Introduction

The materials industry has never been more competitive. Margins are tight, customer requirements are increasingly demanding, and materials are being pushed to the limits of their performance. New drivers of sustainability, compliance, and lightweighting have dramatically changed the competitive landscape.

In today’s climate, material producers can no longer compete purely by selling commodities. Customers expect ‘solutions’, not ‘materials’, and the expectation is that they will be involved earlier and more closely with their suppliers’ new material development activities.

To respond, material producers must clearly make best use of their available assets—in particular all of the available knowledge about their materials and those of the competition.

And yet, despite this, Granta’s research has shown that materials information—one of a material producer’s greatest assets—typically remains scattered around companies in isolated pockets: out of date, untraceable, and often difficult to find and apply. Sales cycles become unnecessarily long; customers do not get the support they need; and new market opportunities may be missed—all through the lack of a systematic approach to controlling and using materials information.

This Guide describes practical approaches and proven technologies to rectify this situation, giving material producers the best possible competitive advantage in the marketplace.
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It seems obvious that materials information is a key asset for materials producers. Organizations making metals, plastics, composites, or ceramics need a detailed understanding of the properties of those materials, and the processing methods applied to them. Developing that understanding, using it to improve the product line, and helping customers to buy and successfully use products are critical tasks. This is even more the case in today’s global market, where there is greater need to differentiate products based on factors other than cost. So materials producers need appropriate, accurate, and up-to-date materials information, such as that illustrated in Figure 1. They dedicate significant spending to the testing and research that generates such information.

Yet we find, perhaps surprisingly, that many materials producers have no consistent strategy or system to store this vital information, to control it, or to analyze and use it to improve their businesses. Materials Information Management is often left to chance, tackled on an ad hoc, project basis, or by site, department, or individuals. And materials information is simply not used as it could be to help optimize the product portfolio, to market products, or to support customers.

Figure 1. Examples of data flow in material producing organizations. Internal data bottlenecks (black arrows) lead to inefficiencies, wasted time, rework, and delays to market. External data bottlenecks (white arrows) lead to longer sales cycles, missed market opportunities, and poor customer relations.
Key industry trends

If such problems have been tolerated in the past, it is because they have often been seen as a tactical inconvenience rather than a major strategic disadvantage. This view, and the current approach to materials information, is becoming unsustainable. Key reasons for this change are shown in Figure 2. These include:

i. The nature of today’s globalized market for materials producers

Globalization, volatile raw material prices, and a challenging economic environment all mean that materials producers must be more responsive in a competitive market. They can’t rely on continuing sales of the same products to the same customers. They need to minimize cost. But, often, they can’t compete on price alone. For example, many of the traditional leaders amongst commodity materials producers are finding that new competitors in emerging economies such as China can produce on a much larger scale, and at much lower prices. These companies must find other differentiators—time to market, product innovation, fulfilling specialist applications, more environmentally sustainable products, or a reputation for service. One senior interviewee for this Guide commented “We no longer sell materials—we sell solutions.”

There is also a growing need to compare and match materials grades made in different regions of the world. Such developments dramatically increase the need for good materials information, for quick access to that information enterprise-wide, and for tools to make a rational and convincing case for the merits of products.

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**Figure 2.** Macro-level trends are driving a new view of materials information.
ii. The structure of materials producers’ organizations

Organizations themselves are more globalized, either through merger and acquisition or through collaboration. They want to realize the benefits of this scale in reduced costs and more effective performance, standardizing processes, and rationalizing product lines. This requires consistent, comparable information and procedures across all of their materials and processes.

iii. Corporate knowledge

The last forty years have seen spectacular innovations in materials performance. Much of the knowledge underpinning companies’ competitive advantages is in the heads of a generation of scientists and engineers now coming up to retirement, or of those moving out of day-to-day operational roles and into senior management. There is also much greater mobility than ever before in the labor market, with staff leaving to join competitors or to pursue other interests. Companies are increasingly aware of the need to capture and protect corporate knowledge.

iv. Environmental and other regulation

New pressures on manufacturing organizations are driving initiatives on lightweight design, particularly in the automotive industry—and the materials industry must respond with solutions to match. Meanwhile, government focus on environment, health, and safety is leading to legislation such as the European Union’s REACH (1), RoHS (2), and WEEE (3) regulations, all of which have consequences for materials. This is having an impact throughout the supply chain. Materials producers and their customers need to track, use, and exchange the right information on what is in a material or process—and on the implications for their products of current and future regulations.

v. Customer requirements

In response to the above, the customers of material producers demand better, more ‘traceable’ information. For example, they may ask questions about a material property that require staff to revisit the original test data from which that property was determined, or they may request access to pedigree information on a specific batch of material.

