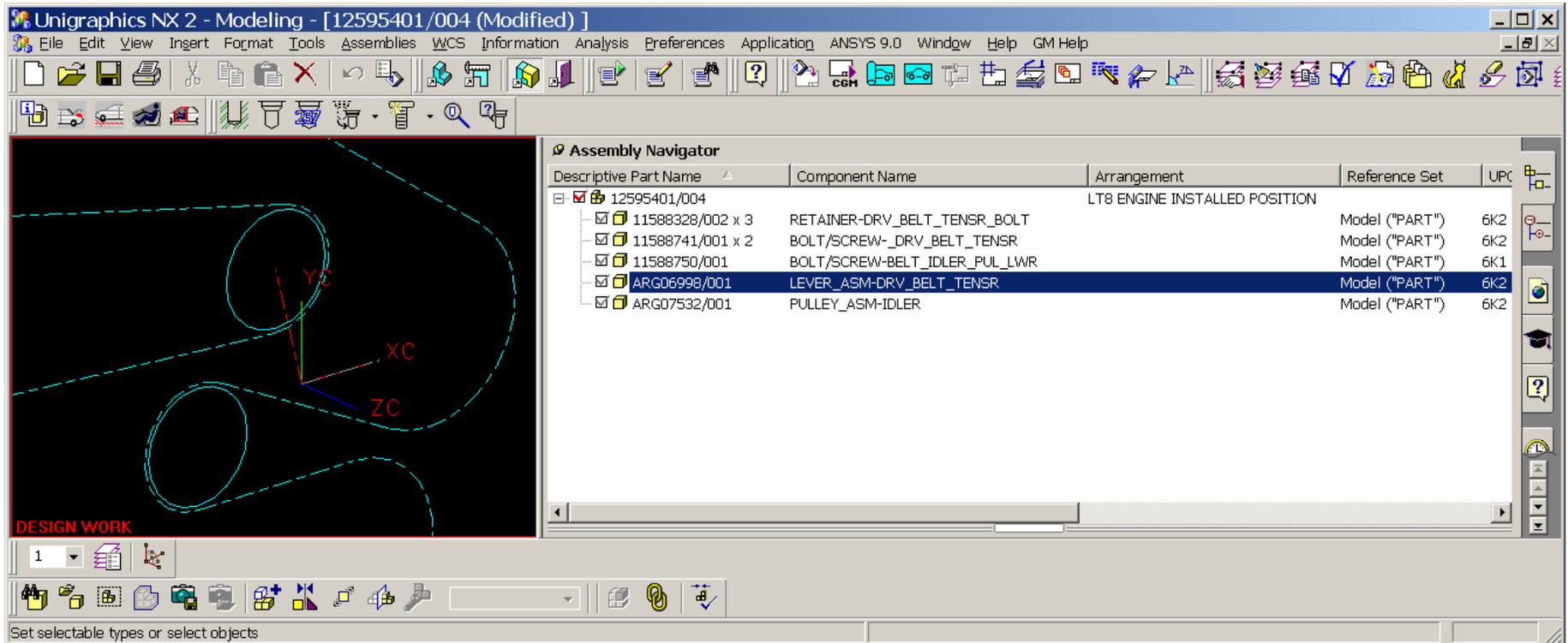
-----
LINKED:LINKED_SKETCH(8) has no parameters

Feature Associativity for: LINKED:LINKED_SKETCH(8)

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=====
```

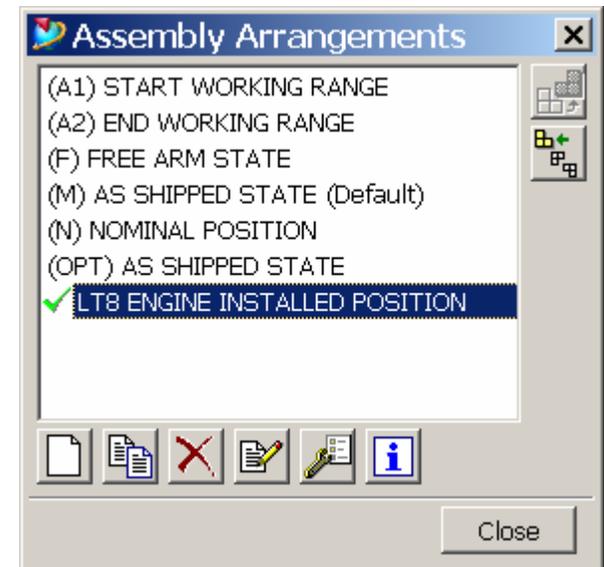
Repositioning the Lever & Pulley Asm for “LT8 ENGINE INSTALLED POSITION”

- “LT8 ENGINE INSTALLED POSITION” Active Arrangement
- Reposition the Lever & Pulley Asm using Assemblies > Components > Reposition Component utilizing the curve from the Linked Sketch.



