

LS-OPT[®] Version 5: A New Flowchart-Based Interface for Process Simulation and Optimization

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Abstract

This paper provides an overview of the new flowchart-based interface for LS-OPT[®]. The primary purpose of this development was to provide an interface for process simulation and optimization. An example of a manufacturing process is used to demonstrate problem setup and GUI functionality.

Introduction

LS-OPT[®] is a powerful companion to LS-DYNA[®] for many of the types of analysis problems involving multiple LS-DYNA runs. In addition to the initial application of design optimization, the code also allows probabilistic analysis and robust design, as well as parameter identification. The optimization capabilities include Multidisciplinary as well as Multi-Objective Optimization [1]. LS-OPT also features advanced job distribution capabilities for securely running jobs remotely and in parallel [1].

Since the first release of LS-OPT in 2000, LS-OPT has seen gradual improvements of its graphical user interface. LS-OPT Version 5, to be released soon, is the first major revision of the GUI and was designed primarily to support the need for Process Simulation and Optimization. This has created the need for a major rework of the user interface and job scheduler.

Although any solution stage which is preceded by a preprocessing or followed by post-processing can be considered a process, Process Simulation and Optimization applies mainly to manufacturing processes. Some of the typical LS-DYNA applications are in sheet metal forming (stamping) but there are also many multi-disciplinary manufacturing processes in which LS-DYNA is used as part of the process while also requiring other solver codes as well as user-defined tools for handling process logistics. One such example is highlighted in Reference 2. It describes an injection molding process featuring a geometric preprocessor (ANSA), a filling analysis (MOLDFLOW), mechanical analysis (LS-DYNA and MOLDFLOW) as well as postprocessors such as METAPost for extracting results. The workflow is rather complex in the

* Speaker

sense that it is not just a simple tree, but a *directed acyclic graph* which can merge and branch (see for example Figure 1).

Although some of the stages in the process can be simulated within in the same run directory, we have anticipated the need for file operations to copy, move, delete and link (soft-link) files. This simplifies the process for the user as he/she can just focus on defining the solver workflow in the graphical flowchart.

The new LS-OPT interface provides transparency allowing the user to graphically follow the complex process that takes place within the iterative LS-OPT engine when running jobs locally or remotely. The interface is centered on a graphical flowchart model allowing direct manipulation by the user. In addition to the standard job progress bars, as applied in the current LS-OPT version [1], features have been added to show progress and completion of any particular stage in the process flow. Furthermore, a feature has been added to visualize the source files (input decks) of process parameters (Figure 2). This feature facilitates troubleshooting and avoids errors in parameter definition.

