True*Grid*®User's Guide For MPACT®

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Introduction

MPACT® is a three-dimensional Finite Element simulation code. The focus in this manual will be on those features in **True*Grid***® that are specific to creating a **MPACT**® input file. The **True*Grid***® User's Manual covers the creation of a mesh and will not be covered in this manual. This manual is incomplete in another sense because it cannot be used as a substitute for a working knowledge of **MPACT**®.

The output files generated for **MPACT**® and the information below is based on the document **MPACT Model Data Base Interface Reference Manual** and discussions with Pedro Marcal.

Conventions Used In This Document

Different fonts are used through out this manual to indicate their meaning. A keyword command or literal is highlighted in **bold**. A symbol to be substituted with a literal or a number is *italicized*. A computer example uses the `Courier font`.

Command List for MPACT Output

The following is a list of **True*Grid***® commands that can be used to produce features that are unique to an **MPACT**® file.

MPACT® feature	**True*Grid***® commands
choose **MPACT**® output format	**mpact**
change the root name of the output files	**mof**
change to first order elements (default)	**linear**
change to second order elements	**triquadratic**
merge nodes (merge phase only)	**t**, **tp**, **stp**
write the output file (merge phase only)	**write**
create a part	**block**, **cylinder**
create beams within a part	**ibm**, **jbm**, **kbm**
create beams along a 3D curve	**bm**
create beams 1 at a time	**beam**

Boundary Conditions, Loads, and Properties

Boundary conditions, loads, properties, and analysis options are not created in **True*Grid***®. These properties are assigned within **MPACT**®.

MDB Output Files

It is required that the **mpact** command be issued before any parts are generated. This is so that **True*Grid*®** knows to save topological data along with the parts to write the GEO file. For this reason, the **readmesh** command cannot be used, since there is no topology found in other mesh files.

The entities such as nodes, solid elements, shells, and beams will be written to the output file with the suffix ".fe" (FE file).

The BODYELEMENT, FACEELEMENT, and LINEELEMENT data are written to the file with a ".geo" suffix (GEO file). Also, the FaceElFace, EdgeElSide, FaceNode, EdgeNode, and VertexNode cards are written to the ".geo" or geometry file. This data is based on the block topology of the parts generated in **True*Grid*®**. All of the brick elements formed in a part will be found in a BODYELEMENT card, one for each part. All of the shell elements generated in a part will be listed in a FACEELEMENT card, one for each part. All of the beam elements formed in a part will be listed in a LINEELEMENT card, one for each part. Faces, edges, and vertices will reflect the block topology of each part. The intent is to give you control on the regions that you might need to identify when applying boundary conditions or loads in **MPACT®** .

At this time the data file (DAT file) is not produced by **True*Grid*®**.

The default root name for the output files is "trugrdo" (i.e. trugrdo.fe and trugrdo.geo) which can be switched using the **mof** command.

Elements Types

The default (**linear** command) first order element types are 8-noded hexahedral (HEXA8) brick elements, 3-noded triangular shell elements (SHELL3) or 4-noded quad shell elements (SHELL4), and 2-noded beam (BEAM) elements.

Second order elements can be generated by issuing the **triquadratic** command prior to any part commands (**block** or **cylinder**). Do not use the **quadratic** command. The **quadratic** command will cause the generation of 20-noded hexa brick elements and 8-noded quad shell elements which will be ignored when the output file is written.

The second order element types are 27-noded hexahedral (HEXA27) brick elements, 6-noded triangular shell elements (SHELL6) or 4-noded quad shell elements (SHELL9), and 3-noded beam (BEAM3) elements.

There is a caveat with second order triangular shell elements. While in the merge phase, you will see that these elements have a center node. When the elements are written to the output files, these nodes disappear. This means that the node numbering in the **MPACT®** MDB files will differ from what

will appear in **True*Grid*®** graphics. This center node is necessary because of the nature of the **True*Grid*®** parts.

