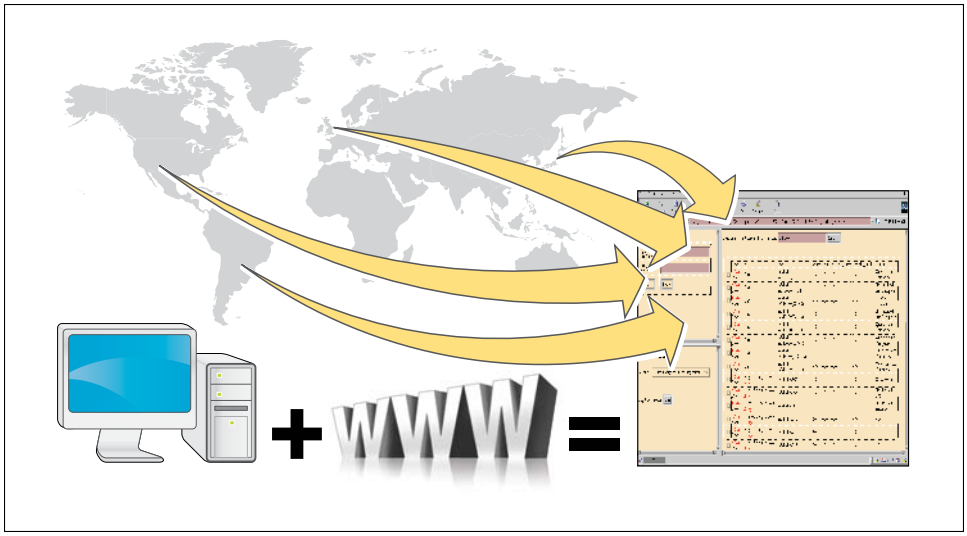
MSC Enterprise Mvision

Quick, Simple and Auditable Access To Engineering Materials Knowledge Throughout a Global Enterprise



MSC Software

Summary

Pressure on manufacturing companies to produce better products, quicker, and more cheaply, has never been more intense. For companies to make the most of their previous experience and get new products to market in ever-decreasing time, information-sharing, or better still knowledge-sharing, has become the necessity. However, the current reality in the case of materials knowledge is that as much as seventy percent of materials data becomes lost and unavailable to future projects. Beginning with a research project for the US Air Force in the mid-1980's, the MSC.Software Corporation has become the leading authority on materials data management. This white paper explains the background to this deceptively challenging subject, before outlining the functionality and implementation of the latest solution technology, known as MSC Enterprise Mvision, which MSC.Software has developed.

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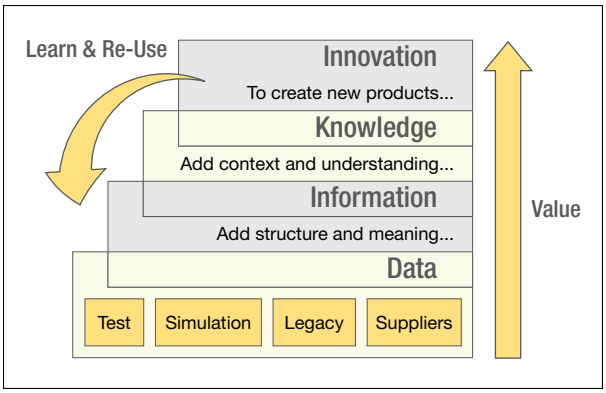
Background

Engineering in the Information Age

Pressure on manufacturing companies to produce better products, quicker, and more cheaply, has never been more intense. This 'better, faster, cheaper' requirement has seen a dramatic shift away from time-consuming and costly fabrication and testing of physical prototypes. Today's products are designed, analysed, manufactured and tested through simulation on the computer screen. The bewildering progression of company mergers, acquisitions and consortia also means that such simulations are no longer carried out only in one office, one building or even one country – today's engineering requires access to common information from computer screens distributed around the world.

Every one of the engineering computing applications in design, analysis and manufacture is hungry for data – property data, external constraint data, and data on operating conditions. The database has therefore become one of the key applications, in engineering now as well as in other business sectors. In isolation, however, simple data are no longer enough. For companies to make the most of their previous experience, and get new products to market in ever-decreasing time, information-sharing, or better still knowledge-sharing, has become the necessity.



