MODELLING AN AUTOMOTIVE DRIVETRAIN TO PREDICT GEAR RATTLE

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NEW VENTURE GEAR

ABSTRACT

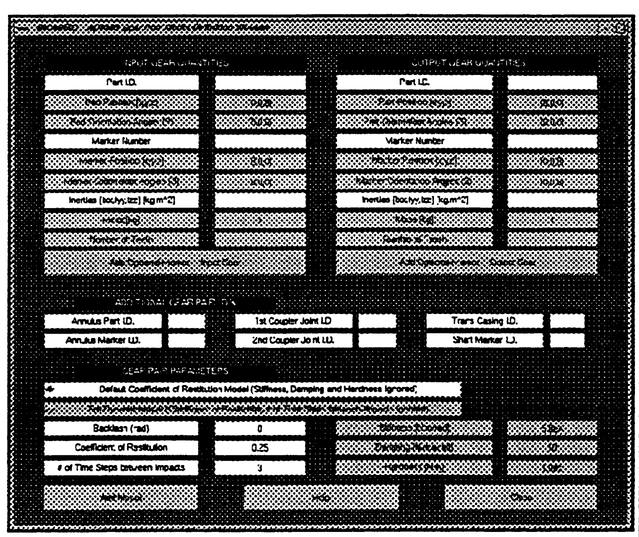
This paper outlines how ADAMS is used for dynamically simulating a rear wheel drive automobile drivetrain. The model is built for analyzing the gear rattle inside the transmission when it is assembled into the drivetrain. The model is made up of separate modules for the different components of the drivetrain. The user describes the parameters of the various components through a separate interface. The interface generates a data set that can then be solved and simulated in ADAMS. An AVIEW interface is also being developed to replace the current interface and enhance the user interaction with the model-building process.

AN overview is also given as to how ADAMS ANIMATION is being used to simulate the operation of an actual transmission.

PRELIMINARY DISCUSSION

We are modelling an automotive drivetrain to predict gear rattle inside the transmission of a rear wheel drive vehicle. What is gear rattle? It is the noise generated when the meshing teeth of a gear pair impact (strike) each other. If they are meshing teeth how can they impact? In a perfect world, they would not ; but for ease of manufacture and assembly some clearance is designed into the meshing pair. How can the teeth separate if the gears are turning and load is being transmitted? Reciprocating engines always generate a pulsating torque signature. Increase and reduction in vehicle speed can also cause the torque to fluctuate.

From the above paragraph it is clear that the gear rattle prediction model has one degree of freedom - rotational. The model consists of separate modules for the engine, the clutch, the transmission and the driveline. Separate interfaces (created in MATLAB) query the user for information specific to each of these components. The interface then generates an ADAMS data set that is then solved in the solver. The data set contains output requests for velocities and accelerations of interest.



MODEL CONSTRUCTION

The top level interface allows the user to pick any one of the separate modules he/she wishes to alter. The separate modules are described below briefly.

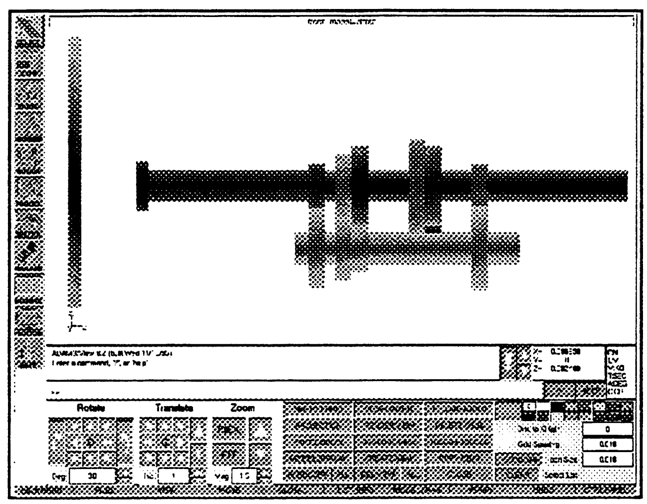
Engine Module: The interface allows us to define engines with different number of cylinders, cylinder sizes, firing order and so on. The user also has the option of using a torque curve generated by an actual engine into the interface.