Use the **block** or **cylinder** commands to create shell or brick elements. Beams can be embedded into the brick or shell parts using the **ibm**, **jbm**, or **kbm** commands. Alternatively, the **bm** command can be used in the merge phase to form beam elements along a 3D curve. As a last resort, use the deprecated **beam** part command to form beams, 1 at a time.

When merging nodes in the merge phase, be sure that no brick elements have collapsed or degenerate edges due to merging, since these elements would be illegal and **True*Grid*®** will give you a warning message when thee output files are written. The only degenerate or collapsed edge that is allowed is with a quad shell element where one edge has been collapsed to form a triangle.

Example 1 - First Order HEXA

True*Grid*® Input

```
mof lhexa
mpact
block 1 2; 1 2; 1 2; 1 2; 1 2; 1 2;
merge
writ
```

lhexa.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          8 Total Elems =          1 */
node         1   1.         1.         1.
node         2   1.         1.         2.
node         3   1.         2.         1.
node         4   1.         2.         2.
node         5   2.         1.         1.
node         6   2.         1.         2.
node         7   2.         2.         1.
node         8   2.         2.         2.
HEXA8        1     1          5          7          1          3
       6           8          2          4
```

lhexa.geo output file

```
FaceNode         1         1         2         3         4
FaceElFace       2         1 2
FaceNode         2         5         6         7         8
FaceElFace       3         1 0
FaceNode         3         1         2         5         6
FaceElFace       4         1 1
FaceNode         4         3         4         7         8
FaceElFace       5         1 4
FaceNode         5         1         3         5         7
FaceElFace       6         1 5
FaceNode         6         2         4         6         8
EdgeElSide       1        1         1        3  3
EdgeNode         1         1         3
EdgeElSide       2        1         1        2 12
EdgeNode         2         1         2
EdgeElSide       3        1         2        4  7
EdgeNode         3         2         4
EdgeElSide       4        1         3        4 11
EdgeNode         4         3         4
EdgeElSide       5        1         5        6  9
EdgeNode         5         5         6
```

```
EdgeElSide        6         1         5         7   1
EdgeNode          6          5          7
EdgeElSide        7         1         6         8   5
EdgeNode          7          6          8
EdgeElSide        8         1         7         8  10
EdgeNode          8          7          8
EdgeElSide        9         1         1         5   4
EdgeNode          9          1          5
EdgeElSide       10         1         2         6   8
EdgeNode         10          2          6
EdgeElSide       11         1         3         7   2
EdgeNode         11          3          7
EdgeElSide       12         1         4         8   6
EdgeNode         12          4          8
VertexNode            1          1
VertexNode            2          2
VertexNode            3          3
VertexNode            4          4
VertexNode            5          5
VertexNode            6          6
VertexNode            7          7
VertexNode            8          8
```

Example 2 - First Order Quad

True*Grid*® Input

```
mof lquads
mpact
block 1 2;1 2;-1;1 2 1 2 0
merge
write
```

lquad.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          4 Total Elems =          1 */
node         1   1.         1.        0.E+00
node         2   1.         2.        0.E+00
node         3   2.         1.        0.E+00
node         4   2.         2.        0.E+00
SHELL4        1     1          1          3          2          4
```

lquad.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
FaceElement          1         1
FaceNode         1         1         2         3         4
EdgeElSide       1        1        1        2  1
EdgeNode         1         1         2
EdgeElSide       2        1        1        3  3
EdgeNode         2         1         3
EdgeElSide       3        1        2        4  4
EdgeNode         3         2         4
EdgeElSide       4        1        3        4  2
EdgeNode         4         3         4
VertexNode          1         1
VertexNode          2         2
VertexNode          3         3
VertexNode          4         4
```

Example 3 - First Order Triangle

True*Grid*® Input