Such is the reliance on the global sharing of data and information, that today's business environment has rightly been termed the 'Information Age'. The Internet, and companies' internal Intranets have become the critical enabling media of information exchange. The Web allows businesses to share information within their companies, and with their customers and suppliers, on a truly global basis. The inefficiencies and overhead costs of previous duplicative methods are simply no longer acceptable.

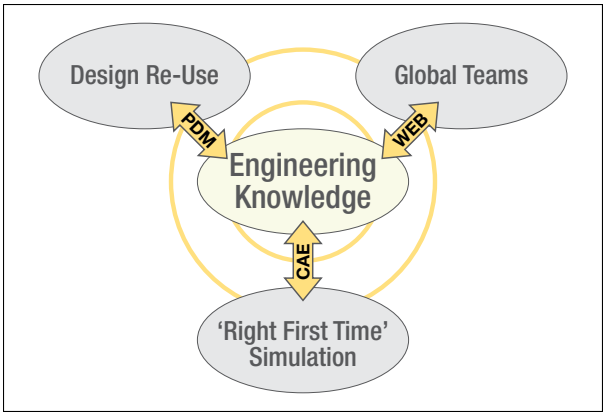
Companies are not embracing the web-enabled global enterprise arbitrarily, but because they have to. Their competition is certainly doing so.

Why Is Data Sharing So Important?

Data, and the processes associated with data acquisition, are extremely expensive. When knowledge is derived from these data, this knowledge is inherently still more valuable - both directly through time and labour and through the intangibles of reuse and 'lessons learned'. These lessons and the trends they establish must be shared throughout a project team, as

well as archived for future consultation. Data sharing is crucial if industry is to advance its quest for increased operating efficiencies, improved product quality, and faster time to market.

It has been estimated that as much as seventy percent of materials data becomes lost and unavailable to future projects. This results in time-consuming and expensive re-tests to obtain the necessary data for new designs. Design knowledge must instead be captured and managed for reuse. The Web allows this knowledge to be shared globally, supporting the 'Design Anywhere, Build Anywhere' business climate.



Technology strategy

The Critical Nature of Materials Information

'Functional data' - such as loads, materials properties and geometrical information - play a critical role in any simulation or design, and are notoriously difficult to handle by software tools not specifically designed for the purpose. None of these data types has a more profound effect, nor is more complex to handle, than materials information. Many of today's innovative designs owe their success and viability to the revolutionary use of materials - from lightweight mobile telephones, to electric vehicles, to advanced fighter aircraft. Such success does not come cheap – turbine manufacturers estimate that it costs over $1m to qualify fully a new candidate material for use in temperature-critical turbine components.

This information is crucially important, but is also very complex. Materials data may consist of tables, curves, matrices, images, or other formats – all of which have supporting metadata and associated footnotes, units and precision. The ability to interpolate curves 'on the fly' as part of a query, for example, is a common requirement and requires a sophisticated solution to be effective. In summary, efficient storage and global dissemination of materials information is a deceptively challenging application, requiring a specifically-designed and world-class computing solution.

The MSC Enterprise Mvision Solution

Overview

MSC.Software Corporation is uniquely qualified to provide the solution for global materials data dissemination, through unrivalled experience gained in the development, support and implementation of the MSC Mvision technology. Developed originally through a research project for the US Air Force in the mid-1980's, MSC Mvision has since become the de facto standard for materials data storage and dissemination to computer-aided engineering (CAE).

From the outset, MSC Mvision was ahead of its time in a number of areas critical to success in managing the complexities of materials information. The system was designed specifically for this application - and combines database, spreadsheet and graphics capabilities to provide all the required facilities. A key strength of the system lies in its combination of performance and flexibility – querying and data retrieval speed is extremely fast, even if simultaneously interpolating from perhaps 5,000 curves in the process. Flexibility is also critical – no company knows from the outset exactly how it should design its implementation, and inevitably changes and modifications will be required subsequently. MSC Mvision enables these changes to be made quickly and safely, without recourse to database programming consultants.

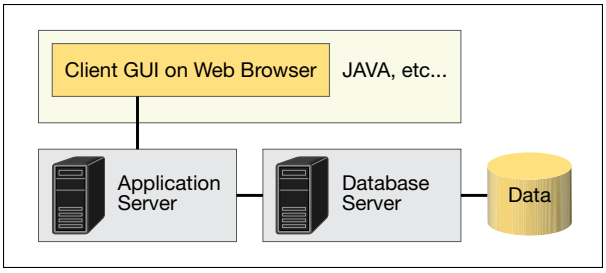
MSC Enterprise Mvision brings all these benefits to the Web environment. The software combines the solid foundation of proven MSC Mvision technology with the latest techniques for Web-enabled global access.

