Technology Programs for Landing Gear Systems

Patrick MONCLAR
Messier-Dowty International
ICAS 2004-7.4.2

Messier-Dowty is world leader in the landing gear market and thus has considerable expertise and experience in the design, development, testing, production and maintaining in service of its landing gears.

The technologies used or envisaged should enable us to improve the performance of our landing gears and optimize all the processes used, from the design phase up to the maintaining in service, allowing us, in particular, to reduce costs and delivery times. In addition, the "system" aspect, specific to the integration of the landing gears under an aircraft or helicopter, is also becoming increasingly important.

The essential and inherent requirement of any landing gear is its absolute reliability, ensuring that landing and taxiing are performed in complete safety. The strength of the landing gear must therefore resist the extremely high external loads involved, and this strength thus remains the absolute criterion in any operation that could have an impact on the design characteristics, during any phase in the landing gear life cycle. Any new development must therefore be regarded as a change that must meet the very severe safety requirements, and also increasingly involves a more accurately defined knowledge and control of the real system limiting factors, so that these can be better taken into account.

Within this context, our technologies are being applied to the preparation of our future products, systems and programs, to an overall reduction of life cycle cost, and to improving our maintaining in service capability. They also allow us to meet the environmental requirements applicable in the aviation and industrial sectors.

1. Technological orientations and preparing the future

Messier-Dowty maintains on-going investment in technologies that allow the various life cycle phases of our landing gears to be optimized. This optimization mainly concerns better control of design reliability (modeling of structures under both static and dynamic conditions, computing and recording of real loadings, modeling of tires and "shimmy", etc.), the possibility of shortening production cycles (higher machining speeds, validation and integration of non-destructive testing, etc.), and a systematically better knowledge of all the elements affecting overall landing gear behavior (seals, shock absorbers, hinges, bearings, etc.).

In addition to the technological work mentioned above, there are also the new technologies, the characteristics of which are very "innovative", and may even represent a complete breakthrough. Main working orientations involving these new technologies include "lightening", "noise", "electrical systems", "Health Monitoring" and "Modeling / Simulation".

Let's have a look at some of this work:

- Work on seals is extremely important in the landing gears sector. The good behavior of the seals used in the shock absorbers and hydraulic actuators ensures that the landing gears operate properly throughout their period of operational use, notably by preventing leaks. The technological work carried out by Messier-Dowty involves defining elastomer seal specifications, modeling their behavior in operational use and also research to identify new materials suitable for this function.

- Our "lightening" work is aimed at making our landing gears lighter overall, within a very stringent safety context, and at increasing our knowledge of the mechanical environment of the loads applied (landing, taxiing, parking, etc.). The main technological breakthroughs concern the use of new materials with

vastly improved characteristics (density and/or strength): titanium, high strength steels, very high strength stainless steels, organic or metallic matrix composites, etc.

- Environmental regulations have led Messier-Dowty to work on reducing noise related to landing gears. The main work concerns the reduction of aerodynamic/acoustic noise generated by landing gear, the level of which must remain consistent with the overall aircraft, engines and airframe. The results of this work, which is currently in the technological demonstration phase, will become visible around the middle of this decade (Airbus A380, Boeing 7E7, etc.).
  We are starting to analyze and integrate noise requirements, to develop a landing gear design that will generate less noise during final landing approach. Flight tests conducted on an A340 in September 2003, and current design work aimed at further reducing noise, have resulted in rapid progress being made in new concepts.

- The other important orientation concerning the environment is the replacement of products, the use of which is becoming increasingly restricted, or even prohibited: hexavalent chromium, cadmium, chlorinated solvents. Our technological work concerns the replacement of these products and the corresponding processes by new, non-noxious processes, that ensure the same characteristics as those previously used. The extremely stringent landing gear surface treatment requirements resulted in all landing gear manufacturers using hexavalent chromium (to reduce friction) and cadmium (anti-corrosion protection). For this reason, Messier-Dowty has been working for many years on a technological plan to investigate and identify substitution products (for example HVOF to replace chromium) and the industrial implementation of the application processes for these coatings, and the corresponding repair processes.

- Actuator systems used to provide the landing gear actuating power are now almost entirely hydraulic. Their gradual replacement by electrical actuators represents a major area of our technological work. These technologies concern both commercial and military aircraft.

