Seeking a Material Advantage

The aerospace and defense industry leverages a wide range of cutting-edge technologies to tackle environmental, safety, cost and many other challenges. A critical area that applies to all these challenges is that of materials, where making an informed decision could mean the difference between project success or failure.

By **Stephen Warde**, Vice President of Marketing – Materials, ANSYS

Getting materials decisions right is always important. But it is more fundamental for some products than for others. In aerospace and defense, engineers often need to push the boundaries of technical feasibility, while guaranteeing safety and reliability. Meeting environmental and cost imperatives for lighter aircraft while maintaining structural integrity demands much wider use of composite materials. Pushing the performance of aero engines means higher operating temperatures for greater fuel efficiency, placing more demands on metal alloys that already operate in an environment that exceeds their melting points. No organization wants to get left behind in the use of new material technologies: for example, applying additive manufacturing to enable on-demand production of parts, or investigating new Kevlar replacements in body armor.

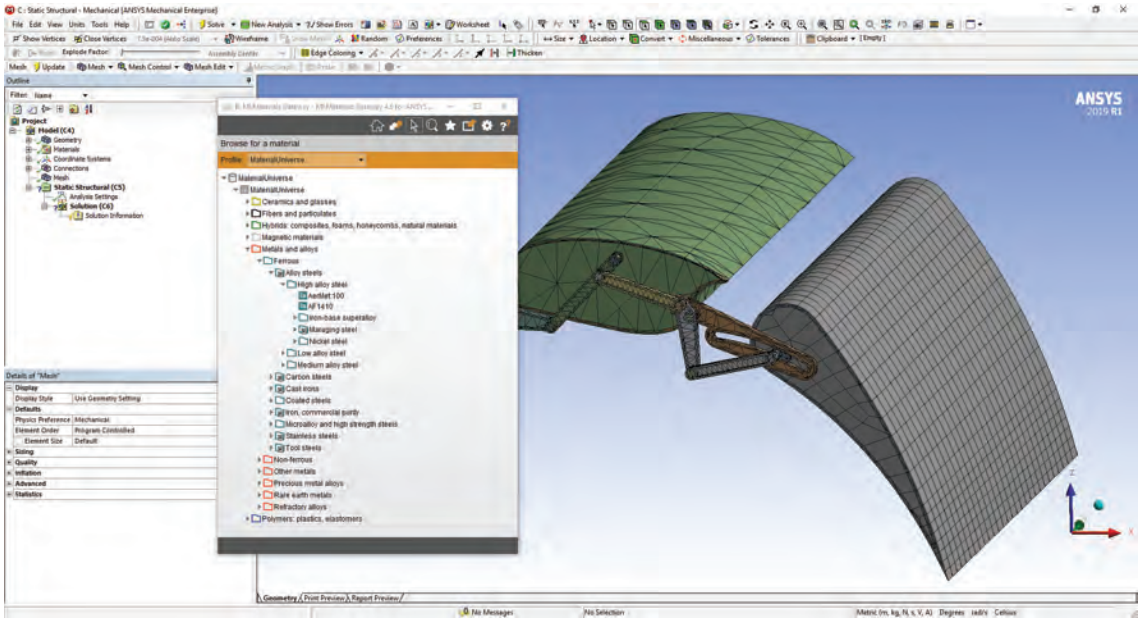
ANSYS acquired Granta Design — based in Cambridge UK — the leader in materials information technology. Granta has close collaborations with a number of aerospace and defense leaders, which can lead to multimillion-dollar benefits.

THE INFORMATION CHALLENGE

Making good decisions requires good information, and materials are no exception. In the examples above, physical property data and test results are central. Composite systems must be qualified for each new application. An aircraft program can require hundreds of thousands of coupon tests, which all need to be captured, analyzed and retained as a coherent data set for certification purposes. For alloys in an aero engine, engineers must keep track of the latest data describing the relationships between mechanical properties and temperature. Materials innovation requires understanding that only comes from effectively combining experimental and simulation data on the relationships between properties, structure and processes.

Much of this data is complex. For example, to adequately describe a metal for the purposes of design or simulation in aerospace requires a series of multidimensional mathematical models characterizing its physical behavior across the full range of operating conditions. There are authoritative sources of such data, like the Metallic Materials Properties Development and Standardization (MMPDS) alloys handbook, but now

"A leading aero engine manufacturer certified benefits of £6.9 million per year (approx. $10 million) through a materials information management project facilitated by GRANTA MI."