This last point suggests that material producers should consider implementation of the innovative approaches to materials information already being followed by some of their customers. We therefore move to a discussion of some of the best practices being implemented by organizations who use materials.
Learning from industry best practice

Granta Design is the world leader in Materials Information Technology, having grown steadily from its foundations in the Cambridge University Engineering Department to become the largest organization in the world dedicated solely to this specialist field.

Used by both material producers and their customers, the GRANTA MI™ platform (Figure 3) is the de facto standard for Materials Information Management. It combines a unique database system for in-house, proprietary materials data and preferred reference information, together with a series of powerful software tools help control, analyze, and apply that data.

GRANTA MI enables material producers to:

- Manage and deploy materials information—ensuring that it is searchable, traceable, secure, consistent, and up-to-date.
- Identify new opportunities using tools to visualize and predict how a material or process will perform in the competitive landscape.
- Use industry standard software to service key customers and involve them more closely in the materials development process.
- Demonstrate the advantages of products to customers through clear graphical presentation of material comparisons and online interactive services.

Figure 3. Granta’s Materials Information Technology platform, GRANTA MI, provides tools and data to help materials organizations take any or all of the five practical steps outlined in this paper.
One major driver for the development of GRANTA MI has been industrial collaboration. The oldest of Granta’s collaborations, dating back to 2002, is the Materials Data Management Consortium (MDMC) (4). The MDMC has made major strides in defining best practice Materials Information Management. Members include Rolls-Royce, Boeing, NASA, and GE. Other sectors, such as medical devices and diversified manufacturers, have similar interests. Emerson Electric, for example, is a leader in two other consortia that Granta supports—the Materials Strategy Software Consortium (5), which applies materials information to optimize materials choices—and the Environmental Materials Information Technology (EMIT) Consortium (6), for restricted substance regulations.

The resulting technology has considerable relevance to materials producers. This Guide draws on Granta’s experience of working with consortium members and on confidential interviews with materials producers. We describe problems and missed opportunities that result from traditional approaches to materials information, suggest solutions, and outline the return on investment from implementing those solutions. We do this by exploring five steps that materials producers can take to get more from materials information.

### The Five Steps:

1. Take a systematic approach to materials positioning
2. Avoid islands of data
3. Capture traceability and pedigree
4. Integrate with customers’ engineering process
5. Use high quality materials data as a differentiator

Some material producers who already use Granta software:

- Materion Brush (formerly Brush Wellman)
- Constellium (formerly Alcan Engineered Products)
- Huntsman
- Hutchinson
- Dow Chemical Company
- Invibio
- Johnson Matthey
- Rhodia
- ThyssenKrupp VDM
Take a systematic approach to materials positioning

Consider these examples of two places where “Materials Positioning” is required:

**Sales**
A Technical Sales department needs to convince a potential customer that an existing material solution is better than anything the competition can offer.

**Early stage R&D / marketing**
An Innovation Team needs to identify new market opportunities for a theoretical material solution before significant development costs are committed.

In both cases, to achieve an effective material positioning, an organization requires:

i. sufficient information about the material itself, to measure its strengths and weaknesses against the competition, or, if such information is not yet available, a mechanism for predicting the properties of a material in development.

ii. similar data on the materials that make up the competitive landscape, including “out of class” competition (an aluminum producer may need to know about composites, for example).

iii. a systematic approach and tools to assist the decision making process, including the ability to generate key performance indices. These provide a quantitative measure of the suitability of a material for a particular application and combine measures of both cost and function. For example, they can help you to minimize the cost to achieve a particular stiffness of panel, or the weight needed to achieve a certain thermal insulation.

Materials Information Technology is a key enabling solution for these three requirements. The Case Study on page 9 demonstrates how such an approach can be applied.

It is worth mentioning here that imprecise data can still play a valuable role in competitive analysis. The goal is not to calculate the precise cost and performance of an as-yet undeveloped material or application, but simply to answer the question: “is this idea likely to be competitive?”

Discussions with leading material producers at a 2011 Materials Strategy Software Consortium meeting (7) suggested that accuracy in a key performance index of about +/- 20% was sufficient to guide early stage go / no-go decisions on material programs.