Clutch Module: The interface allows us to define the various stages, their stiffness, damping and hysterisis properties. Here too the user can opt to insert the torque displacement curve measured off an actual production clutch.

Transmission: The different gear pairs, the backlashes, the shafts etc. are defined in this interface. The gear teeth impacts are modeled with specially written subroutines.

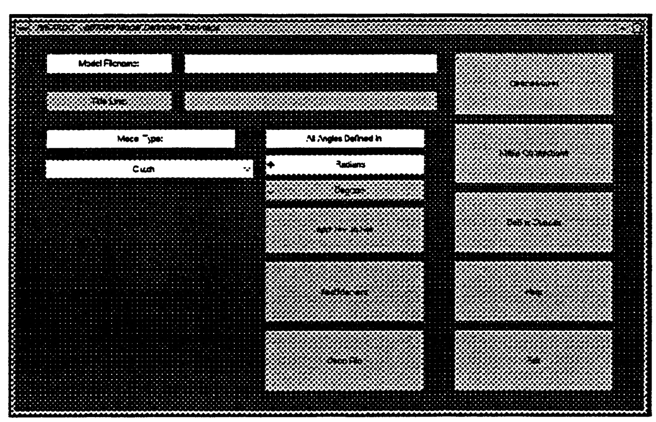
Driveline: The driveline consists of the propeller shaft, the differential, the tires and the wheels. Inertial, spatial and stiffness information of these components need to be inserted into the driveline interface.

The MATLAB interface assimilates all the information in the different modules described above and then generates an ADAMS (*.adm) file that can be read into ADAMS. A simple pictorial representation of the drive-train model is also generated by the interface. A simple AVIEW picture of only the clutch and the transmission is shown here.



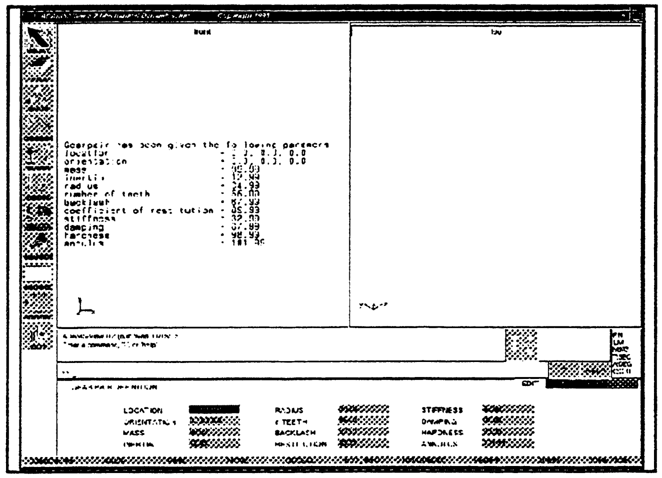
INTERFACES:

The model is currently being developed with an interface written in MATLAB. An example of the top level MATLAB interface is shown here.



Work is currently underway to develop a friendlier interface in ADAMS/VIEW. A first cut at the gear pair modelling interface is shown below. The new interface will also parameterize the model to a larger extent and enable more visual interaction with the model.

POST PROCESSING:



The results generated in ADAMS are in the time domain. They are then transformed into the engine cycle domain using special routines written in MATLAB. The engine cycle domain is more conducive to make comparisons with engine performance.

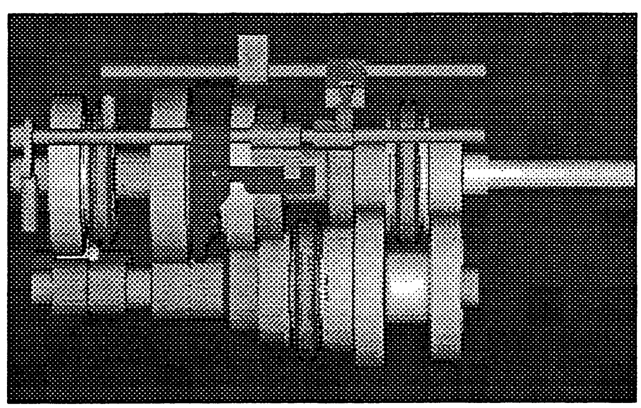
FUTURE WORK:

After validation of predicted results important parameters in the model need to be identified and the ADAMS interface needs to include these parametrizations. A library of the different standard components needs to be compiled so future modelling is made easier. Visual interface to the model will be enhanced.