Tensioner Asm - Other Arrangements

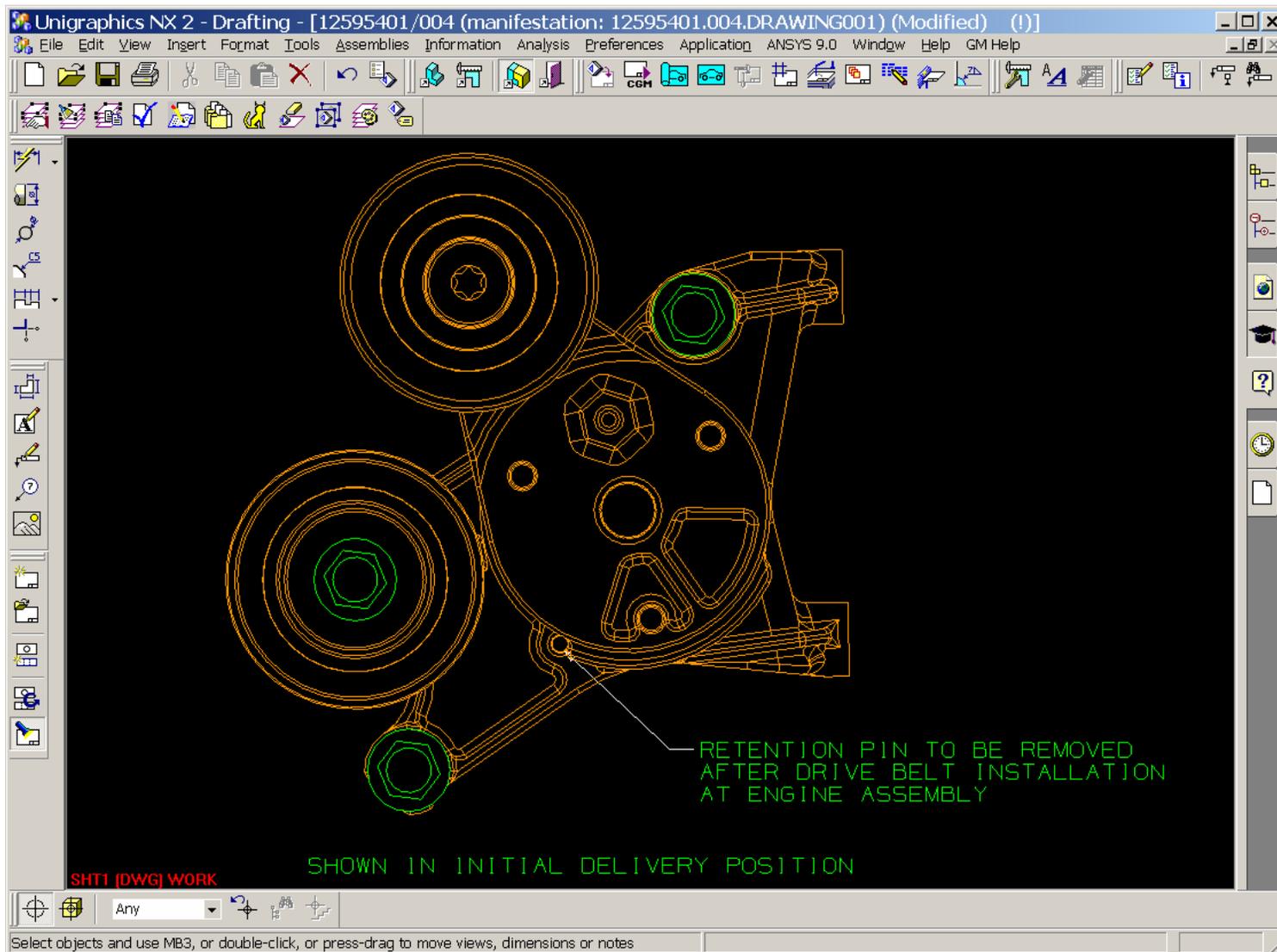
- The existing Arrangement was copied five more times. These were used to show other key positions in