Materials data in a GRANTA MI database can be accessed from within ANSYS Mechanical.

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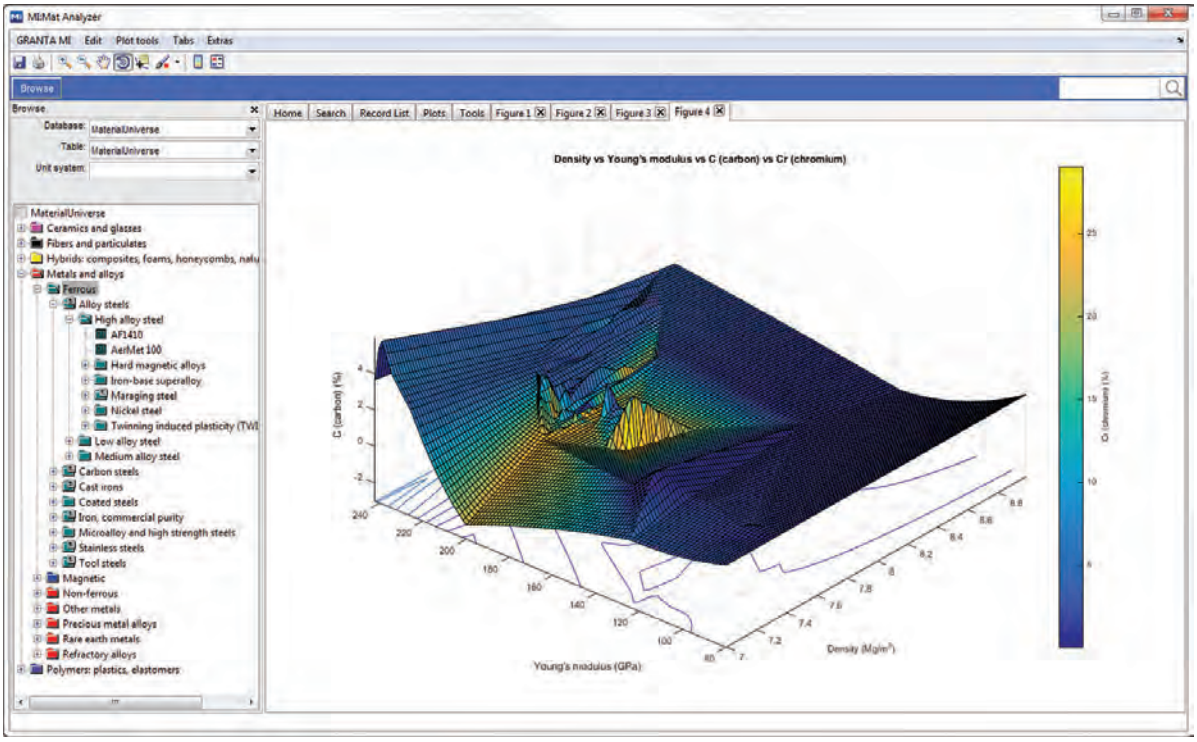


Analysis of materials engineering data in GRANTA MI

engineers need to access this data in an easy-to-use digital format. And, for a new or modified material system, or one being used in a new application, the "design allowable" data must be generated anew via in-house or outsourced testing and analysis. Similarly, ongoing tests ensure quality and enable study of materials in-process and in-service. This generates a vast body of test results, analysis, quality assurance data and research information, all of which provide vital intellectual property (IP) from which aerospace and defense enterprises must extract maximum value.

TRACEABILITY FROM TEST TO DESIGN

Historically, many organizations failed this test. Today, many enterprises still do not have systematic programs to manage and apply materials information. As a result, they duplicate tests, waste time searching for data, or put simulation and design work at risk due to inaccurate or inconsistent inputs.

The good news is that this situation is changing, and fast. This is partly in response to the work of the Material Data Management Consortium (MDMC), a project founded by NASA, ASM International and Granta in 2002. Today's members include Honeywell Aerospace, GE Aviation, Rolls-Royce, UTC, Los Alamos National Laboratory and Northrop Grumman. The collaboration has defined best practices in managing enterprise materials information and focuses on the process whereby materials test results are captured, processed, analyzed to generate design data and deployed for design. This must all be achieved while ensuring appropriate access control and traceability: allowing a design decision to be tracked back to the information used to make it, and the data and analyses that underlie that information.