“...the benefits of finding just one new successful market opportunity or removing the need to manufacture just one grade could be measured in millions”
A Case Study

A material producer is considering developing a new material and process for natural fiber-reinforced polyurethane sandwich panels and targeting a transportation application. Competitive options have been selected from a library of 3,000 material families based on criteria including manufacturability, durability, and thermal stability. Two key performance indices (cost and mass per unit of stiffness for a panel in bending) have been chosen. Performance indices like these (which combine both functional and economic drivers) are crucial in positioning competitively.

The resulting positioning is shown below, with the new material in orange. The large bubble is indicative of the relative uncertainty in properties at this early market stage. Nonetheless, clear conclusions can be drawn: the product is competitive against most alternatives, but will struggle to compete on price against materials such as fiberboard. Within seconds, the user can generate a side-by-side comparison to identify the relative strengths and weaknesses of fiberboard in this application.

This analysis could guide a decision to pursue the marketing of this product for the chosen application, and identifies the need for strong market differentiation against fiberboard, perhaps building on the durability and water resistant properties of the new product.

This type of analysis applies both to offensive marketing efforts (e.g., identification of new markets for an existing technology) and defensive strategies (e.g., identifying the strengths of an existing product in an application so as to better defend it against the competition).
So how does such a systematic approach to material positioning lend itself to improved market share? When used by sales teams, the benefits of a systematic solution, supported by Materials Information Technology, for positioning fall into three main categories:

- The value of actually making the sale (including repeat business), where the sale is made possible by the presentation of a compelling positioning argument.
- The reduction in time from “inquiry to quote” made possible by having all the required data for the positioning exercise in a single software tool. A shorter sales cycle can be directly related to increased revenue.
- The opportunity to reject (“qualify out”) certain sales opportunities—where a positioning analysis shows that a company’s materials are unlikely to be competitive. This means that the sales force can concentrate on genuine opportunities instead. The earlier they can do this, the better.

Meanwhile, for strategic marketing exercises, the benefits of finding just one new successful market opportunity or removing the need to manufacture just one grade could be measured in millions.

And of course, materials R&D is about rejecting lines of research as well as pursuing them. An early analysis of competitive unmarketable opportunity can mean getting to market months earlier; or avoiding months of unmarketable development work.

## Avoid islands of data

Materials Information Technology can help to ensure that the right information reaches the right people, in the format they need it, as quickly as possible. In a typical material producing organization, these “customers” of materials information are likely to have quite different views on what they need from a materials information “system”, as shown in Figure 5.

The situation is complicated further by geographical spread: large companies, particularly those who have grown by acquisition, tend to have R&D, test labs, sales teams, and marketing groups dispersed over multiple sites. The result tends to be that large companies develop multiple ‘islands’ of materials information, each serving a particular community, each with its own idiosyncrasies and update schedules. There are several major risks arising from the current situation in many companies:

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<th>Island solutions tend to be owned by individual experts: when they leave the company, the data can become impossible to maintain.</th>
<th>Data is not synchronized, leading to inconsistencies and errors which eventually find their way to customers or slow projects down.</th>
<th>Tests are repeated because the technical teams in two different sites weren’t aware that they were both doing the same work.</th>
<th>Marketing teams are unable to respond quickly to competitive pressures because it takes too long to get up-to-date product information.</th>
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Of course, it is unrealistic to suggest that a single user interface can meet the needs of a sales rep, a material test lab engineer, and a technical marketing specialist. However, there is an alternative to the island approach, which is to deploy several different tools that all run off a common “gold source” of materials information.
Figure 5. Three very different applications which all require tensile data for a particular material. If there is no “gold source” for this data in a common, traceable repository, customer response times are slowed, development projects take longer, and business can be lost.

Materials Information Management software such as GRANTA MI supports this through a combination of user “Profiles”, which define the level of detail needed by individual users, coupled with specialist tools for particular needs. Examples include:

- **Simple profiles** for sales teams which allow fast searching of the company materials catalogue to identify materials that might meet a customer’s requirements.

- **Extended profiles** for R&D teams who need to explore and analyze test data for materials in development.

- **Access controlled areas of data** create information resources for specific customer projects that can only be accessed by authorized users.

- **Specialist charting tools** for marketing analysts, such as those shown in the previous section.

- **Standard reports and notifications** for QA teams who need to monitor large quantities of test data for materials in production.

