

# A Customized Job Manager for Metal Forming Simulations with LS-DYNA<sup>®</sup>

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## Abstract

*In the metal forming analysis, the simulation time of each job is relatively short. However, due to the iterative modifications of the forming tools based on the simulation results, generally there would be several numerical tryouts. Also in addition to those with a single keyword file input, the number of simulation jobs consisting of several (e.g. the progressive die forming) or even dozens of sequential simulations (e.g. the iterative springback compensation process), is increasing. In comparison to conventional simulations, simulation submission and file management of these jobs have become more time-consuming. Therefore, a simple application (Job Manager) has been customized for LS-DYNA metal forming users to manage the simulation jobs more efficiently and reduce the total time cost.*

## Introduction

In metal forming analysis, the simulation time of each numerical tryout is relatively short, but generally there would be many tryouts due to iterative modifications of the forming tools based on the simulation results. To reduce the total time cost and avoid the tedious file management, it would be nice to provide a Graphic User Interface (GUI) for the user to manage the simulation jobs effectively (e.g. simplified submission procedures and quick file operations on the results), especially in case of simulation jobs that consist of several (e.g. the progressive die forming) or even dozens of sequential simulations (e.g. the iterative springback compensation process). Based on these traits, a simple application (Job Manager) has been customized for our metal forming users with the intention to help them manage the simulation jobs.

## Applications and settings of Job Manager

### The submission of a multi-OP simulation

For multi-OP (i.e. multiple stages) simulations such as progressive die forming or springback compensation, the sequential submission of its OPs /stages is needed. In most cases the precisions and the version of the solver would differ in different OPs. For example, the OP of implicit gravity or springback requires the double precision solver, yet for the drawing and flanging simulations the single precision solver would be adequate with faster simulation time; While new features are needed in trimming or springback compensation, official releases are still recommended for other common processes (e.g. drawing) because they are more stable. Currently LS-PrePost<sup>®</sup> EZSetup has supported the setup of these jobs for metal forming users. The simulation of each OP will be performed in its own folder, making it clearer to process the results. A batch file will be created by LS-PrePost EZSetup to perform the simulations. Now a GUI called Job manager has been further customized with enhanced features for the users to manage the simulation jobs more easily.

The submission of a multi-OP job in Job Manager is shown in Fig. 1. The batch file created by LS-PrePost EZsetup can be directly loaded into Job Manager. Automatic detection of the job status can help the user easily start or resume the workflow, without checking which of the OPs are already completed. For these multi-OP jobs, file cleaning is another time-consuming task for forming users, since a large number of files would be created. In the newly developed Job Manager, a job file clean filter is preset and can be customized by the user to clean all unneeded files with one simple click.