OTHER WORK IN ADAMS:

Besides the Gear Rattle Modelling project described above, NVG uses ADAMS ANIMATION extensively. We have currently animated one of our transmissions through its six forward speeds and reverse speed. The model is built and animated in AVIEW using only relevant joints and motions on simple stick and disc geometries. The graphics file is then used to animate the actual parts whose geometries are imported from a CAD package.

Recording from ADAMS ANIMATION with different transparency, visibility and frame rate settings a series of *.tiff files can be generated. These files can then be made into a movie file on an SGI machine to create an impressive tool for presentations. Technical details of each component in the transmission will also be available for ready reference at the click of a mouse button. A picture of this animated transmission is shown here.



The overheads that will be shown at the presentation of the paper are attached at the end of this paper.

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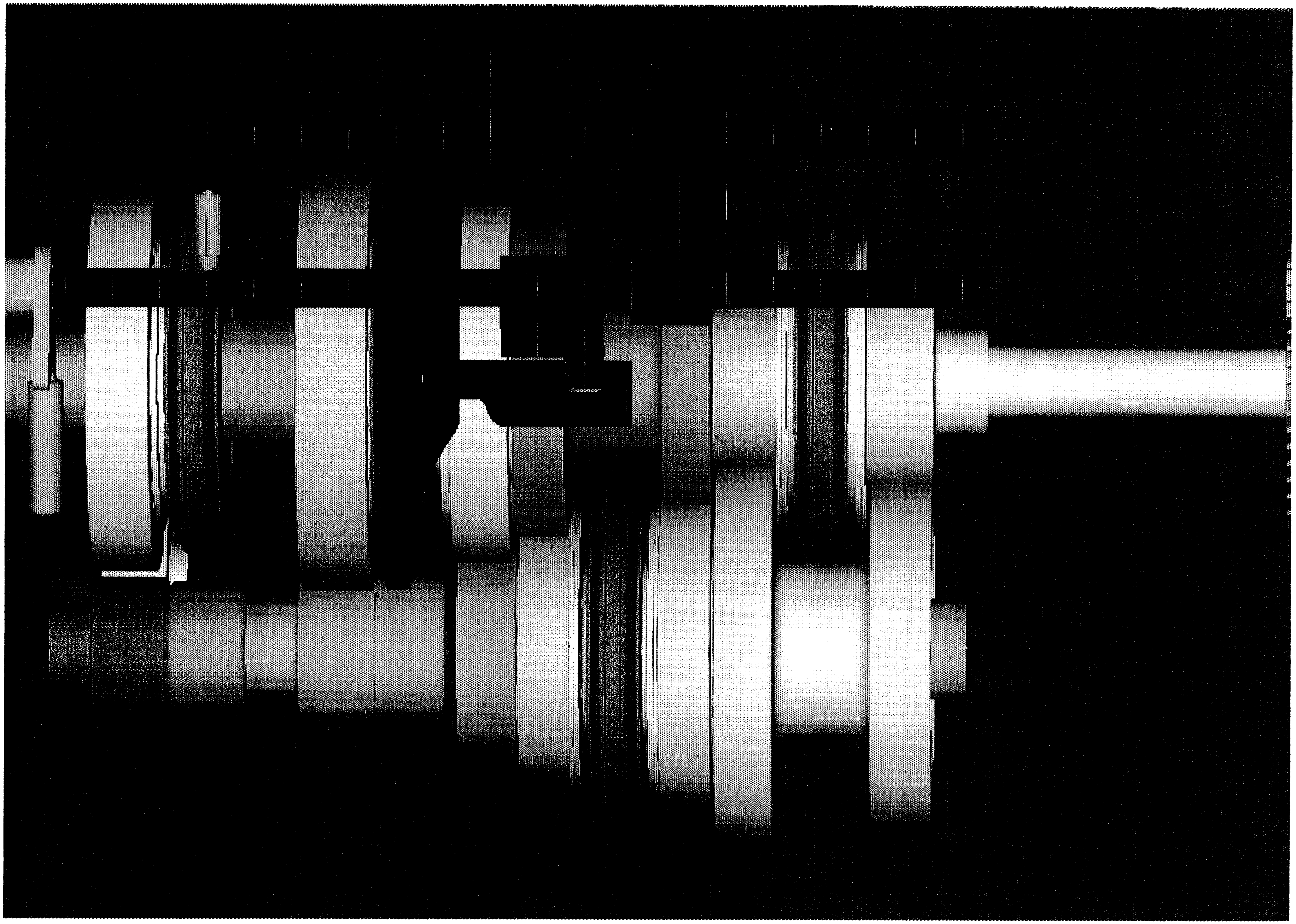

