A Best-of-Breed Approach to Marine Design Tools

D Larkins, ShipConstructor Software Inc., Canada

SUMMARY
The purpose of this paper is to explore the benefits and challenges inherent in a recent shift in how Integrated Shipbuilding Environments (ISEs) are created and deployed amongst the world's leading shipbuilders, offshore experts and marine-focused software vendors. The paper will also outline a case study in which this approach has been employed.

NOMENCLATURE

SSI	ShipConstructor Software Inc.
ISE	Integrated Shipbuilding Environment
FEA	Finite Element Analysis
SCDN	ShipConstructor Development Network
API	Application Programmer Interface
NSRP	National Shipbuilding Research Program
STEP	Standard for the Exchange of Product Model data
MIM	Marine Information Model
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing

1. INTRODUCTION

The status-quo for an enterprise level Integrated Shipbuilding Environment (ISE) is a monolithic software system that is statically defined and contains a tool for each of the major disciplines (Hull Structure, Pipe, HVAC etc...). These systems are traditionally closed to tight integration with 3rd party applications, and can be difficult to customize.

Unfortunately, because no two shipbuilders have the same requirements, and in fact many shipbuilders realize a competitive advantage with these differences, customizing the system is a fundamental requirement of the industry.

The three key aspects of an ISE that address these concerns and will be addressed by this paper are:

- Modular systems with best-of-breed building blocks tailored to a specific customer.
- Open, accessible data architectures.
- Industry driven concepts within the UI and data architecture.

Each of these aspects is dependent on the others, and all are required to be in place to make this overall approach work.

2. MODULAR SYSTEMS

Each application in a traditional ISE is not necessarily the best in class for that domain. This stems from many causes, not least of which is the requirement for different skill-sets and specialized knowledge for each area of the shipbuilding process.

In some areas, the detail design of Hull Structure and Mechanical Systems for example, the benefits of having a hand-selected product are outweighed by the tight integration required in engineering between these disciplines. Fortunately the skill-set required to develop software in these areas, while not identical, is similar enough that if one product is well suited to a specific customer, the other should also be fairly well suited.

However in other areas, like initial design, schematics, equipment design, visualization, clash detection, pipe flow analysis, and FEA extensive specialized knowledge is required. As a result, companies who develop specialized products in these areas often create better products than what is available 'in-the-box' with a traditional ISE.

These best of breed applications are not usually available as part of a traditional ISE. In some cases the data in the ISE is difficult to access externally making an application developed by the company who developed the core products the only viable solution. Sometimes, the revenue potential from delivering that additional application as part of the core package is more than sufficient cause. In some cases the reasons make sense to the client and the result is acceptable.

2.1 REINVENTING THE WHEEL

In some cases the reasons are not apparent to the client and there is an obvious alternative that is a superior product.

An example of this in a ShipConstructor-based modular ISE is Autodesk Navisworks. For design review and visualization Navisworks is a clear leader due to its excellent feature-set and ability to read a wide variety of data formats directly. Clearly SSI could have developed and delivered a ShipConstructor-branded design review tool, however it's likely that the result wouldn't have been better than Navisworks.

One of the trends that have developed around traditional ISEs in larger shipyards is towards more software development savvy in-house IT resources. Currently some larger shipyards have teams of IT people whose sole responsibility is to customize and integrate the software they have purchased into their processes in order to retain a competitive advantage. This is a challenging task due to the complexity and inaccessibility of a traditional ISE.

In a ShipConstructor-based ISE this modular approach has been cultivated to a level where the flexibility of the overall system offers great benefits to a shipyard or design office. As the core of the ShipConstructor software is based on AutoCAD (the best-of-breed 2D/3D design and drafting software) each ShipConstructor installation must be installed on top of AutoCAD. However, in order to provide utmost flexibility to the client, each ShipConstructor installation can be performed on top of any one of the many AutoCAD verticals available today. This allows a client to tailor the ShipConstructor experience to each user based on the tasks that user is to perform. A piping designer can use ShipConstructor on top of an instance of AutoCAD P&ID allowing both toolsets to be available in the ShipConstructor environment. Similarly a structural designer can utilize the benefits of AutoCAD Mechanical while working with ShipConstructor.