the travel and positioning of the components. They were renamed:
- (A1) WORKING RANGE START
- (A2) END WORKING RANGE
- (F) FREE ARM STATE
- (N) NOMINAL POSITION
- (OPT) AS SHIPPED STATE



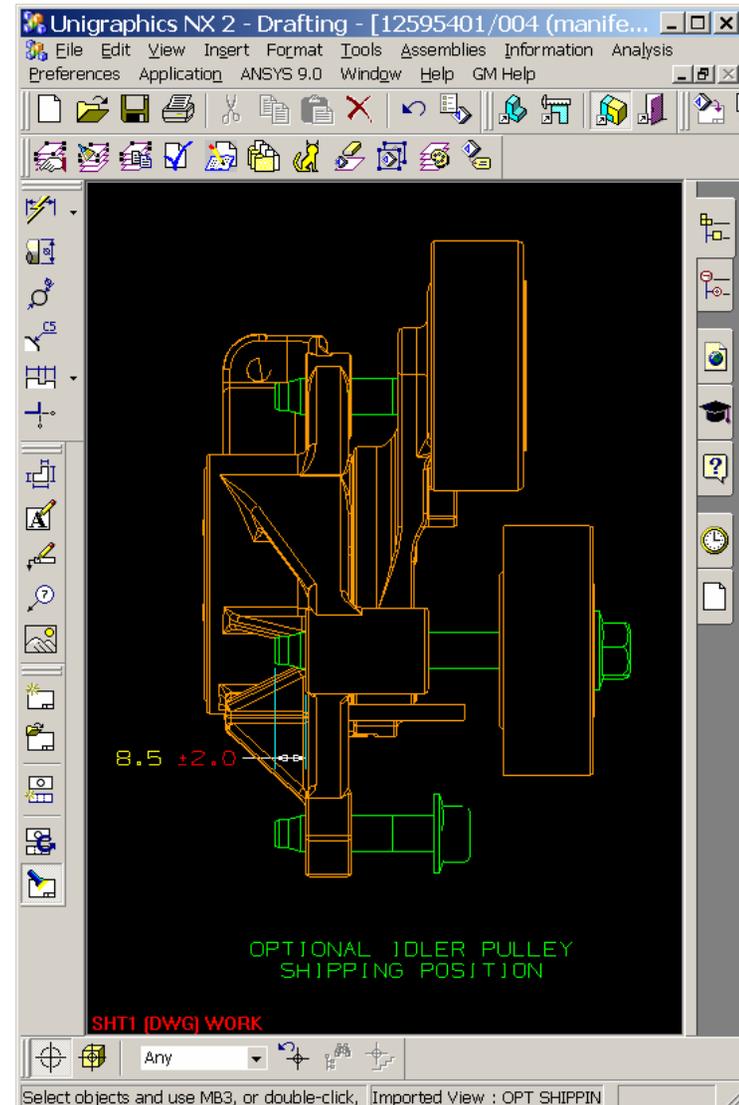
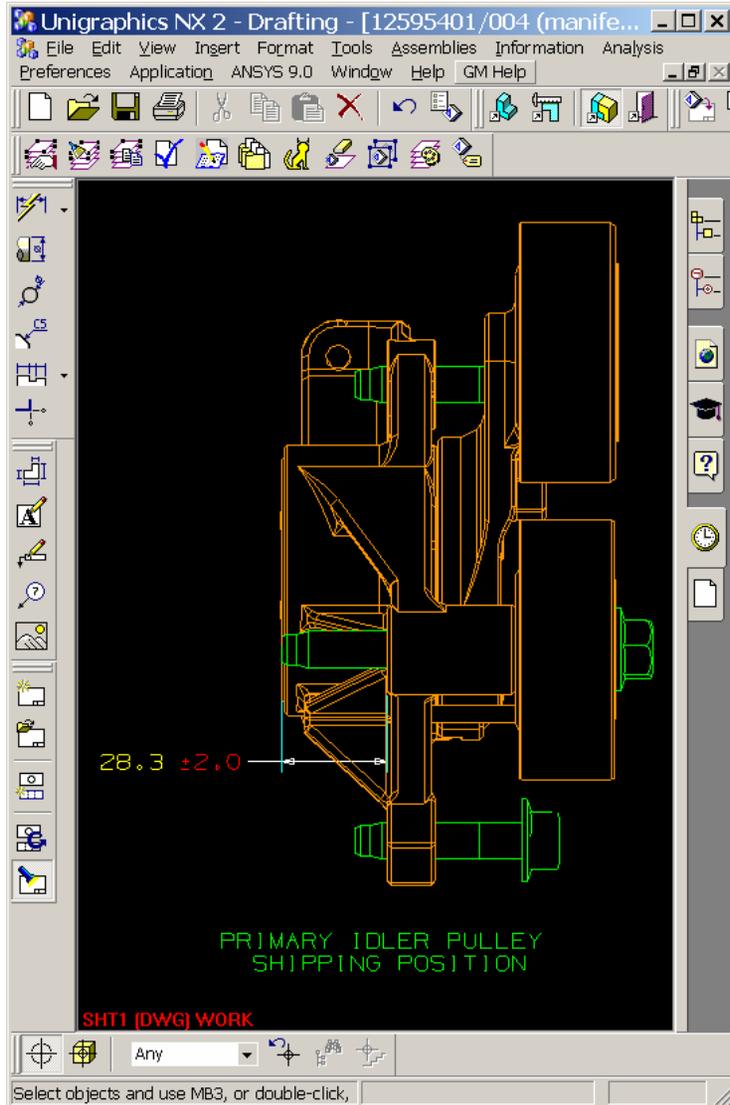
Display of Multiple Arrangements on the same Drawing

- Requires Arrangements in the Drawing file.
