Optimization by iSIGHT

Introduction

Porto Ricerca a Team specializing in consulting for Aero design of aircraft, racing cars and boats, is the exclusive distributor in Italy of the fluidodynamics software by AMI Inc, and Pointwise the leader in software dedicated to CFD. Porto Ricerca has now acquired distributorship rights for the company Engineus for the products iSIGHT, and FIPER, two software that drive intelligent automation to make design exploration and optimization more efficient. Engineous' number one product, iSIGHT, has been delivering exceptional business benefits to engineers for years, and is the platform of choice for process integration and design optimization. Engineous' iSIGHT software integrates and manages the computer software required to execute simulation-based design processes, including commercial CAD/CAE software, internally developed programs, as well as Excel spreadsheets and Matlab.

ISIGHT

As it can be seen in the diagram (Fig 1), iSIGHT automates the process of selecting design alternatives, and making changes to files to execute the different alternatives. ISIGHT is an "intelligent" program, that chooses design points and execute the simulation process. There is a set of design algorithms that allow the program to do so, such as Optimization, Design of Experiments, Approximation Models, and Quality Engineering Methods.

How iSIGHT works

Doesn't matter the product you are using, engineers around the world all follow similar steps to ultimate a design process, going through the steps of developing a design concept, then to building a computer model-including evaluation of design alternatives-to final verification of results. With iSIGHT all the computer models are integrated and simulations are coded together avoiding the iterative process as showed in Fig 1.
The programs used for simulation of the final product performance go from a commercial CAD to define geometry to a CAE solver or even and Excel spreadsheet or MATlab mathematical model. All of these codes and more of the type can be integrated using iSIGHT

Saranno confrontati il codice a pannelli solutore dell'equazione di Laplace e il codice solutore delle equazioni RANS, allo scopo di dimostrare che il codice a
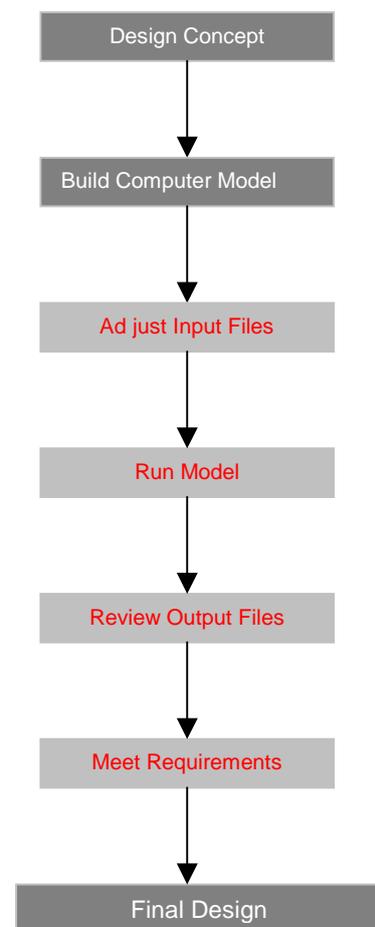
Design Concept → Build Computer Model → Ad just Input Files → Run Model → Review Output Files → Meet Requirements → Final Design

Fig 1

Ad just Input Files
Run Model
Review Output Files

Are all iterative processes typically are done manually

This software can also link international codes such as Fortran, C+++, Visual Basic, and Unix scripts, with little or no programming. Once the process is being integrated in the iSIGHT framework, the user defines input and output bounds, initial values, and objectives for the design study. , and defines a design study strategy, that is dependent on the scope and type of problem being solved.

The design process can be monitored by the user during its progress in real time, and user can make changes in the design definition or exploration plan if so wishes. When the design process ends, the user can access a set of visualization and statistical analysis tools. These tools are helpful to determine if final design satisfactory meets product requirements

Process Integration

The iSIGHT Process integration enables a rapid coupling of simulation processes regardless of areas, programming language, or format. It specifies how the process executes, in the sense of which codes are required, order of execution, mode of passing data between the processes. An interface has been built, that provides visualization of data and control flows, with a hierarchical viewer friendly to use. The hierarchical layout allows multi-level problem formulation of tasks. Each task can have its own design study strategy. This unique task modeling facility also gives iSIGHT the capability to support multi-disciplinary design optimization methods (MDO). When input or output files are required in a simulation process, iSIGHT File Parser can be employed to extract key parameters from these files. The user friendly interface provides a set of tools to enable users to navigate through text-based files, so identifying any values that will be changed during the design process, or any parameters that must be monitored. The interface provides graphical actions and feedback, so users are not required to write scripts to create the commands needed to parse the data files.

Problem Definition

After formulating a process by process integration, the next step is Problem Definition, where the user defines why the design process will be executed. That is objects will be specified e.g. what purposes do we have in mind? To identify the most reliable design? Or maximize selected outputs? Etc. The problem definition step uses 4 strategies :
-Optimization
-Design of Experiments
-Approximation Methods
-Quality Methods

They are part of the Intelligent automation phase

Optimization consists of three different categories: numerical, exploratory, and knowledge based. Numerical techniques assume that design space is unimodal, convex and continuous, exploratory techniques do not focus only on one region, contain single and multi-objective Genetic Algorithms and Adaptive Simulated Annealing, while knowledge based techniques follow user-defined rules describing parameter characteristics, and their influence in obtaining desired solutions.