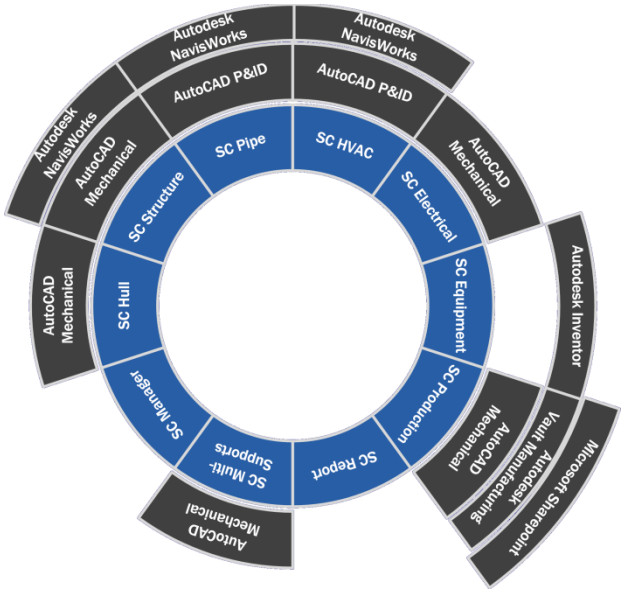

Figure 1- The core of a ShipConstructor-based ISE

This modular approach to building an ISE has been applied effectively at shipyards around the world. One of the most critical aspects for this to be truly successful is the capability for effective integration between the individual components.

3. ACCESSIBLE DATA ARCHITECTURE

There are a few trends that can be seen in the development of software applications in almost every domain. These include the use of industry-standard relational databases for data storage, the use of the Microsoft .NET framework in development, the development of industry standard formats for data exchange and the development of Application Programmer Interfaces (APIs). These trends played a pivotal role in the rise of modular ISEs.

Many traditional ISEs were developed before these technological trends were in full swing, and some before they even existed. Unfortunately many of these ISEs are still in use today. Many of the paradigms used to date for the storage of geometric data do not lend themselves very well to storage in a relational database (except as binary large object data, or BLOBs, which defeats the purpose of storing the data in a readily accessible way.)

3.1 DATA EXCHANGE FORMATS

The establishment of industry standard formats for data exchange has allowed some applications to ship with a viable integration path into a modular ISE. As an example, a US Navy National Shipbuilding Research Program (NSRP) funded project called NSRP ISE-6, in which ShipConstructor Software Inc. (SSI) was involved, was conceived to further the implementation of a few shipbuilding specific variants of STEP. The shipbuilding specific Standard for the Exchange of Product model data (STEP) formats include AP 212, AP215, AP216, AP218, AP227 and cover a wide range of shipbuilding disciplines from curved shell plating to piping and other mechanical systems. Currently ShipConstructor can read and write STEP AP227, allowing the exchange of piping data between ShipConstructor and other applications that have similar capabilities.

3.2 APPLICATION PROGRAMMER INTERFACES (API)

An API allows software developers, either from one of the software vendors or from the client, to integrate applications in a manner familiar to most developers. This level of integration allows the most seamless experience for the end user. In some instances, the integration between a Piping & Instrumentation Diagram (P&ID) and the 3D model for instance, this level of integration is required to make the experience and process integration acceptable for the client.

The establishment of a Microsoft .NET Datalayer API has allowed for the integration of other applications into the ShipConstructor ISE. This API provides full access into the data which represents the ShipConstructor 3D Marine Information Model (MIM). Applications in the realms of FEA, pipe isometrics and production planning have been integrated into a ShipConstructor-based ISE in this fashion.

3.3 RELATIONAL DATABASES

The use of a Relational Database Management System (RDBMS) is an important piece of the puzzle in creating a truly modular ISE. Storing of both the geometry and attribute information for the 3D model in a relational database creates avenues of integration into other processes and applications that don't require the involvement of 3rd party developers.

With the widespread use of these databases in other applications, both engineering and corporate, many

clients have IT staffs that possess the requisite skills to access this data. Prior to the emergence of this trend this data was locked behind closed doors and was only accessible to those who had an in-depth understanding of the end user application.