Success is partly about having the right information technology (IT). The MDMC advised Granta on the development of its GRANTA MI software, which enables user organizations to create a robust corporate materials information system. It is also about having the right people and processes in place and ensuring that the IT integrates smoothly with these workflows.

THE BIGGER INFORMATION PICTURE

There is also a bigger picture, beyond materials engineering and its connection to design. Any effort to manage materials information in an enterprise must account for the way in which materials are described within that organization. This is often in terms of specifications or standards that define the physical properties and processing requirements that must be met, rather than a specific purchasable grade of a material. Specifications are often defined in unstructured documents and connect engineering materials with process data, surface treatment requirements and related chemical substances — posing a difficult information challenge.

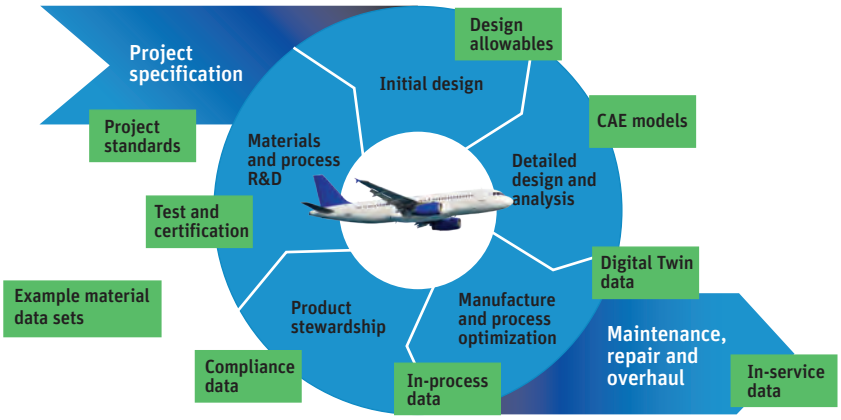
> *"GRANTA MI data structures deal with the complexities of specialist materials data, while retaining flexibility."*

One real-world example is restricted substance regulatory compliance. For a product with a long lifespan, such as an aircraft, manufacturers want to ensure future compliance with ever-changing regulations, such as the European Union's REACH directive, which controls the use of chemicals that may harm the environment or human health. If a new chemical is added to the at-risk list, manufacturers want to understand which of their products, materials or specifications could be impacted. That requires systematic management and linking of information about each of these factors throughout the product lifecycle.

THE GRANTA MI ADVANTAGE

GRANTA MI provides this control and linkage. User organizations store all materials and process information in one system. GRANTA MI data structures deal with the complexities of specialist materials data, while retaining flexibility — for example, so they can be configured to support a developing additive manufacturing project. Critically, integration technologies enable seamless exchange of data with other engineering software (CAD and CAE tools, PLM systems) ensuring that the materials information system does not itself become an isolated silo. One such integration enables data in GRANTA MI to be accessed from directly within ANSYS Workbench. Different aspects of the organization's varied materials and process data can be connected with each other and compared with the best available reference information, which is also stored in the database — the MMPDS aerospace alloy handbook data, for example, or Granta's unique database of restricted substances and related regulations.

Substantial benefits accrue, as described by customers at Granta seminars and webinars. A leading aero engine manufacturer certified benefits of £6.9 million per year (approx. $10 million) in efficiencies and more effective use of materials IP through a materials information management project facilitated by GRANTA MI. The world's largest aerospace company described a project on restricted substance risk assessment. A query about which specifications used an at-risk chemical, which previously took a team of 11 people 14 hours to fulfill, was completed in 20 minutes. Perhaps more importantly, it discovered impacts that the initial search had missed. A tier-1 supplier of systems and equipment in the aerospace and defense markets spoke about saving time in communicating between the materials lab and the design office, supporting a move from certifying one new engine every 10 years, to three engines every two years. The leading supplier of products for the space industry in Europe captured inspection data on the performance of materials and shared it to save time and improve consistency.



Product development process for an aerospace project and the various types of materials data required throughout that process

CONCLUSION

Materials matter, and the newest addition to the ANSYS portfolio is helping aerospace and defense enterprises to get critical decisions right, ensuring accuracy and traceability for design and simulation. Not only will the combination of ANSYS and Granta make it easier for simulation analysts to find the materials input data that they need, it will also enhance the connection between experiment and simulation — making it easier to compare data, and to validate and calibrate tests and analyses. This will help tomorrow's enterprises to realize the promise of simulation: dramatically reducing the number, and thus cost, of physical tests — gaining a material advantage.

Material Intelligence
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