

# GENERIC FIGHTER — General Description and guide to files - (incomplete)

---

Simão MARQUES — ECERTA PROJECT TEAM

*CFD Laboratory - University of Liverpool*

*December 2, 2009*

# Configuration

The Generic Fighter Configuration, results from the efforts of trying to build a realistic size aeroelastic test case. The geometry is based on publicly available data for the F-16. The F-16 has a documented history of exhibiting LCOs for certain configurations at specific flight conditions. This prompts a significant research effort using this configuration.

The starting point of this configuration was an artistic impression, general purpose CAD model. The initial model had general dimensions loosely corresponding to the F-16. Several modifications were made to give the model a closer representation of the F-16 aerodynamics; these included changing the twist at the wing root and wing tip and adding leading edge root extensions. To reduce the size of the computational model, the tailplane was removed, originating current configuration shown in figure 1. The correspondent IGES file is available from this website.

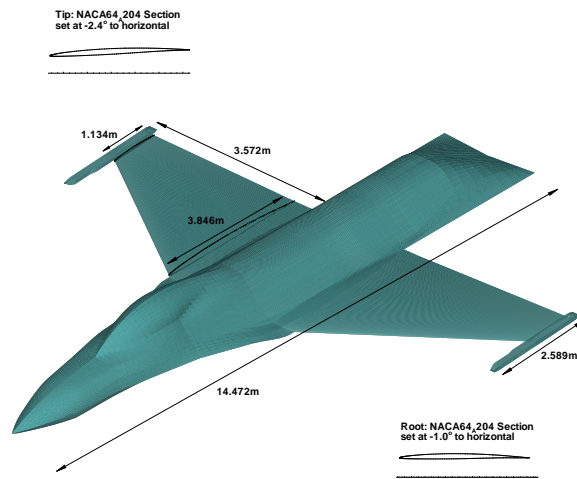


Figure 1: Generic Fighter configuration and dimensions

# MSC. Nastran Structural Model and MatLab mode generation

## MSC. Nastran Structural Model

There is a Nastran input deck that includes the final structural model. This model was based on the work of Cattarius [1]. The planform of the model follows the wing planform and the fuselage dynamical behaviour is modeled through the central section of the model. The actual wing structure is broken down into three distinct parts: root, middle (pylon) and tip. Several different parameters that define the finite elements were selected to perform the finite model updating, originating the current version. In order to parameterise the model to perform interval analysis, the Nastran input deck was split, by removing certain parameters from the main file and specifying them through the parameter file (`parm.dat`). This made the implementation of the optimisation problem more straightforward. In these pages the two formats are made available. The parameter file uses the nominal values, therefore both sets of files produce the same results.

The following files are provided:

- `m16_pp_mode.bdf` - Nastran input deck with frequency analysis
- `struct_m16_pp_upd.dat` - Nastran Structural Finite Element Model
- `parm.dat` - Separate file containing certain parameterised Nastran elements for Structural Model

---

To run the frequency analysis, download and unzip file into a new directory. Run Nastran using the `xxx.bdf` file, e.g.:

```
/home/username> nast2006 m16_pp_mode.bdf
```

The parameters included in `parm.dat` correspond to structural properties which have a high impact on flutter, these are: rotational spring coefficient for the store attachment, the Youngs modulus of the wing root section and the pylon, and the densities for the wing root and tip regions and the pylon.

- rotational spring coefficient
- `struct_m16_pp_upd.dat` - Nastran Structural Finite Element Model
- `parm.dat` - Separate file containing certain parameterised Nastran elements for Structural Model

## MatLab mode generation

Throughout this work, it was necessary to generate new normal modes files automatically. This was implemented in MatLab using the files described above. The MatLab function made available here requires two input arguments: an array with the variation factor for each parameter (in the present case there are six parameters), this is consistent with the parameter file (`parm.dat`); the second argument is an integer, set here to the iteration number, this is used to distinguished between files if the user requires further used of them in the future.

The variation factor array ( $f_i$ ) is intended to contain values that will produce the required update to the structural parameter ( $p_i$ ). For example, the six parameters can have the upper and lower bands formulated according

---

to:

$$\bar{\mathbf{x}} = \begin{bmatrix} k_{\theta_z} \\ E_{Root} \\ E_{Middle} \\ \rho_{Root} \\ \rho_{Middle} \\ \rho_{Tip} \end{bmatrix}; \quad (1)$$

$$p_i = f_i \bar{x}_i \quad (2)$$

$$\begin{bmatrix} 0.85 \\ 0.90 \\ 0.90 \\ 0.90 \\ 0.85 \\ 0.90 \end{bmatrix} \leq \mathbf{f} \leq \begin{bmatrix} 1.15 \\ 1.1 \\ 1.1 \\ 1.1 \\ 1.1 \\ 1.1 \end{bmatrix} \quad (3)$$

# CFD Model

The CFD solver used in this work requires multi-block structured grids. The ICEM Multiblock link downloads two ICEM CFD native files: a geometry file (`xxx.tin`) and a blocking file (`xxx.blk`). A multi-block CGNS formatted grid is also made available; this file has only been tested successfully in Tecplot only. An ASCII version of the multi-block grid generated using the native ICEM files is also provided under the Tecplot link.

# Aeroelastic Calculations



# Bibliography

- [1] Cattarius, J, Numerical Wing/Store Interaction Analysis of a Parametric F-16 Wing, PhD Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S., 1999.