CISPAR

Open Interface for Coupling of Industrial Simulation Codes on PARallel Systems

----Esprit Project 20161----

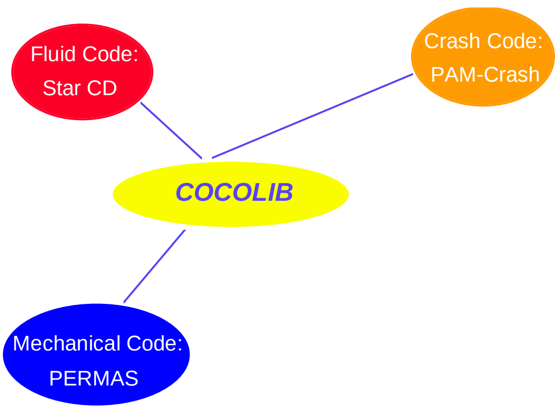
Coupled Simulations using Industrial Codes

Now, after dramatic progress in software and hardware technology coupled simulations are close at hand. Coupling dedicated industrial codes is of particular interest since:

- *The functions of both fluid and structural codes are fully preserved;*
- *The experience of the structural and fluid dynamics engineers can be used in a joint solution procedure;*
- *No training for new software packages is necessary and user-supplied extensions as well as pre-and post-processors to either package remain applicable.*

CISPAR approach

CISPAR has embarked on coupling dedicated software packages (PERMAS, STAR CD, PAM-CRASH/PAM-SAFE) by developing the COCOLIB coupling library. The library can be used for coupling arbitrary parallel codes since these are interfaced via the common COCOLIB library rather than some proprietary interface.



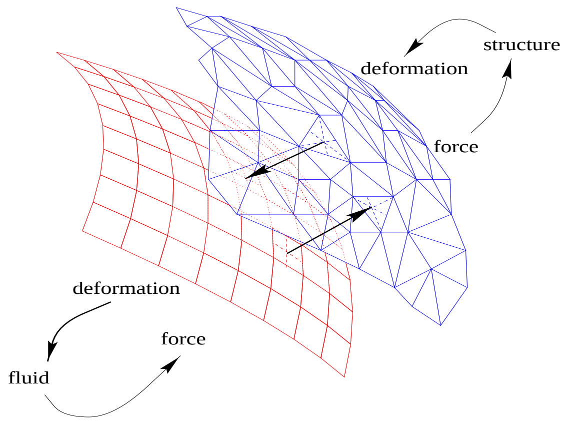
Basic Decisions

The basic COCOLIB design is characterised by the following properties:

- *loose coupling between codes, i.e. communication between codes is performed at most once per time or inner iteration;*
- *minimal source code changes for the simulation codes by using the COCOLIB subroutine interface instead of separately coding the coupling for all pairs of code*.
- *no knowledge of the other codes is required to perform the coupled computation.*

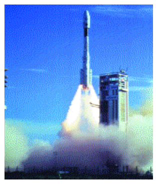
Driven by the need for large computing resources, CISPAR focuses on implementation of coupled simulations on parallel computers. The parallel message passing versions of the industrial codes are used. The basis for parallelisation is MPI.

All communication between the different codes is carried out transparently through COCOLIB library calls. COCOLIB provides the interpolation between different meshes, and manages the complex connections between the surface-meshes without the codes being involved. Each code simply works with its own local mesh and needs no specific modification for the codes with which it is coupled.



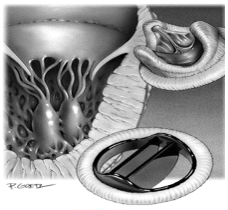
Applications

Aerospatiale: *Cooling a hypersonic combustion chamber*



The design of local cooling techniques (e.g. injection of hydrogen) is a necessity due to the very high level of convective fluxes in a scramjet combustion chamber and to the peaks of fluxes. Therefore, the main purpose of our participation within CISPAR is to determine the equilibrium heat fluxes and the strains and stresses occurring inside the wall between the hydrogen tank and the scramjet chamber.

Sulzer Innotec: *Artificial heart valve*



The design and development of artificial heart valves require a detailed examination of structural behaviour and fluid dynamics. Within CISPAR, coupled computation will provide information about structural loads, bending of stent cusps, opening/closing of the leaflet and flow conditions during operation. Simulation of fluid-structure interaction supports product design and process optimisation.

Mercedes-Benz: *Rubber flaps and torque converter*

In the shroud for the electrical fan in front of the condenser there are six openings to control cooling air. Rubber flaps moved by the pressure open/close these openings which requires the simultaneous solution of a fluid and mechanical problem. A second test case is the torque converter whose shape is being optimised in order to minimise the mass. The goal within CISPAR is to optimise the shroud design and torque converter before first prototyping in order to save costs.

Germanischer Lloyd: *Slamming of a ship bow*

When a ship encounters high waves its bow area might be elevated out of water. The hull falls down some seconds later and slams onto the water surface which causes high impact pressure at the slamming area. The analysis of the slamming induced impact pressure yields a fluid-structure problem. The goal within the CISPAR project is to investigate loads induced by slamming in order to take them into account in ship design.

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