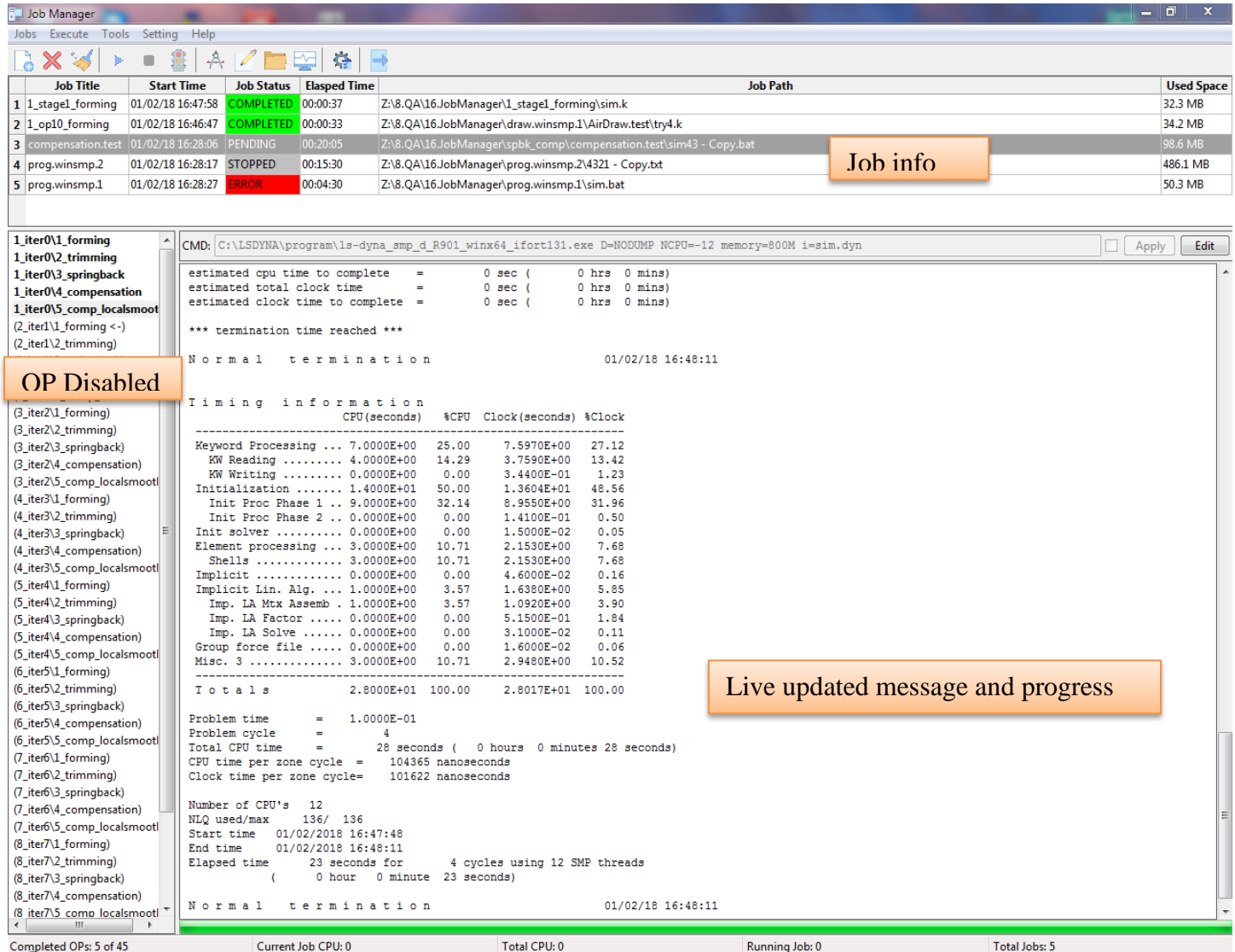


Fig.1 Multi-OP submission from the EZsetup batch file in Job Manager

### The submission of a single process simulation

A common single submission (e.g. a single drawing simulation or the blank shape estimation with the one step method) is also supported by Job Manager. As shown in Fig.2, the solution settings allow the user to select the preset default solvers, CPU and memory parameters, or directly browse for another solver and input the solution parameters manually (see next section)

The screenshot shows the Job Manager interface with a table of jobs and a terminal window displaying simulation output.

Job Title	Start Time	Job Status	Elapsed Time	Job Path	Used Space
1_stage1_forming	01/02/18 16:47:58	RUNNING	00:00:30	Z:\8.QA\16.JobManager\1_stage1_forming\sim.k	1.1 MB
2_op10_forming	01/02/18 16:46:47	COMPLETED	00:00:33	Z:\8.QA\16.JobManager\draw.winsmp.1\AirDraw.test\try4.k	34.2 MB
3_compensation.test	01/02/18 16:28:06	PENDING	00:20:05	Z:\8.QA\16.JobManager\spbcomp\compensation.test\sim43 - Copy.bat	98.6 MB
4_prog.winsmp.2	01/02/18 16:28:17	STOPPED	00:15:30	Z:\8.QA\16.JobManager\prog.winsmp.2\4321 - Copy.txt	486.1 MB
5_prog.winsmp.1	01/02/18 16:28:27	ERROR	00:04:30	Z:\8.QA\16.JobManager\prog.winsmp.1\sim.bat	50.3 MB