```
mof ltri
mpact
block 1 2;1 2;-1;1 2 1 2 0
pb 2 1 1 2 2 1 y 1.5
merge
stp .001
write
```

ltri.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          3 Total Elems =          1 */
node         1   1.          1.        0.E+00
node         2   1.          2.        0.E+00
node         3   2.          1.5       0.E+00
SHELL3        1     1          1          3          2
```

ltri.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
FaceElement          1         1
FaceNode         1         1         2         3
EdgeElSide       1        1        1        3  1
EdgeNode         1         1         3
EdgeElSide       2        1        1        2  3
EdgeNode         2         1         2
EdgeElSide       3        1        2        3  2
EdgeNode         3         2         3
VertexNode          1         1
VertexNode          2         2
VertexNode          3         3
```

Example 4 - First Order Beams

True*Grid*® Input

```
mof lbeam
mpact
block 1 2;1 2;-1;1 2 1 2 0
ibm 1 1 1 2 2 1 2 1 1 j 1 ;
mate 0
merge
writ
```

lbeam.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          4 Total Elems =          2 */
node         1   1.         1.        0.E+00
node         2   1.         2.        0.E+00
node         3   2.         1.        0.E+00
node         4   2.         2.        0.E+00
BEAM        1     1          1          3
BEAM        2     1          2          4
```

lbeam.geo output file

```
//* MPACT Geo File. Generated by TrueGrid.*/
LineElement          1         1
LineElement          2         2
```

Example 5 - Second Order HEXA

True*Grid*® Input

```
mof qhexa
triquadratic
mpact
block 1 2; 1 2; 1 2; 1 2; 1 2; 1 2;
merge
write
```

qhexa.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =         27 Total Elems =          1 */
node          1   1.          1.          1.
node          2   1.          1.          1.5
node          3   1.          1.          2.
node          4   1.          1.5         1.
node          5   1.          1.5         1.5
node          6   1.          1.5         2.
node          7   1.          2.          1.
node          8   1.          2.          1.5
node          9   1.          2.          2.
node         10   1.5         1.          1.
node         11   1.5         1.          1.5
node         12   1.5         1.          2.
node         13   1.5         1.5         1.
node         14   1.5         1.5         1.5
node         15   1.5         1.5         2.
node         16   1.5         2.          1.
node         17   1.5         2.          1.5
node         18   1.5         2.          2.
node         19   2.          1.          1.
node         20   2.          1.          1.5
node         21   2.          1.          2.
node         22   2.          1.5         1.
node         23   2.          1.5         1.5
node         24   2.          1.5         2.
node         25   2.          2.          1.
node         26   2.          2.          1.5
node         27   2.          2.          2.
HEXA27         1     1         19          22          25
                               10          13          16
                                1           4           7
                               20          23          26
                               11          14          17
                                2           5           8
```

```
                              21          24          27
                              12          15          18
                               3           6           9
```

qhexa.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
BodyElement           1          1
FaceElFace         1          1 3
FaceNode           1          1          2          3          4
5          6          7
                      8          9
FaceElFace         2          1 2
FaceNode           2         19         20         21         22
23         24         25
                     26         27
FaceElFace         3          1 0
FaceNode           3          1          2          3         10
11         12         19
                     20         21
FaceElFace         4          1 1
FaceNode           4          7          8          9         16
17         18         25
                     26         27
FaceElFace         5          1 4
FaceNode           5          1          4          7         10
13         16         19
                     22         25
FaceElFace         6          1 5
FaceNode           6          3          6          9         12
15         18         21
                     24         27
EdgeElSide         1          1          1          3  3
EdgeNode           1          1          2          3
EdgeElSide         2          1          1          7 12
EdgeNode           2          1          4          7
EdgeElSide         3          1          3          9 11
EdgeNode           3          3          6          9
EdgeElSide         4          1          7          9  7
EdgeNode           4          7          8          9
EdgeElSide         5          1         19         21  9
EdgeNode           5         19         20         21
EdgeElSide         6          1         19         25  1
EdgeNode           6         19         22         25
EdgeElSide         7          1         21         27  5
EdgeNode           7         21         24         27
EdgeElSide         8          1         25         27 10
EdgeNode           8         25         26         27
EdgeElSide         9          1          1         19 12
```

```
EdgeNode          9          1         10         19
EdgeElSide       10         1         3        21  9
EdgeNode         10          3         12         21
EdgeElSide       11         1         7        25  2
EdgeNode         11          7         16         25
EdgeElSide       12         1         9        27  6
EdgeNode         12          9         18         27
VertexNode            1          1
VertexNode            2          3
VertexNode            3          7
VertexNode            4          9
VertexNode            5         19
VertexNode            6         21
VertexNode            7         25
VertexNode            8         27
```