MSC Enterprise Mvision is a true client-server application, in which each component is optimized for the specific requirements it must support, while removing the need for any software to be installed on end-user's machines – the so called 'zero footprint' approach. All Mvision technology resides on a server machine, providing access to centralised databanks and data manipulation functionality via standard Web browsers on any platform.

MSC Enterprise Mvision is not 'simply' a database, nor 'simply' a Web site. It is a sophisticated CAE technology in its own right that incorporates these and other components to deliver auditable information to end users and their applications.

Architectural Overview

MSC Enterprise Mvision is based on a three-tier, client-server architecture:



The user interface and its customisation are discussed in Section 2.3, below. The application and database servers make up the middle layer of the architecture - a robust set of MSC Mvision tools that store and retrieve data from the materials databank(s). Via the features of the 'Intelligent Database Component' application server, customised views of materials object models can be created, along with actions - such as displaying to screen or writing a file – which operate on those views. This middle tier also allows access control to be implemented - user interface view(s) can be defined which automatically filter out data to which access is not permitted. Different users, or groups of users, can therefore only see the subsets of data to which they have authorised access.

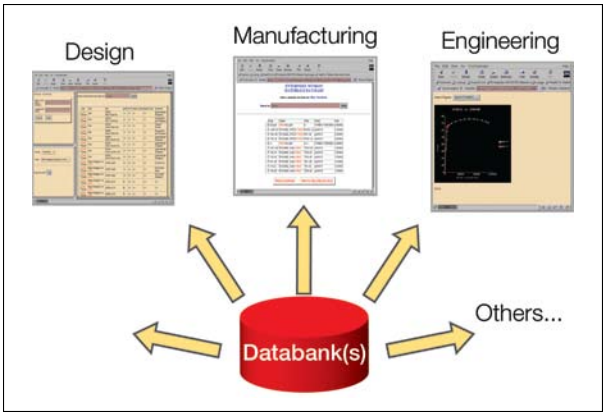
The ‘lowest’ level of the system is the database ‘engine’ itself. Currently this uses MSC’s Mvision technology, providing the benefits described above - although the flexibility of the architecture makes it possible to work with other database technologies if required.

In summary, the features offered through this architecture include:

- True client-server operation, with no extra software to install on end-users’ machines
- Accessible from standard Web browsers
- Based on established MSC Mvision core database technology that provides powerful querying and data manipulation tools
- Uses all existing MSC Mvision Databanks, created in-house or supplied by MSC.Software
- Process-dependent views of the same data readily created
- Provides access control by user or by group, even to different subsets of the same databank

‘Data plus Methods’ – the Customisation Options

‘Out of the box’, MSC Enterprise Mvision includes predefined user interfaces that companies can use immediately. However, one of the key features of the system is an almost limitless capability for customisation - to address the unique needs of different teams’ access to the same materials data.



Enterprise Mvision provides different views of the same data to enable better collaboration

No two companies have exactly the same design-to-manufacturing environment. Rigid tools that are not easily adapted, force companies either to alter their process, an expensive task, or to seek alternative tools. On the other hand, tools that easily conform not only to different companies’ environments, but also to multiple disciplines within a single company, provide immeasurable value. Many teams within a company – for example, manufacturing, design and engineering – all have the basic need for materials data. However, each team will certainly require unique views and interpretations of the same data.

Since this advanced customisation capability enables local expertise and practice to be built-in to the Enterprise Mvision system, one customer described this as moving from a simple ‘database’ concept to that of a ‘data plus methods base’. The benefits are clear, in moving up the progression from data management towards information and knowledge management, as explained in earlier paragraphs.

Using the predefined interfaces as a starting point, companies customising their Enterprise Mvision implementations do so using the standard languages HTML and JavaScript. A series of HTML page templates controls the data presentation to the user. These templates are based on a well-documented, high-level library of Mvision ‘tags’ - a ready-made toolkit for complete system redesign. The availability of all of these simple customisation tools means that very little time is required to implement a company-specific Web-based materials data management system.