The terminal window shows the following output:

```

CMD: C:\LS-DYNA\program\ls-dyna_smp_s_R901_winx64_ifort131.exe ncpu=-8 memory=600m i=sim.k d=nodump
Memory required to begin solution      : 1278K
Additional dynamically allocated memory: 532K
Total: 1809K
2846 t 5.1228E-03 dt 1.80E-06 flush i/o buffers          01/02/18 16:48:24
initialization completed
3085 t 5.5512E-03 dt 1.80E-06 write d3plot file           01/02/18 16:48:24
3085 t 5.5530E-03 dt 1.80E-06 write adaptivity stress file 01/02/18 16:48:24
3085 t 5.5530E-03 dt 1.80E-06 increase shells from 4324 to 4324
3085 t 5.5530E-03 dt 1.80E-06 increase shells from 4324 to 4324
3085 t 5.5530E-03 dt 1.80E-06 increase shells from 4324 to 4324
Memory required to process keyword      : 934418
input of data is completed
Memory required to begin solution      : 1278K
Additional dynamically allocated memory: 532K
Total: 1809K
3085 t 5.5530E-03 dt 1.80E-06 flush i/o buffers          01/02/18 16:48:25
initialization completed
3324 t 5.9832E-03 dt 1.80E-06 write adaptivity stress file 01/02/18 16:48:26
3324 t 5.9832E-03 dt 1.80E-06 increase shells from 4324 to 4324
3324 t 5.9832E-03 dt 1.80E-06 increase shells from 4324 to 4324
3324 t 5.9832E-03 dt 1.80E-06 increase shells from 4324 to 4324
Memory required to process keyword      : 934462
input of data is completed
Memory required to begin solution      : 1278K
Additional dynamically allocated memory: 532K
Total: 1809K
3324 t 5.9832E-03 dt 1.80E-06 flush i/o buffers          01/02/18 16:48:27
initialization completed
3563 t 6.4116E-03 dt 1.80E-06 write d3plot file           01/02/18 16:48:27
3563 t 6.4134E-03 dt 1.80E-06 write adaptivity stress file 01/02/18 16:48:27
3563 t 6.4134E-03 dt 1.80E-06 increase shells from 4324 to 4324
3563 t 6.4134E-03 dt 1.80E-06 increase shells from 4324 to 4324
3563 t 6.4134E-03 dt 1.80E-06 increase shells from 4324 to 4324

```

At the bottom of the window, a progress bar shows 'Completed OP: 0 of 1', 'Current Job CPUs: 8', 'Total CPUs: 8', 'Estimated Remaining Time: 00:00:17', and 'Total Jobs: 5'.

Fig. 2 Single submission of a single keyword inputdeck in Job Manager

## The user settings in Job Manager

As shown in Fig.3, the user settings can be defined and saved in the configuration window. The default parameter for the SMP and MPP solvers can be specified and become available in the solver lists as in Fig.4. In addition to local solvers, user-defined submission commands can also be customized here according to the user's job submission protocol (currently working with Windows OS). So it is possible to run different OPs of the same job in the local workstation and HPC in a mixed manner (e.g. simulating forming in the HPC for the faster and stable solution with the official release, and then spring-back compensation in the local workstation for the new features in a beta solver). The license setup let the user run LS-DYNA with valid license info, without modifying the system environment variables. It also allows the user to define the postprocessor, the text editor and the job file clean filter for quick file operations from the toolbar or the popup menus in the main window.

If a beta solver needs to be used instead, the user can browse for the solver and replace the current solver with the new one (as in Fig.4). For the multiple-OP simulation, all the OPs with the same solver can be replaced in one operation if necessary.