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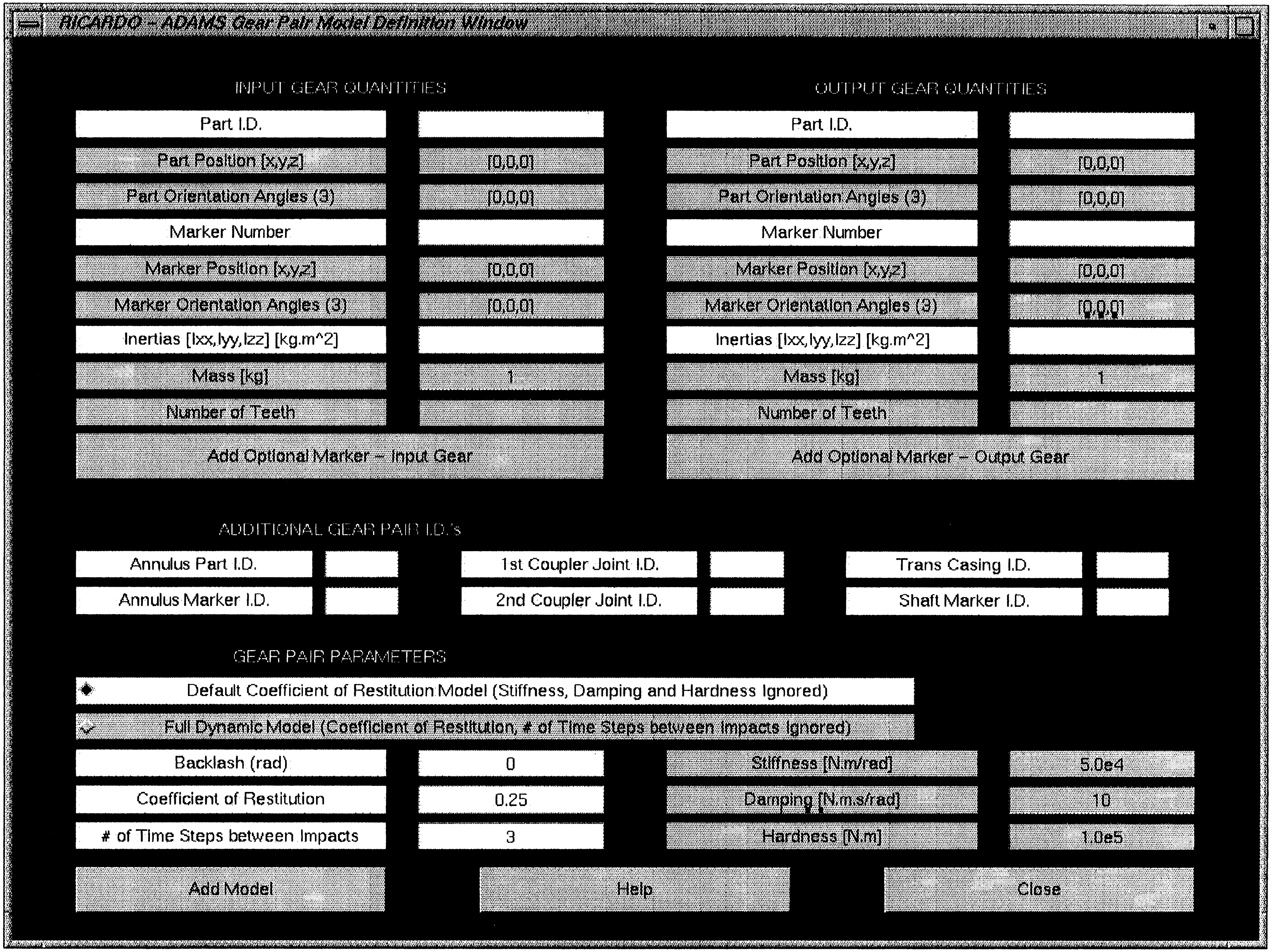