- Each “Drawing Arrangement” will use a unique Arrangement of the Tensioner Asm (an Arrangement of an Arrangement)
- “Drawing Arrangement 1” uses “(M) AS SHIPPED STATE” Arrangement
- “Drawing Arrangement 2” uses “(OPT) AS SHIPPED STATE” Arrangement
- An “Exploded View” is used to capture the “(OPT) AS SHIPPED STATE” since Exploded Views are arrangement-specific

Display of Multiple Arrangements on the same Drawing

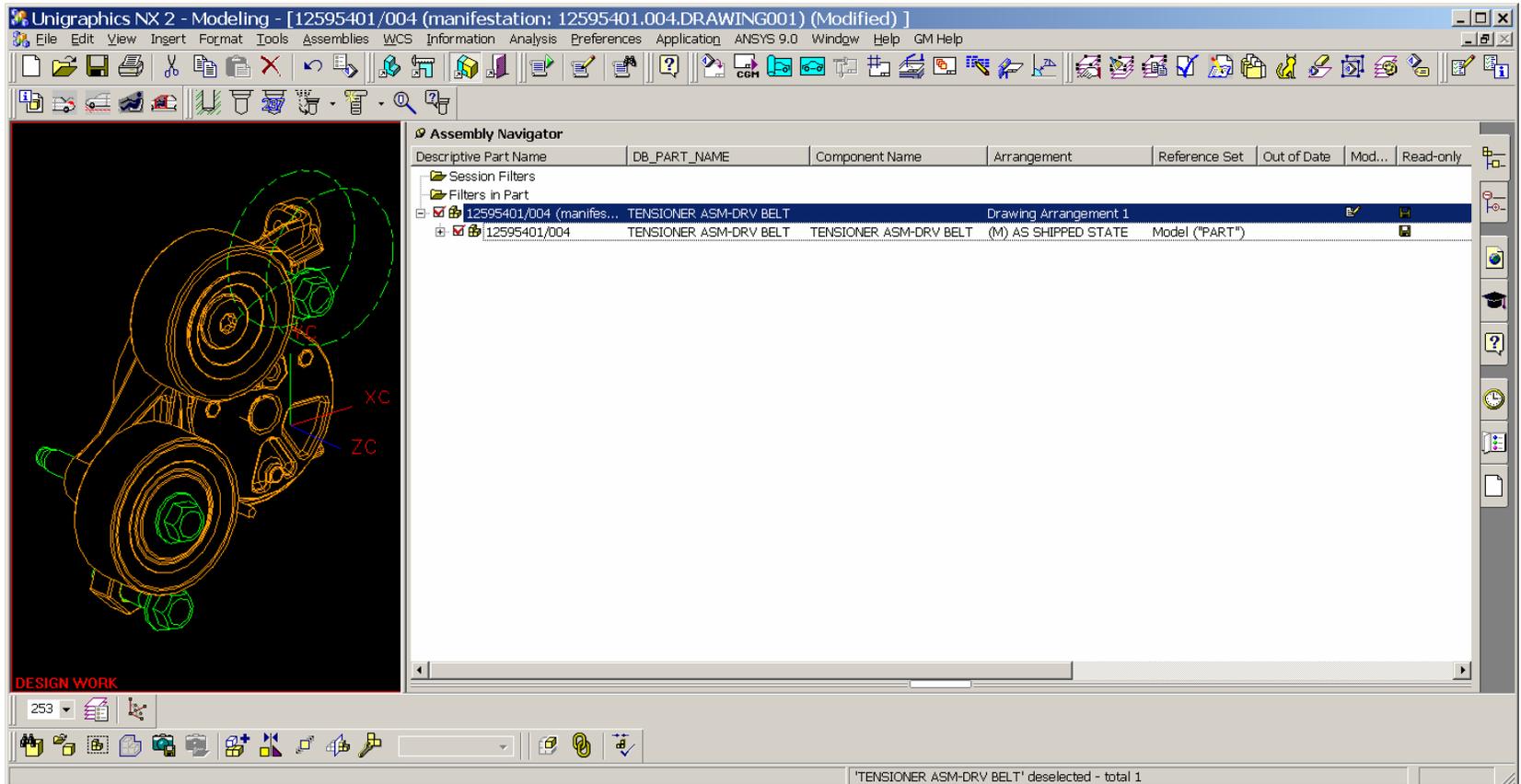


Display of Multiple Arrangements on the same Drawing



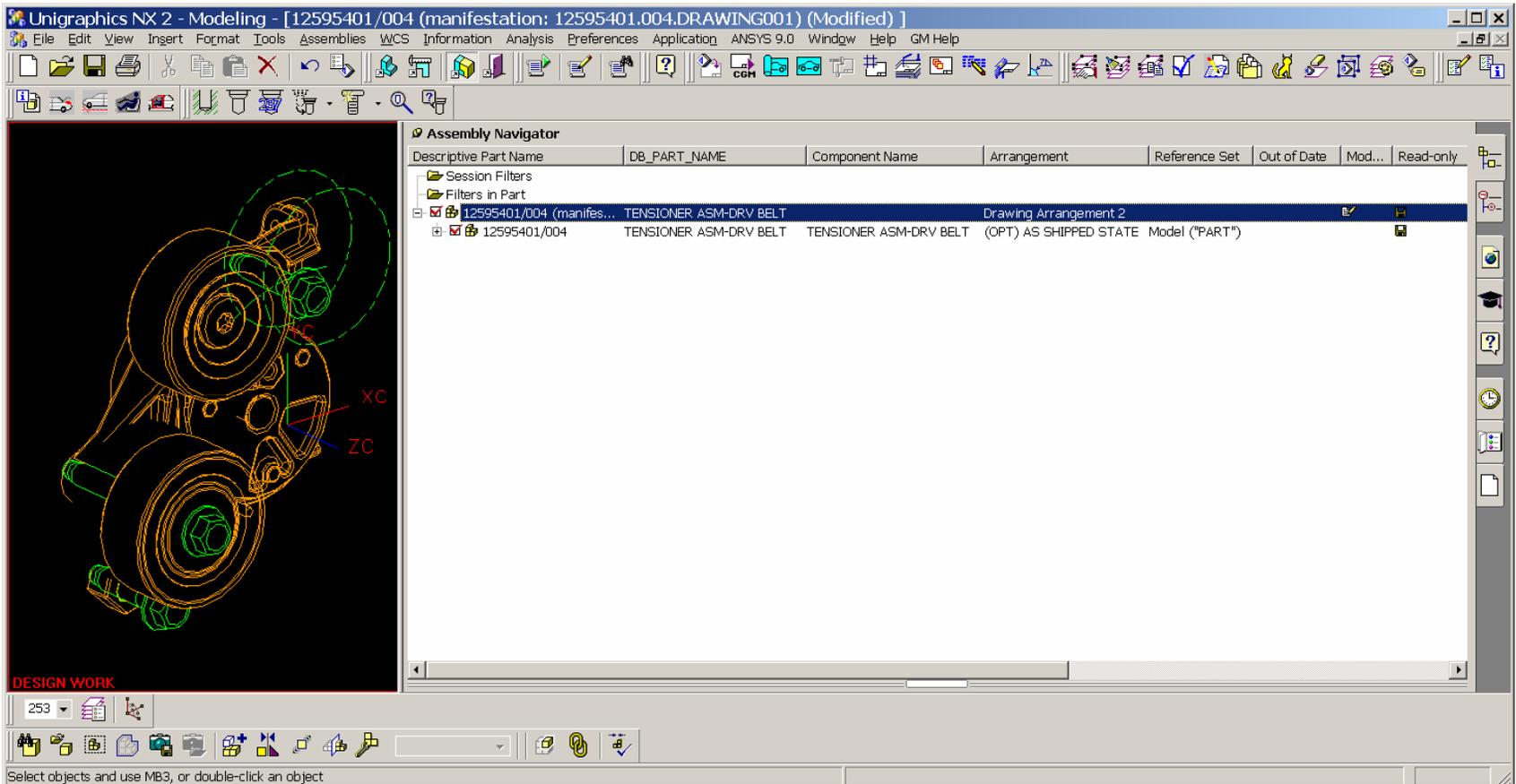
Drawing Arrangement 1

- In the Drawing file, go to the Modeling Application. Rename the default Arrangement to “Drawing Arrangement 1”. Use the “(M) AS SHIPPED STATE” Arrangement of the Tensioner Asm



Drawing Arrangement 2

- Copy “Drawing Arrangement 1” and rename it “Drawing Arrangement 2”
Use the “(OPT) AS SHIPPED STATE” Arrangement of the Tensioner Asm



Creating the “Exploded View”

- With Drawing Arrangement 2 active, orient the view in Modeling to correctly represent the view required on the Drawing
- Select View > Operation > Save-As, enter “OPT SHIPPING STATE” for the name of the view
- To create the Exploded view, select Assemblies > Exploded Views > Create Explosion. Enter “(OPT) AS SHIPPED STATE” for the name of the Explosion

Creating the “Exploded View”

The screenshot displays the Unigraphics NX 2 software interface. The main window shows a 3D model of a mechanical assembly, primarily yellow, with green shafts and bolts. The assembly is partially exploded, with components labeled 'YC' and 'ZC'. The 'LEFT WORK' area is visible at the bottom left of the model.