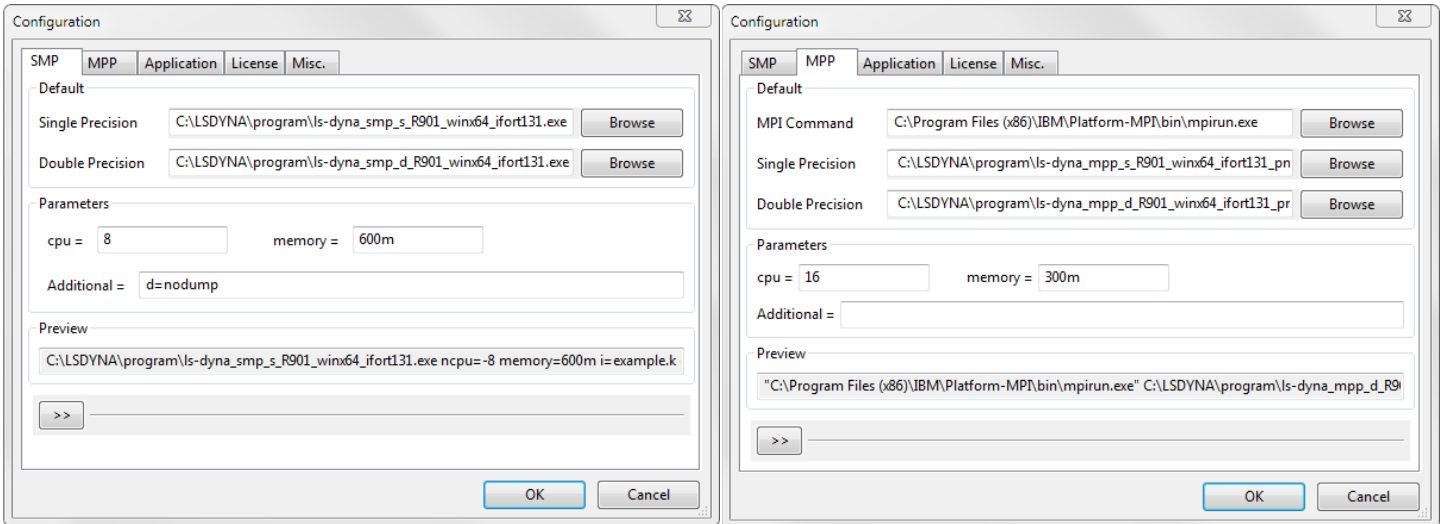


Fig. 3 the user settings in Job Manager

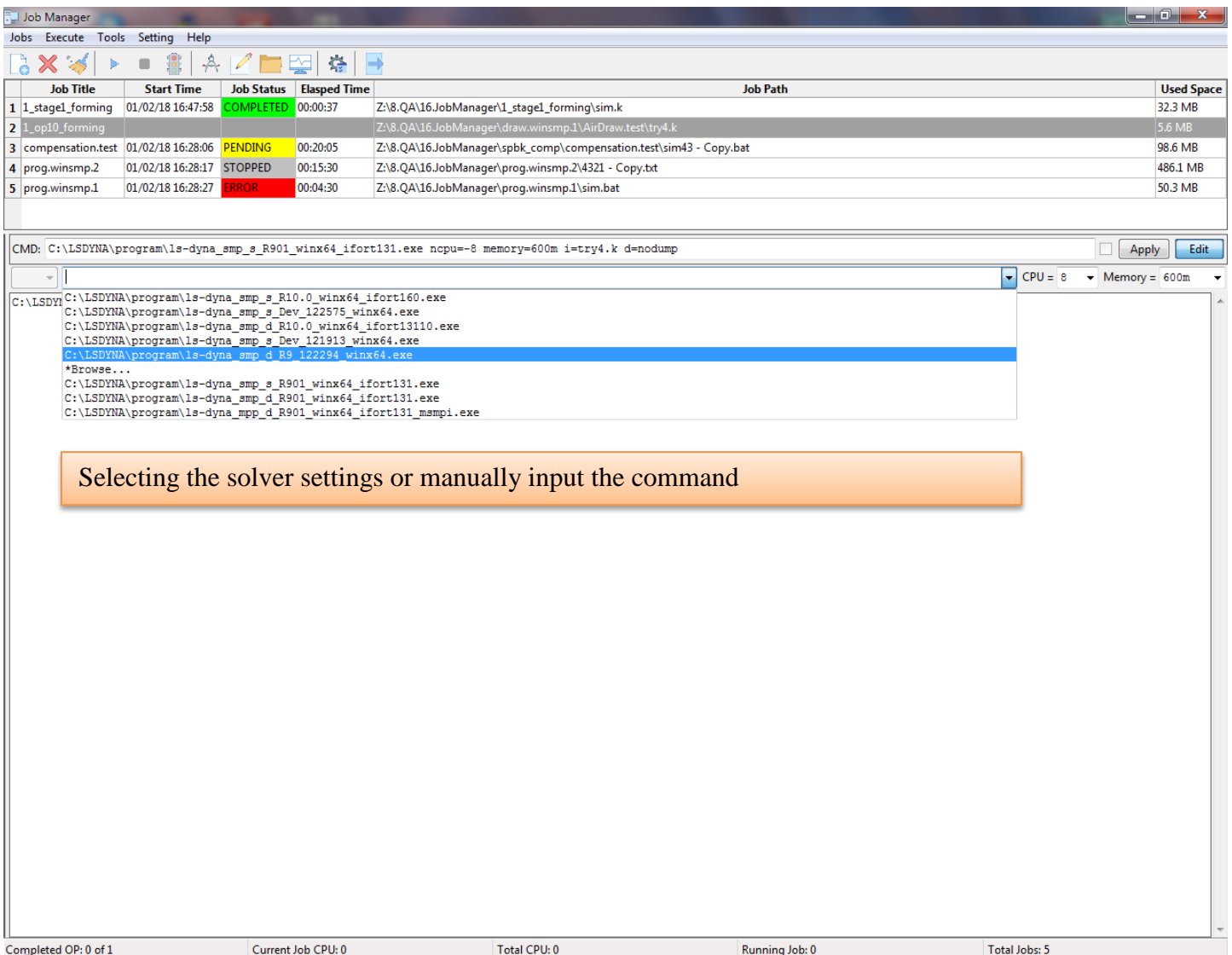


Fig. 4 switching to a beta solver in Job Manager

## Current features of Job Manager

1. Supporting sequential submission of the multi-OP jobs in metal forming simulations (e.g. progressive die simulation) minimizes the possible waiting time between two OPs to reduce the total time cost.
2. Automatic multi-OP job status detection makes it easier for the user to resume the job correctly and prevent the possible file conflict in case of running tests in the same folder.
3. Three ways of starting a simulation job in Job Manager:
  - a) GUI: Dragging the job file into Job Manager or using the “Add Job” button.
  - b) Windows Open-With: File extension association by Windows with the simulation file like “\*.k” or “\*.dyn”.
  - c) Command line: Sending the file via command line to start, stop, queue or delete a job..
4. The solver info can be loaded from the EZSetup file or manually defined, allowing the user to change the solver settings for a partially completed multi-OP job.
5. Jobs can be queued for later submission. OPs of a job can be disabled so that part of a job can be simulated.
6. The local SMP and MPP simulations are supported. It also works with the HPC that supports Windows submission command.
7. Simulation status monitoring:
  - a) Real-time update of the solver message for the running job (local) allows the user to easily monitor the simulation progress.
  - b) The progress bar shows the current percentage of the simulation with an estimate of the remaining time.
  - c) Job status pops up in the taskbar when the job ends normally or in error.
8. Utilities such as the popup menus, job grid sorting, simulation files cleaning and hard disk usage make it easier to manage the simulations (especially jobs consisting of dozens of OPs). The user-defined shortcut to launch the post-processor also helps the user to quickly evaluate the results.
9. A fail-safe scheme is implement to instantly restore the work flow upon staring Job Manager, if the job is found still running in the OS, in case of abnormal termination of Job Manger .The current Windows batch has the limitation that the user would have to wait for the current OP to finish or kill it, so that the batch file can be started in order to make the following OPs automatically submitted again.
10. As a standalone executable, it acts like a hub and allows the user to close the pre-processor after submitting the job.

## Summary

A user-friendly GUI has been customized for LS-DYNA metal forming users, with the intention to help them manage the simulation jobs effectively and further reduce total time cost. The current version works in MS Windows. The future vision may also be extended to Linux.

## Acknowledgement

Important help and valuable feedbacks from LSTC LS-PrePost team are greatly appreciated. Special thanks go to General Motors Corporation for HPC tests.