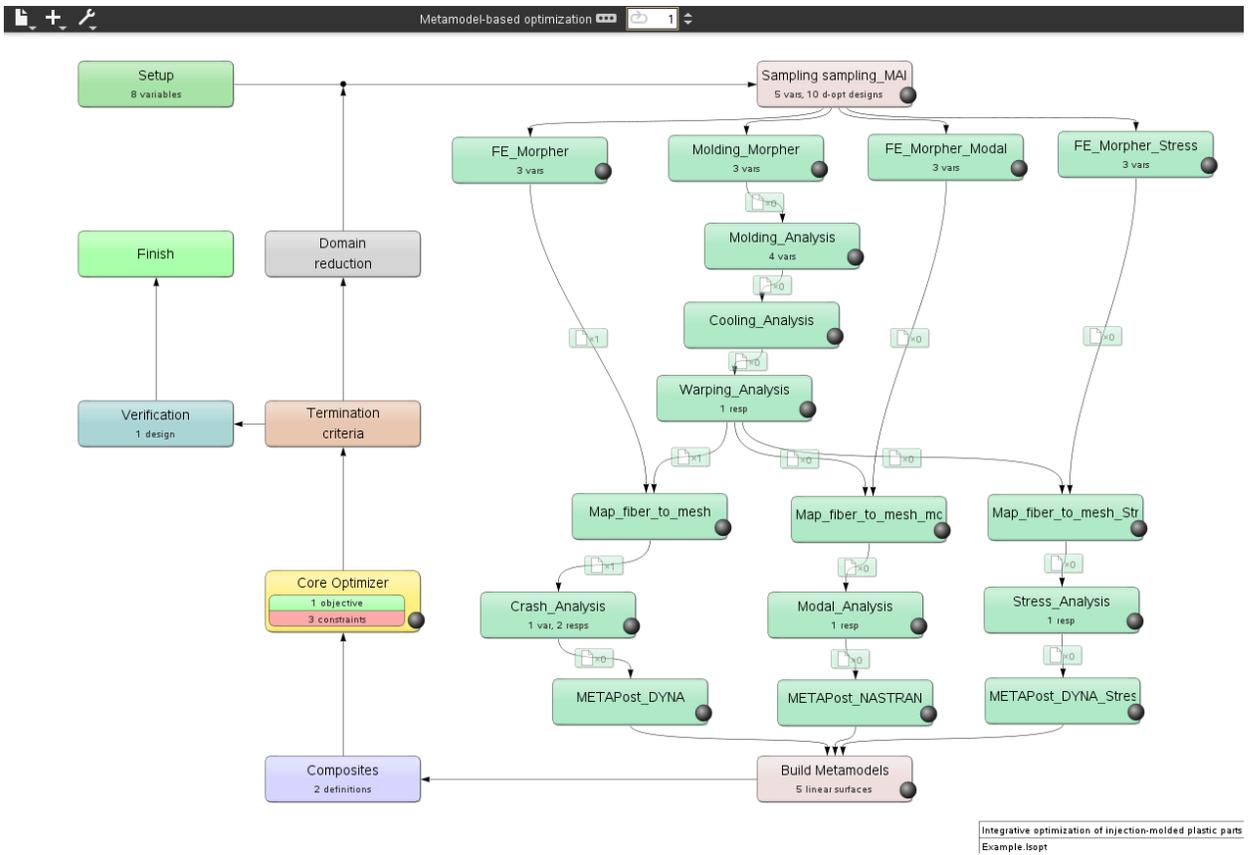
The purpose of this presentation is to demonstrate the functionality of the new graphical user interface.

Example

The example depicted in Figure 1 and Figure 2 is based on the injection molding example provided in Reference 2. The reference describes the analysis of a manufacturing process in which a part is formed through molding and then subjected to cooling and warping analyses. In order to enable the Finite Element definition for structural analysis of the part, the fibrous material properties are mapped onto an FE mesh after which multiple structural analyses such as impact analysis, modal analysis and stress analysis can be conducted.

The main feature of the LS-OPT GUI is its flowchart-based display (Figure 1) which allows the user to construct the flow of the design process. The various components of the flowchart are used as portals to the user dialog for entering the design data. For the purpose of setting up a process, the process was divided into stages. Each stage represents a particular solver, pre-processor, post-processor or other function involved in the process. File operations such as copying, moving or linking files are handled through a special stage type in between the major stages.

Figure 2 was obtained by double-clicking on *Setup* in Figure 1.



Integrative optimization of injection-molded plastic parts
Example:lsopt

Figure 1: Flowchart-based interface of LS-OPT Version 5. The interconnected boxes between *Sampling* and *Metamodels* represent multidisciplinary solution stages of a manufacturing process.

| Variable Setup | Stage Matrix | Sampling Matrix |
|------------------|--------------------------|-------------------------|
| | FE_Morpher | Molding_Morpher |
| | Molding_Analysis | Cooling_Analysis |
| | Warping_Analysis | Map_fiber_to_mesh |
| | Crash_Analysis | Modal_Analysis |
| | METAPost_DYNA | METAPost_NASTRAN |
| | FE_Morpher_Modal | Map_fiber_to_mesh_modal |
| | Stress_Analysis | METAPost_DYNA_Stress |
| | Map_fiber_to_mesh_Stress | FE_Morpher_Stress |
| dyna_1 | | |
| t_inner | | |
| t_outer | | |
| t_middle | | |
| Gate_location | | |
| Injection_time | | |
| Melt_temperature | | |
| Tool_temperature | | |

Legend: - Variable found in file(s) (hover mouse above to see filename(s)) - Variable manually added - Variable defined upstream

Figure 2: Chart for visualizing parameter definitions and sources for each stage.

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References

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2. Wüst, A., Hensel, T., Jansen, D. Integrative Optimization of injection-molded plastic parts – multidisciplinary shape optimization including process induced properties. *Proceedings of the 7th European LS-DYNA Conference, Salzburg, Austria, May 14-15, 2009.*