The 'Assemblies' menu is open, showing the following options:

- Delay Interpart Updates
- Update Session
- Context Control
- Components
- Exploded Views**
 - Create Explosion...
 - Edit Explosion...
 - Auto-explode Components...
 - Unexplode Component
 - Delete Explosion...
 - Hide Explosion
 - Show Explosion
- Sequences
- Variant Configuration...
- Cloning
- Edit Component Arrays...
- WAVE Geometry Linker...
- WAVE Attribute Linker...
- WAVE
- Advanced
- Reports

The 'Navigator' panel on the right shows a table of components:

Component Name	Arrangement	Reference Set	Out of Date	Mod...	Read-only
ASM-DRV BELT		Drawing Arrangement 2			
ASM-DRV BELT TENSIONER ASM-DRV BELT	(OPT) AS SHIPPED STATE	Model ("PART")			

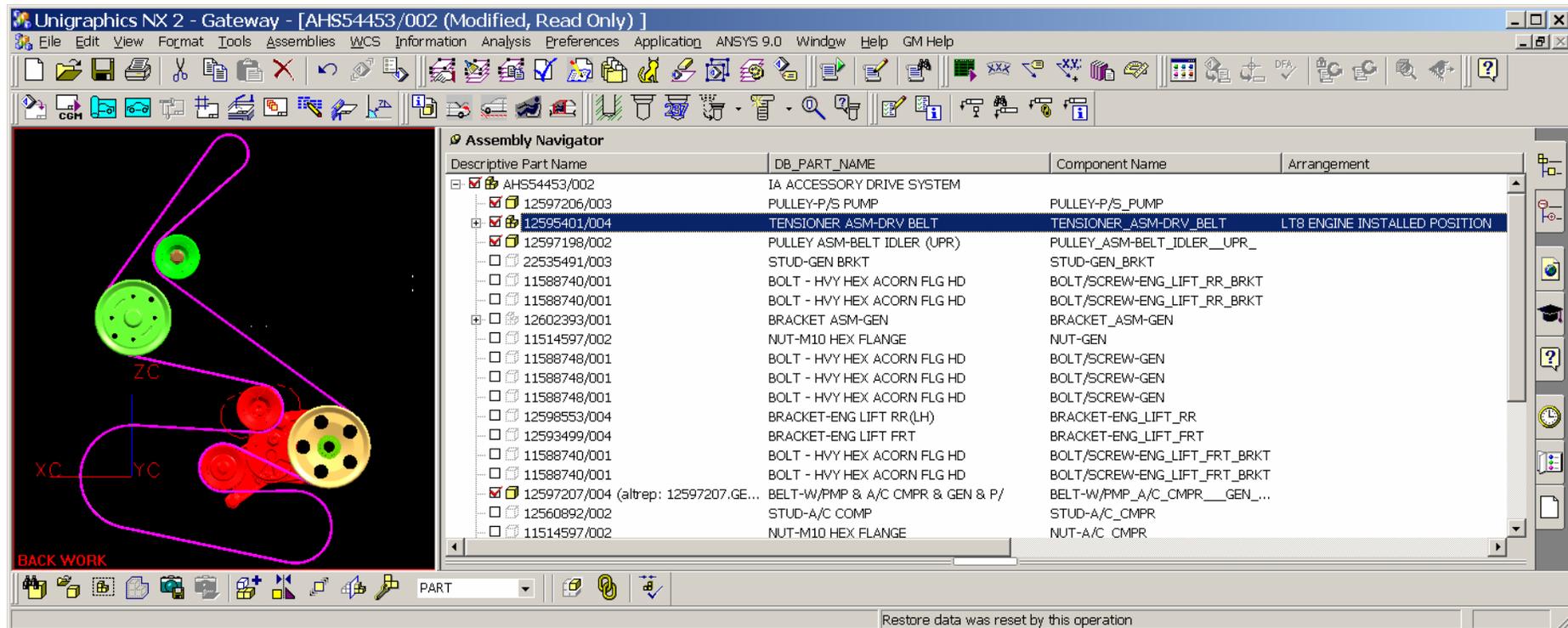
The status bar at the bottom indicates: "Select objects and use MB3, or double-click an object" and "Restore data was reset by this operation".