Design of Experiments offers a systematic and efficient way of analysis of a design space, providing essential information for design variable screening (design space reduction), assessment of design variable impact, and identification of significant design variable interactions. In addition, the structured set of experimental design data can be exploited in the construction of response surface approximation for approximation –based optimization

Approximations models can replace or increase the detailed analysis and simulation programs to make the application of intensive and optimization methods feasible for large scale and complex design problems.

Quality Engineering problems in real world engineering involve at least some uncertainty elements , such as in loading conditions, material characteristics, analysis-simulation model accuracy ,geometric properties, manufacturing precision etc. Quality Engineering Methods in iSIGHT address uncertainty and randomness through statistical modeling and probability analysis . These techniques can be implemented within an optimization framework to search for design that qualify as not only feasible, but as consistently feasible in the face of uncertainty.

ISIGHT vers 8.0 supported platforms:
Sun SPARC, HP PA-RISC, SGI MIPS, IBM RS6000 DEC-Compaq Alpha, Intel Pentium and Titanium 2.

Operative Systems: Solaris 7,8,9, HPUX, IRIX 6.5.8.+ AIX 4.3.3, 5L v5.1,5L v5.2, Tru64 UNIX 5.1 Windows 2000 sp3 Windows XP Pro sp1 Red Hat Linux 9 HPUX 11i v 1.6

Application Cases of iSIGHT

ISIGHT applications in the from the automotive to the aerospace to the turbomachinery to the industry. Some cases are discussed below that show the obvious advantages of adopting an optimizator to speed up the design process.

Aerospace Industry

High lift System Optimization (Fig 1)

A leading commercial aircraft manufacturer posed a series of difficult test cases to determine whether engineers could predict the maximum lift on slotted airfoils. The purpose was to assess the validity of analysis techniques for performing flap and slat gap overhang optimizations. The blind tests proved to be very successful. For each of the test cases, the results were among the best ever seen and matched wind tunnel results, both in terms of forces and pressure distribution. It was concluded that the analysis codes were valid for slotted airfoils.

Shape optimization of an adaptive wing

A major manufacturer was investigating the benefits of adaptive wings to reduce aircraft transonic drag. The wing shape was changed in flight by adjusting the height of a bump at the location of the shock and by small deflections of a fowler flap. Initially, the wing box shape was left constant, and the adaptive geometry was varied to minimize drag. This approach did not bring the advantages sought. Pointer guided optimizer was ported to a CFD analysis code and optimized the shape of the wing leading edge, box, and trailing edge, as well as the deflections of the adaptive geometry simultaneously for eight operating conditions. An aircraft wing design was found within a week that achieved (in subsequent wind tunnel testing) the high goals set for the program.

Icing analysis on a military transport

The FAA required a major military aircraft manufacturer to investigate the possible icing scenarios for a new aircraft configuration. The critical ice shapes for wing and tail surfaces had to be defined analytically using CFD methods correlated with wind tunnel testing. Together with the customer, engineers developed FAA-approved ice scenarios. The ice shapes were computed using the NASA Lewis Ice Accretion Code, LEWICE. The ice shapes were analyzed with a viscous CFD code in conjunction with wind tunnel data. After these shapes were approved by the FAA, they were manufactured and tested during a powered wind tunnel test and in flight.

Racecar (Fig 2)

To stay competitive, race cars are constantly being redesigned to improve performance. Designs need to be produced quickly and efficiently with optimal results. In this instance, designers were asked to improve performance through modifications to the front wing of a formula-one car. The objective was to maximize the down force produced by the wing to enable higher cornering speeds. The initial wing design showed very good maximum lift coefficient (~1.0). Engineous PIDO software was used to integrate the ESF library with a CFD analysis method. Then the Pointer optimizer was used to drive the shape optimization. The resulting optimum design showed a 100% increase in down force and very low drag (no flow separation). It is known from theory that this performance is practically impossible to exceed for a single element wing. The optimized shape is illustrated to the right.
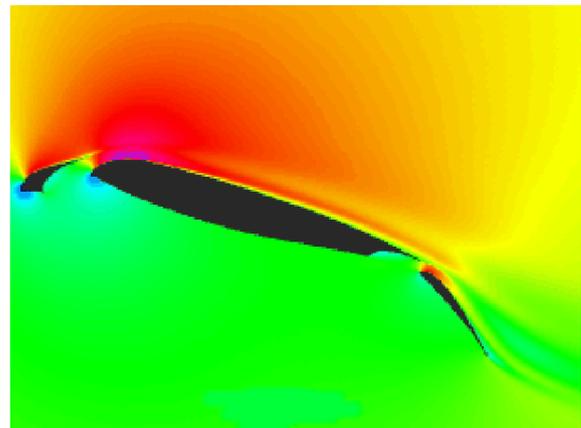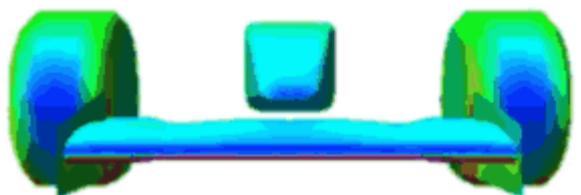

Fig. 1

Fig. 2