- The Health Monitoring principle involves the very early measuring and detection of micro-defects (flaws, cracking, corrosion, etc.), to enable planned replacement or correction. This thus represents an extremely high level of preventive maintenance, that integrates a measuring capability and a knowledge of the actual environment to which the gear is subjected. Preliminary work has been carried out over the last few years, to design and achieve an operational flying status for a first Health Monitoring system.

- The "Modeling / Simulation" work enables the latest techniques to be implemented to model and simulate landing gear behavior, from the most detailed parts up to its overall behavior under the aircraft, during the various phases of landing and taxiing. One of the stated objectives is to enhance design option reliability as early as possible, thus reducing the testing requirement. In general terms, this means considerable improvements in quality and design options, and the shortening of design cycles.

The adopting of these technologies has undoubtedly contributed to the many commercial successes of Messier-Dowty. The most recent of these are the RRJ (Sukhoi's Russian Regional Jet), the Airbus A400M and the Boeing 7E7. Most of these newly developed technologies will thus become operational well before the end of the decade on all Messier-Dowty's traditional aircraft equipment programs, including long and medium-range commercial aircraft, regional transport aircraft, business aircraft and military aircraft. Work will also be carried out for new types of aircraft, the UAV (Unmanned Aerial Vehicle) and UCAV (Unmanned Combat Aerial Vehicle), and

Messier-Dowty will thus be able to apply its skills to the design of the light and strong landing gears required for these new operational applications.

2. Organization and Programs

All the Research and Technology work is being carried out by Messier-Dowty teams, mainly in the Company's three laboratories (Bidos in France, Gloucester in the U.K. and Toronto in Canada) and four design departments, at Vélizy in France, Gloucester, Toronto, and Seattle in the USA. This international structure gets the best from the various local technological cultures, and also ensures an excellent presence and communication with our main aircraft manufacturer customers (Airbus, Boeing, Bombardier, Dassault, etc.).

In addition, the French, British and Canadian governments, through their various civil and military Research agencies (DPAC and DGA in France, DTI in the U.K. and the Canadian Research agency) provide support for our production technology work. The well-established role of the European Community in this work should also be mentioned, through the R&D frameworks, and the increasing role of the various regions' interest in our work (the Aquitaine region in France and Yorkshire in the U.K.).

Our main current work includes the European programs: SILENCE(R) for noise reduction and POA for a "more electric" aircraft, together with design work being conducted in France and in the U.K. to assess the impact of using titanium, very high strength stainless steels or titanium matrix composites, and electrical technologies, for our landing gears.

3. Technological partnerships

For many decades, Messier-Dowty has possessed all the skills and expertise required for its various Design, Research and Technology work in the fields of materials (steels, titanium, aluminum, composites, elastomers, etc.), surface treatments, machining processes, non-destructive testing and inspection, overall design and the design of landing gear structures.

In addition, Messier-Dowty also has the advantage of a certain number of technological partnerships with industrial or university organizations outside the Snecma group. These partnerships mainly concern cooperation in the fields of:

- Materials, particularly with producers and forging sources,
- Sealing systems,
- Health Monitoring,
- Testing (co-financing of the "MEGA" large landing gear test facility, with CEAT/DGA).

European Research and Technology programs also represent an opportunity to set up partnerships with the major systems suppliers (Airbus, Boeing, Dassault, Bombardier, BAe Systems, etc.) and many European laboratories (DLR, NLR, Poland, etc.). We should also mention the university partnerships in France (LEG and ENSEM in the electrical field) and in the U.K. (notably with the Aerospace Manufacturing Research Center co-founded by Sheffield University and Boeing, in the field of machining).

Finally, and this is a major factor in the development and expertise in our technologies, the in-house skills of Messier-Dowty are reinforced by its close links with the Snecma Group in the Technology and Processes fields. In fact, throughout the Group and its subsidiaries, the synergy is organized so that the teams of engineers and experts can easily communicate and help each other in all the newly developing sectors. This particularly concerns the fields of materials, elastomers, surface treatments and processes, in which the earliest and most beneficial contacts were made. For example, we could mention the titanium matrix composites cooperation between Messier-Dowty and Snecma Moteurs. At the present time, the integration of Acoustics, the use of electrical systems in landing gears, and the need for increasingly reliable and sophisticated Modeling and Simulation are among the major priorities of the Snecma Group (for example, the MAIA program for advanced modeling in the field of mechanical engineering).