- **Direct integration** of in-house materials information within a third party software application such as a CAE package used by an Application Engineer.
All of these systems are designed to meet the particular needs of the end user, but a critical point is that the underlying data source is a single, controlled repository with full control over version history, access rights, and traceability. This traceability is discussed further in the next section.

Our separate white paper ‘The Business Case for Materials Information Management’ (8) shows how the productivity savings alone from deploying a Materials Information Management system can run to millions of dollars. We demonstrate a typical return on investment of 13:1 based on these savings and reduced risk in a mid-sized manufacturing enterprise—we expect similar savings for materials producers with multiple sites and significant quantities of test data.

Figure 6. Clockwise from top: a simple tool for sales teams to answer customer queries; a user of Abaqus/CAE selecting material models for finite element analysis, and a fatigue test data management solution for a metallurgy lab. Three different tools for different audiences, but all draw on a single common data source.
Capture traceability and pedigree

A key point about materials knowledge is that it often resides not just in the property data itself, but in connections between data. These relationships are often lost, particularly where a system not designed for materials information is used. ‘Traceability’ is not maintained.

For example, it is hard to follow the route from a property in a product datasheet back to the analysis and raw data used to derive it. This can slow down efforts to improve products and make it hard to answer customer questions. Interviews at materials producers found examples of simple customer queries that took weeks to answer because the relevant data had been lost, needed to be regenerated, was held in multiple formats and locations requiring consolidation and re-analysis, or was lacking pedigree information.

An extreme example of the importance of traceability is seen in the world of composite materials (Figure 7). It is meaningless to speak of the “strength” or “stiffness” of a particular composite system without knowing the full composition and processing history of that system. The composition will involve a complex interaction between matrix materials, reinforcements, intermediates, and adhesives—each of which will have its own processing history and properties (9).

“Customer queries took weeks to answer because the relevant data had been lost, needed to be regenerated, was held in multiple formats and locations... or was lacking pedigree information”

Figure 7. High level overview of a data schema developed by Granta for the Materials Data Management Consortium to ensure traceability of composites information. The schema shows the types of data required to characterize composites, and the connections between them.

For producers of materials it is therefore vital to keep good pedigree information. Companies may want to ensure traceability from any testing or design data back to raw data about the original batch of material. Or they may simply want it to be possible to find all test and production data related to a specific material batch or production run. For example, in aerospace engineering, if a test shows a problem in materials production, engineers will want to quickly find full information about the source
for this material, its processing, and where else it has been used. Regulators or customers may
demand similar searches as a matter of routine. Without effective Materials Information
Management, these searches can take days, weeks, even months. They should take minutes.

A good Materials Information Management system can deliver this level of pedigree and traceability.
The result is: faster customer responses, fewer repeated tests, and a much more efficient R&D
environment.

4 Integrate with customers’ engineering processes

Large engineering organizations expect their material suppliers to work closely with them in
developing new solutions tailored to their requirements. This presents both a challenge and an
opportunity: a challenge because suppliers will have to involve the customer much earlier in the
development process; an opportunity because smart use of Materials Information Technology can
make it very difficult for the competition to displace a supplier whose test data programs are tightly
integrated with the customer’s.

Figure 8. Mechanical property data generated by a material producer (left) and corresponding ANSYS input file
required by a customer (right). Conversion between the two need not be a time consuming, error-prone process.
How is such an integration possible? Once the foundations of a Materials Information Management system have been implemented, a number of benefits immediately follow:

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<th><strong>A faster response</strong></th>
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<td>If the data required by a customer can be accessed quickly through an electronic search, response times can be hours instead of days, increasing the likelihood of meeting customer deadlines.</td>
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<th><strong>Tailored formatting of data</strong></th>
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<td>If the customer requires a particular material model for a Finite Element Analysis, a Materials Information Technology system can produce a correctly formatted file (Figure 8) automatically, drawing on the key material property data already stored in the system.</td>
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<th><strong>Fidelity of data exchange</strong></th>
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<td>By setting up a structured ‘schema’ for materials data, it becomes possible to transfer material information across the supply chain with minimal risk of error.</td>
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<th><strong>Security of data exchange</strong></th>
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<tr>
<td>Access Control can ensure that individual customers see only authorized data, allowing material producers to ringfence project test information and make available key information to support the engineering process.</td>
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<tr>
<th><strong>Two-way communication</strong></th>
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<tr>
<td>By using a common data schema and a commercially available Materials Information Management system, customers and suppliers can exchange materials information such as test curves, material models, and specifications—without time consuming reformatting and manual entry of information.</td>
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Use high quality materials data as a differentiator

There is another benefit to collecting a structured, traceable resource of high quality materials information: the very fact that such data is available—and it can be deployed in a searchable, easy-to-use manner—can be a major differentiator against competitors.