To summarise, MSC Enterprise Mvision customisation features include:

- Complete, ready-to-go interfaces supplied with the system.
- Interfaces quickly customised if required using standard languages.
- Local implementers can readily define different views of the same data, to reflect the needs of users in different functions or manufacturing teams.
- Extensive library of pre-written software components provided for user interface building, including components that handle all the database interactions.
- Fully documented, including comprehensive customisation examples.

Integration of Materials Data with CAE Simulations

In many otherwise sophisticated CAE environments, the entry of input data to CAE programs is often the weak link in the auditability chain. Opportunities for error are significant – from a simple typing error through to use of data for a material at, say, a different heat treatment or whose properties have been calculated via an inappropriate model. As a product of MSC.Software, MSC Enterprise Mvision predictably features strong emphasis on auditable and convenient direct data export to CAE programs.

Having queried, browsed or otherwise determined the material of interest, Enterprise Mvision users may create run-ready data files for the major CAE codes with a single mouse-click. The exported data are ready for immediate application, since Enterprise Mvision performs unit conversion, checks for valid materials identifiers, checks for negative values of specific heat and other constants and screens negative plastic strains. Each record is thoroughly commented and identifies its exact source.

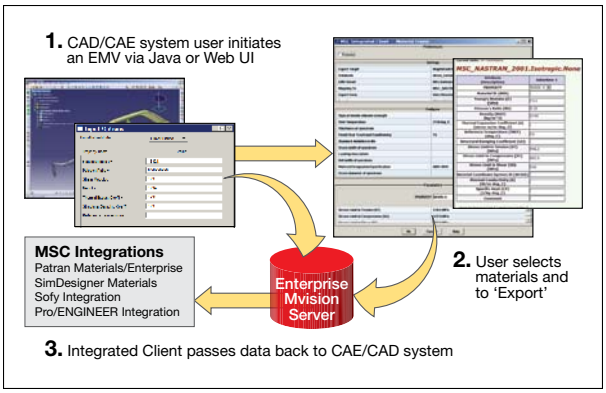
Enterprise Mvision includes ‘off-the-shelf’ Export capabilities to leading CAE tools such as MSC Nastran, Ansys and Abaqus for a wide variety of linear and non-linear (eg temperature dependent) isotropic and orthotropic materials models. Continuing the emphasis on flexibility, the Export functions can also be modified to enable integration with customer-proprietary tools. The following example is typical of a fully-documented data file, as produced by this Export process.

```
$ Materials record(s) generated by MSC/MVISION
$ Number of material records generated = 1
$ Materials data exported using template =
  MSC_NASTRAN.Isotropic.None
$ Materials data exported from database = D:/msc/
  emv2008r1/databases/mil5.des
$ Unit conversion = US-Consistent
```

```
$
$ Material Record 1 of 1
$ Databank Keys for record 1:
$ Databank Record Number = 3413
$
$ User entered comments = This data file generated as
  a test.
$
$  UNS= A97150
$  DESIG= AMS 4306
$  DIMS= Thickness: 0.750-1.000 in
$  PROPERTY.ROW_ID= 2340
$  PROPERTY.BASIS= A
$
$  Units and Footnotes for record 1:
$  Field     Units        Footnote
$  -----     -----        --------
$  FILENAME
$  MID
$  E         psi
$  NU
$  RHO       lb/in^3
$  ALPHA
$  TREF      deg_F
$  GE
$  ST        psi
$  SC        psi
$  SS        psi
$  MCSID
$  K
$  CP
$
$  Data Source for record 1:
$  Field     Data Source  Expression
$  -----     -----------  ----------
$  FILENAME  *Modified By User*
$  MID       *No Data*
$  E         Databank     E11T
$  NU        Databank     NU12
$  RHO       Databank     DENS
$  ALPHA     *No Data*    INTERP_X(CTE11VSTEMP, TEMP)
$  TREF      Databank     TEMP
$  GE        *No Data*
$  ST        Databank     YS11T
$  SC        Databank     YS11C
$  SS        *No Data*    YS12S
$  MCSID     *No Data*
$  K         *No Data*    INTERP_X(CTC11vsTEMP, TEMP)
$  CP        *No Data*    INTERP_X(CPVSTEMP, TEMP)
$
$ This record will be written as an isotropic
  material with
$ constant elastic properties.
$
$ The material properties written to the following
  MAT1 bulk data entry are:
$                     Material ID (MID) = 1
$                    Young's Modulus (E) = 1.0200E+007
$                  Poisson's Ratio (NU) = 3.3000E-001
$                          Density (RHO) = 1.0200E-001
$     Thermal Expansion Coefficient (A)  = 0.0000E+000
$           Reference Temperature (TREF) = 7.0000E+001
$   Structural Damping Coefficient (GE)  = 0.0000E+000
$           Stress Limit in Tension (ST) = 7.9000E+004
$      Stress Limit in Compression (SC) = 7.7000E+004
$             Stress Limit in Shear (SS) = 0.0000E+000
$ Material Coordinate System ID (MCSID) = 0
$
MAT1     1      1.02+7      0.33000 0.10200      0.0
  70.0000      0.0+M     1
+M       1 79000.0 77000.0      0.0      0
```