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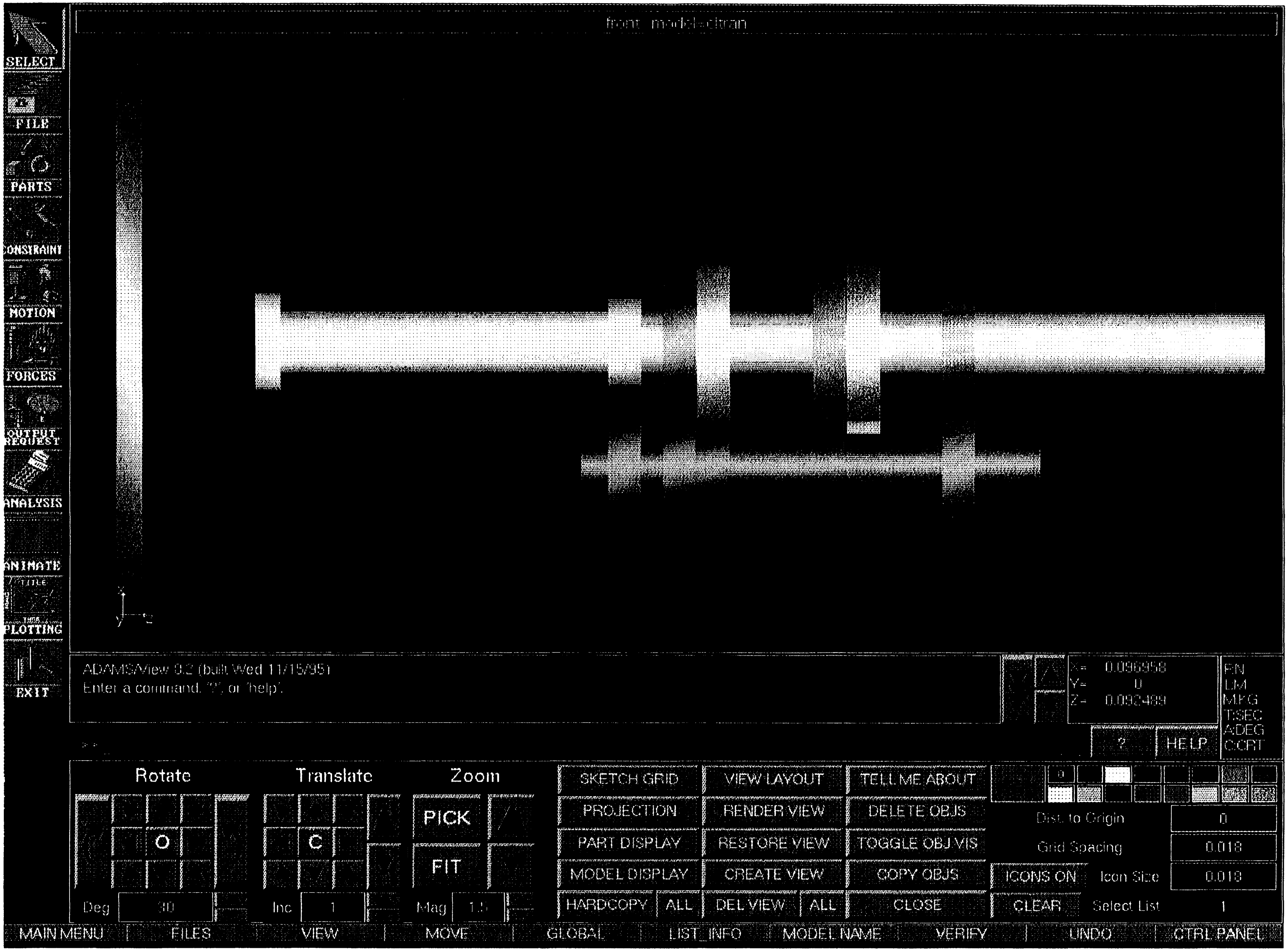