Examples of uses of Materials Information Technology to publish information in this way include:

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<th>Industry collaborations</th>
<th>Increasing the profile of a particular class of materials by providing a freely available reference source. (See the case study, below)</th>
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<tr>
<td>Website-based material selection tools</td>
<td>Giving customers an easy-to-use tool to find out whether anything in the product line can meet their requirements.</td>
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<tr>
<td>Providing in-depth specialist resources to customers.</td>
<td>E.g., a polymer producer who can make detailed creep data available to potential customers in an accessible electronic format can win business from competitors with similar materials but no such value-added resources</td>
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Of course, when materials data is exposed outside an organization to the general public, the usability and intuitiveness of the tools used to deploy it become critical. Non-expert users may wrongly judge the quality of data by the quality of the user interface, or they may simply be unable to find what they are looking for. Developing intuitive user interfaces is a specialist skill—a strong argument for using commercial off-the-shelf software tools rather than developing a system in-house.

A Case Study

The Global Powder Metallurgy Database was developed as joint project between the leading regional powder metallurgy (PM) trade associations in Europe (EPMA), North America (MPIF), and Japan (JPMA). The database is the world’s most comprehensive and reliable PM data source—and allows producers of these materials to share information with potential customers to promote the usage of Powder Metallurgy and Metal Injection Molding.

Users of the database can quickly access key property information, and easily export data to Excel or other software platforms for further analysis.

Figure 9. Powder Metallurgy data within GRANTA MI—you can browse, search, and apply data as numbers, texts, and (where appropriate, e.g., for temperature-dependent data) graphs & functions.
Conclusions

We have looked at five ways in which Materials Information Technology can help mitigate some of the challenges faced by material producers:

**Adopt a systematic approach to materials positioning**

- **R&D**: assess competitiveness of solutions before significant development costs are committed.
- **Sales**: articulate the benefits of your materials over the competition's.
- **Technical marketing**: identify new market opportunities; position existing materials against competition.

**Avoid islands of data**

- **R&D**: avoid repeat testing; spend more time developing materials and less time answering queries from colleagues.
- **Sales**: shorten sales cycles by getting fast answers to customer questions.
- **Technical marketing**: ensure datasheets and customer facing collateral is accurate and up-to-date.

**Capture traceability and pedigree**

- **R&D**: support forensic analysis, avoid repeat testing, provide an audit trail.
- **QA**: capture and analyze ongoing test data for materials in production to ensure quality standards are met.

**Integrate with customers’ engineering processes**

- **Sales**: ensure strong customer retention by selling business partnerships rather than just materials.
- **R&D**: avoid errors and delays when developing materials in collaboration with customers.

**Use high quality materials data as a differentiator**

- **Technical marketing**: educate the market and provide visibility for products; differentiate against the competition by providing value added services.
Our related white paper (8) suggested a return on investment for Materials Information Management of as much as 13:1. But that study excludes the following potential returns. Consider the value of a 1% improvement in any of these areas on your business:

- Length of sales cycle
- Repeat customer business
- Business from new applications of existing materials
- Business from new materials
- Time spent investigating new market opportunities
- Defense of existing market share against competitors for a particular product line

If these benefits might help your business, why not get in touch with Granta to discuss how you can put these suggestions into place, and help protect and increase your market share?

**Further Information: get in touch!**

One common concern among organizations contemplating these issues is that a project to address them is simply too large to add to their already crowded ‘to do’ lists. Although the Granta software can provide a comprehensive solution across all of these use cases, initial implementations usually focus on one or two key problems, often within a specific part of the organization. This allows the technology to be introduced and validated quickly and to deliver a short term return on investment. User organizations can be confident that these tools can, if required, be extended to other use cases or departments, minimizing the risk of creating isolated ‘island’ systems.

Readers in materials producing organizations with interests in any of these use cases may wish to identify a solution that could help them. A good first step is often to discuss materials information usage and requirements with a Granta expert. An initial consultation can quickly establish the scope of your needs and identify areas in which it may be worth exploring use of the Granta software.

Full contact information for Granta is available at [www.grantadesign.com](http://www.grantadesign.com).
References