Data Access from Other Systems

In an integrated CAE environment, no system exists as 'islands of standardisation' without 'talking to', and exchanging data with, other applications. This is particularly true of a system that acts as custodian to a company's engineering knowledge, so MSC Enterprise Mvision was designed to support interoperability.



Enterprise Mvision features an Integrated Client for providing access to Mvision data from within remote programs such as CAD or CAE systems. Integrations between Enterprise Mvision and MSC Patran, MSC Sofy, Dessault's Catia, Altair's HyperMesh, ProENGINEER Wildfire, and a host of customer in-house applications have proven to integration to be an effective strategy for improving the reliability of data transfer and traceability of data transfer between software applications and has been a significant factor in the success of global implementations.

Implementation of MSC Enterprise Mvision

Using 'Out-of-the-Box' Interfaces for Deployment

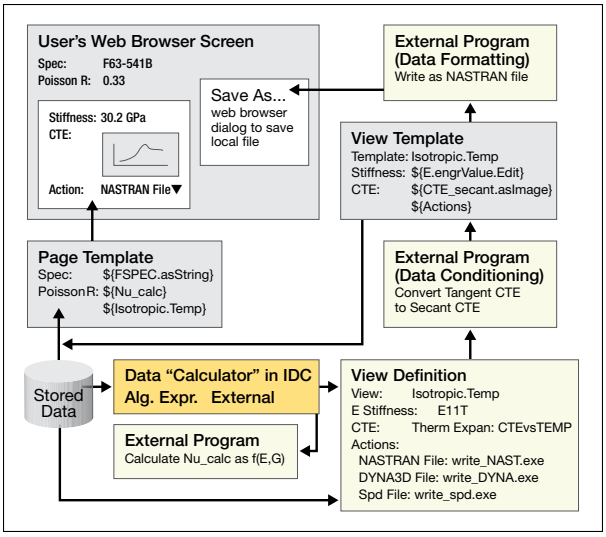
Deployment of MSC Enterprise Mvision using existing Databanks, whether MSC-supplied or developed in-house, involves the following simple steps:

- Install Enterprise Mvision server software on server machine.
- Install Databanks on server machine.
- Apply simple utility to convert Mvision 'form definition' files (used to lay out the user interface) to enable these definitions to be used in the Web environment.

- If required, carry out modest HTML modification to present data and data flow to best advantage.
- If required, create Export functions (in 'C') for pre-formatted data provision directly to proprietary CAE packages.
- Provide URL to user community, providing the system's full functionality to Web browsers at any location.

Creating a Customised System

Most companies implementing Enterprise Mvision will wish to take advantage of the extensive customization facilities, to produce a system that truly reflects their in-house terminology, processes and practice. The system is supplied with a complete toolkit to facilitate this, with Page Templates and View Templates created during implementation defining the design of the User Interface:



In the diagram above, the box in the top left-hand corner represents an HTML page, or window, as it would appear on the end-user's computer. It can be seen that this window displays some general data about the material, a property value with units from a property table (Stiffness in this case), an X-Y graph, and an action button (write a file for MSC Nastran).

The combination and positioning of all of these different elements can be designed by the system implementer – as can the number of such screens that are displayed, and the order, or flow, between them. An analyst, perhaps, may wish to choose a materials name from a list and click a button to create a file. A designer involved in comparative design evaluations, meanwhile, may wish to call up several sets of graphical data, review case histories of previous components, and run an external lifing program from data sets for candidate materials.