Example 6 - Second Order Quad

True*Grid*® Input

```
mof qquads
mpact
triquadratics
block 1 2;1 2;-1;1 2 1 2 0
merge
write
```

qquads.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          9 Total Elems =          1 */
node          1   1.          1.         0.E+00
node          2   1.          1.5        0.E+00
node          3   1.          2.         0.E+00
node          4   1.5         1.         0.E+00
node          5   1.5         1.5        0.E+00
node          6   1.5         2.         0.E+00
node          7   2.          1.         0.E+00
node          8   2.          1.5        0.E+00
node          9   2.          2.         0.E+00
SHELL9         1     1          1          4          7
                                2          5          8
                                3          6          9
```

qquads.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
FaceNode          1          1          2          3          4
5          6          7
                     8          9
EdgeElSide        1         1         1         3  1
EdgeNode          1          1          2          3
EdgeElSide        2         1         1         7  3
EdgeNode          2          1          4          7
EdgeElSide        3         1         3         9  4
EdgeNode          3          3          6          9
EdgeElSide        4         1         7         9  2
EdgeNode          4          7          8          9
VertexNode           1          1
VertexNode           2          3
VertexNode           3          7
VertexNode           4          9
```

Example 7 - Second Order Triangle

True*Grid*® Input

```
mof qtri
mpact
triquadratic
block 1 2;1 2;-1;1 2 1 2 0
pb 2 1 1 2 2 1 y 1.5
merge
stp .001
write
```

qtri.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          6 Total Elems =          1 */
node         1   1.         1.        0.E+00
node         2   1.         1.5       0.E+00
node         3   1.         2.        0.E+00
node         4   1.5        1.25      0.E+00
node         5   1.5        1.75      0.E+00
node         6   2.         1.5       0.E+00
SHELL6        1     1          3          2          1
                               5          4          6
```

qtri.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
FaceNode         1         1         2         3         4
5         6
EdgeElSide       1        1        1        6  1
EdgeNode         1         1          4          6
EdgeElSide       2        1        1        3  3
EdgeNode         2         1          2          3
EdgeElSide       3        1        3        6  2
EdgeNode         3         3          5          6
VertexNode          1         1
VertexNode          2         3
VertexNode          3
```

Example 8 - Second Order Beams

True*Grid*® Input

```
mof qbeam
mpact
triquadratic
block 1 2;1 2;-1;1 2 1 2 0
ibm 1 1 1 2 2 1 2 1 1 j 1 ;
mate 0
merge
write
```

qbeam.fe output file

```
/* MPACT Finite Element Data File. Generated by TrueGrid
  Total Nodes =          6 Total Elems =          2 */
node          1   1.          1.         0.E+00
node          2   1.          2.         0.E+00
node          3   1.5         1.         0.E+00
node          4   1.5         2.         0.E+00
node          5   2.          1.         0.E+00
node          6   2.          2.         0.E+00
BEAM3         1     1           1           3           5
BEAM3         2     1           2           4           6
```

qbeam.geo output file

```
/* MPACT Geo File. Generated by TrueGrid.*/
LineElement          1          1
LineElement          2          2
```

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