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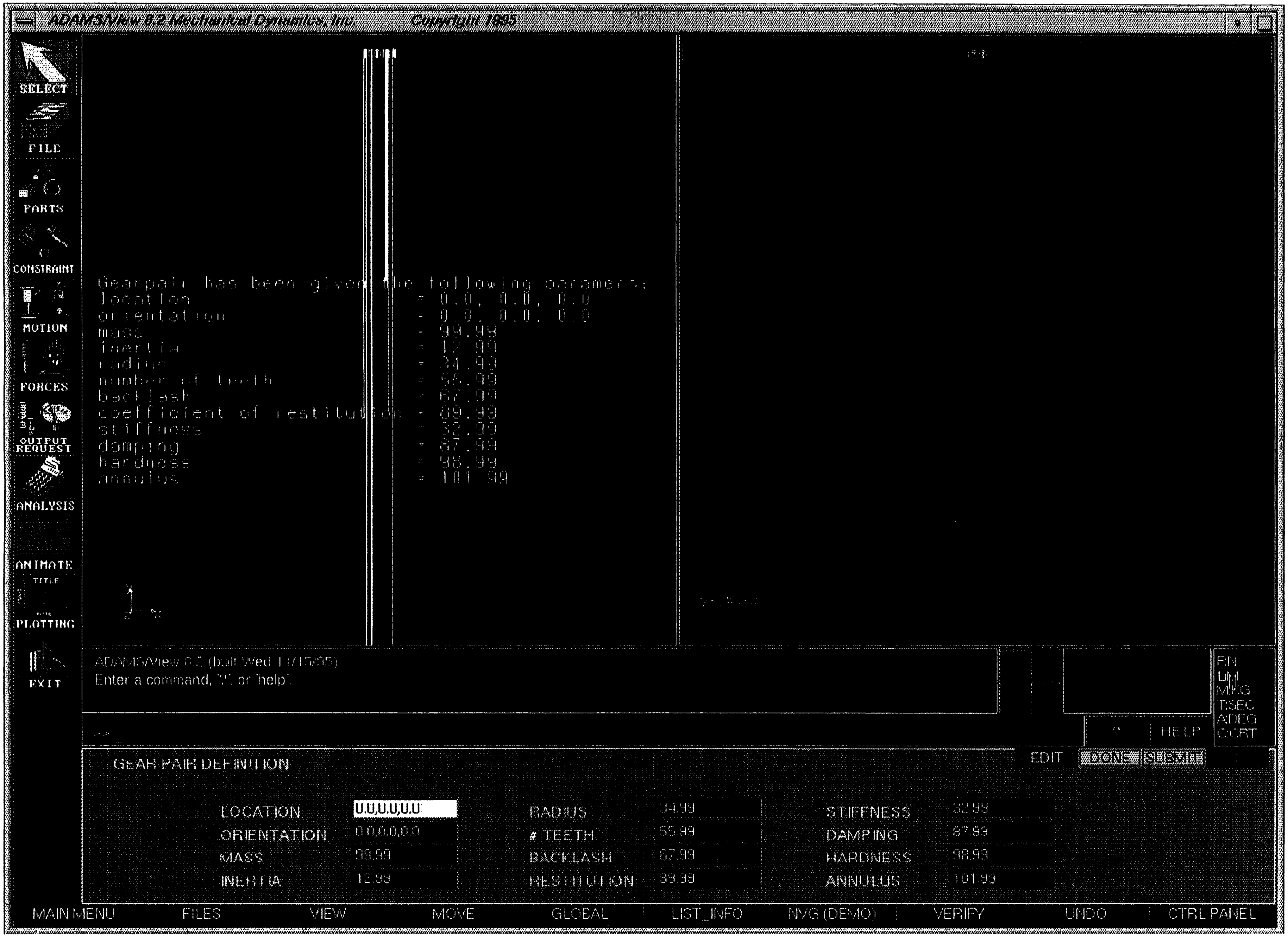

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