Placing the Exploded View on the Drawing

- Switch the active arrangement back to “Drawing Arrangement 1”
- Note that the “OPT SHIPPING STATE (EXPLODED)” view retains its “snapshot” of the alternate positions, since Exploded Views are arrangement-specific
- Return to the Drafting Application. Add the “OPT SHIPPING STATE (EXPLODED)” view to the Drawing using the Import View option.
- Remember to have “Drawing Arrangement 1” as the active arrangement prior to performing Update Views

"Installed State" within the Engine Asm File

- Once the Arrangements are created within the TENSIONER ASM, it is a simple matter to edit the IA ACCESSORY DRIVE SYSTEM. Make the "LT8 ENGINE INSTALLED POSITION" the active arrangement and file the IA



The screenshot displays the Unigraphics NX 2 software interface. The main window shows a 3D model of a belt drive system with a purple belt and various pulleys. The Assembly Navigator table is visible, listing parts and their arrangements. The table has four columns: Descriptive Part Name, DB_PART_NAME, Component Name, and Arrangement. The row for 'TENSIONER ASM-DRV BELT' is highlighted, and its arrangement is set to 'LT8 ENGINE INSTALLED POSITION'.

Descriptive Part Name	DB_PART_NAME	Component Name	Arrangement
AHS54453/002	IA ACCESSORY DRIVE SYSTEM		
12597206/003	PULLEY-P/S PUMP	PULLEY-P/S_PUMP	
12595401/004	TENSIONER ASM-DRV BELT	TENSIONER_ASM-DRV_BELT	LT8 ENGINE INSTALLED POSITION
12597198/002	PULLEY ASM-BELT IDLER (UPR)	PULLEY_ASM-BELT_IDLER__UPR_	
22535491/003	STUD-GEN BRKT	STUD-GEN_BRKT	
11588740/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-ENG_LIFT_RR_BRKT	
11588740/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-ENG_LIFT_RR_BRKT	
12602393/001	BRACKET ASM-GEN	BRACKET_ASM-GEN	
11514597/002	NUT-M10 HEX FLANGE	NUT-GEN	
11588748/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-GEN	
11588748/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-GEN	
11588748/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-GEN	
12598553/004	BRACKET-ENG LIFT RR(LH)	BRACKET-ENG_LIFT_RR	
12593499/004	BRACKET-ENG LIFT FRT	BRACKET-ENG_LIFT_FRT	
11588740/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-ENG_LIFT_FRT_BRKT	
11588740/001	BOLT - HVY HEX ACORN FLG HD	BOLT/SCREW-ENG_LIFT_FRT_BRKT	
12597207/004 (altrep: 12597207.GE...	BELT-W/PMP & A/C CMPR & GEN & P/	BELT-W/PMP_A/C_CMPR__GEN...	
12560892/002	STUD-A/C COMP	STUD-A/C_CMPR	
11514597/002	NUT-M10 HEX FLANGE	NUT-A/C_CMPR	

Next Steps

- We would like the functionality to MATE each of the Arrangements uniquely within the Tensioner Asm file to have a truly “Linked” system.
- Datums would be created from the Linked Sketch
- Each Arrangement would then be Mated
- In this manner, the entire system could be driven by one Sketch

Questions