All of these options are designed by the implementer using a Page Template for each page or screen displayed, and View Templates to define each data object view and the actions performed on it. All of the associated customisations are written in standard HTML and JavaScript. The flow and relationships between the underlying components can be seen in the above diagram.

Implementing Links to other Software Systems

Section 2.5, above, described the protocol for sharing Enterprise Mvision materials data objects. Implementers would link to this capability via the 'integrated client' API.

In addition, access to external programs can also be enabled via scripts connected to the UI pages. Many users of MSC.Mvision access other programs via external functions in the spread-sheet – in Enterprise Mvision a more general facility is available whereby calls to external programs or functions can be made directly from the HTML pages making up the user interface.

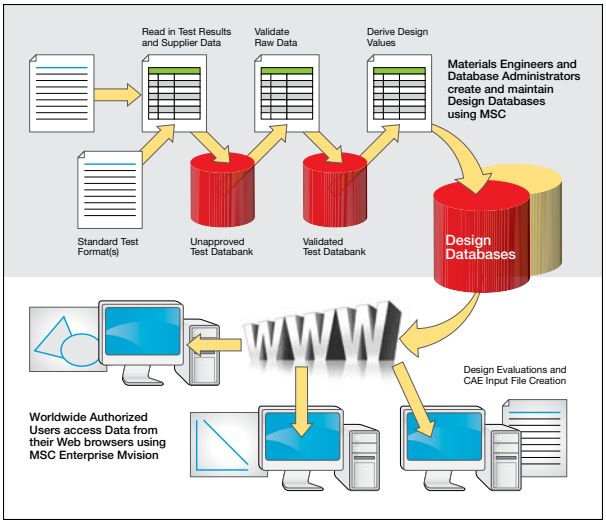
Updating the Database – Centralised Data Management and Control

No materials database ever remains static – some MSC Mvision users report regularly modifying as much as 10 or 15% of their entire database. The system must be able to support this level of transaction, and indeed Mvision users over many years have built up sophisticated processes linking the software to data capture facilities, Laboratory Information Management Systems (LIMS) and other technologies.

The benefits are directly applicable when the databanks are sub-sequently deployed across the Web using Enterprise Mvision. As soon as the latest data are added to the database and released on the central server, users around the world can immediately have access to the latest information via their Web browsers.

Significantly, the ability to modify or update the database is not limited to editing the data content – as a company's implementation evolves and user feedback is incorporated there is often a requirement to change the structure of the databanks themselves. This is an extremely straightforward operation with MSC Mvision and one that many users have been grateful to take repeated advantage of – and once again, as soon as the new structure is released, it is available to all users world-wide across the Internet.

Many papers have been published on the implementation of materials data management using MSC Mvision, and the capture of test data for processing and reducing into design allowables is a procedure at which the software excels. The diagram below illustrates the overall process:



Applications Beyond Materials

Much of the foregoing has been concerned with addressing the challenges associated with managing and disseminating information on engineering materials, and this was indeed the original driver behind the development of the MSC Mvision and MSC Enterprise Mvision technologies. However, many of the same challenges apply to other types of functional data, and the system's combination of database, Web browser, customisation and engineering data-handling capabilities is readily applicable to these applications also.

The technology has been applied by MSC.Software customers for the creation of such systems as:

- Database of road load test data, with images of test conditions and instrument location, fully searchable metadata and link to specialist lifing software
- Single-environment system for storage and comparison of in-flight load data to CAE simulation results for aircraft frame structure
- Web-based catalogue of standard beam sections and other components
- On-line handbook for aircraft composite wing damage categorisation and repair

Support from MSC.Software Corporation

MSC Implementation Services

MSC.Software offers a full Implementation Services facility, through which expert consultants can provide Requirements Specification, Implementation and Customisation services – anywhere in the world. These consultants have extensive experience in supporting MSC Mvision and MSC Enterprise Mvision in a wide variety of applications, and have direct communication back to Product Management and the Development team. MSC.Software is uniquely qualified to assist with materials data management challenges!

'Hotline' Customer Support

MSC.Software provides the industry's most comprehensive support system, with over 50 offices worldwide to provide local and centralised support. Investing in MSC.Software solutions provides access to extensive client support through MSC's comprehensive documentation, direct technical expertise, and customised training classes.

Information about MSC.Software products and local office locations is available from the following world area headquarters:

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