4. INDUSTRY-SPECIFIC DATA

This democratization of the information stored in the data model for an ISE can only be fully effected if another change takes place. Some of the systems available today do not define the geometry and relationships in the product model in marine-specific terms. They have moved towards geometry models that are purely defined by parametric geometric elements. Most end users, whether they are in shipbuilding or IT, have very little understanding of these geometric concepts. These concepts have no real world counterpart and therefore do not map easily onto the processes that are found in the shipbuilding and offshore industries.

This is particularly true when looking at the associative and parametric relationships within the 3D model of a vessel. In many systems these relationships are geometric only. This can make it very difficult for someone without specialized training to extract the information about the *logical* relationships they *know* exists.

As an example of this, try to remember the last time you were walking through a shipyard and saw a burning machine that was marking the edge of a face of a body which is coincident with the face of the body of the plate being marked. In shipbuilding terms what is being referred to in this example is the marking of the moulded line of a stiffener on a plate. Logically the stiffener is attached to the plate as part of a stiffened panel. In some of the ISEs currently available the data cannot be accessed in shipbuilding terms. A detailed understanding of the geometry model must be developed in order to access this data.

Areas of the ISE that need to be integrated and rely on these concepts, like production automation and production planning, must have access to the geometry in the model in these same shipbuilding terms if access to this information is truly to be democratized.

5. BENEFITS OF A MODULAR ISE

The obvious benefit of this approach is an ISE in which each element is hand-selected because it is the *right* solution for a particular client. There are also a few other advantages that are perhaps even more beneficial for certain clients.

5.1 SCALABILITY

An increasing number of shipyards today are performing a wide variety of projects including repair, refit, commercial and military contracts. Each of these types of projects has different requirements in terms of processes, implementation and deliverables.

Unlike a traditional ISE, a truly modular ISE can scale to suit projects of various requirements without losing effectiveness or reducing efficiency. Each component of the modular ISE has been selected specifically for the needs of the client and has been integrated according to the processes it is designed to facilitate. It should be evident that the same component can be integrated in a different fashion for another type of project or left out altogether.

5.2 ADAPTABILITY

Making a change to a new ISE is both a substantial cost and a substantial risk to any organization. Due to the costs involved, both direct and indirect (in the areas of workforce training and implementation), the selected ISE will likely be in use for many years, if not decades. While traditional ISEs are updated as new technologies come along, they aren't usually updated in all of the various domains and usually aren't updated as quickly as the individual components of a modular ISE would be.

Each of the components of any modular ISE can be replaced as advancements are made, or new products come to market in that domain. Because the core CAD/CAM product and each of the components was selected in part for their ability to be integrated into the larger whole, they can also be replaced by plugging in the latest and greatest module.

The resulting ISE will stay relevant for longer and will be more effective during that time due in large part to the ability to prune components that are no longer showing the desired results.

6. INDUSTRY CHANGES

The adoption of the modular ISE will require changes to how both software vendors and shipbuilders do business. Currently software vendors providing their own software only require knowledge during the sales process of whether the software will satisfy the needs of the target client. Once a sale has been made, consultation and implementation services are acquired to ensure a successful adoption of the software.

6.1 CONSULTATIVE SALES

With a modular ISE, significant knowledge of the client and the components of the 'ideal' ISE, as well as how these components will be integrated into each other and existing processes is required early in the sales process. As a result, a portion of the sales team needs to be educated on what the best-of-breed components are in each domain, and how they can be applied.

This consultative sales process benefits the client as it ensures that the sales team truly understands their needs and how well the software solution will meet them. The client needs to understand and accept the benefit of a modular ISV, as the sales process will be more invasive and will take slightly longer than with a traditional approach.

An approach that has worked for SSI is to establish a sales channel in each market that has an extensive background in both the marine and IT industries. The ShipConstructor sales channel is composed of naval architects and marine engineers who have either established their own IT companies or who have extensive background in implementing IT solutions for the marine industry. These people have the ideal set of skills to put together a modular ISE.

6.2 VENDOR COLLABORATION

One of the concerns clients will have around the implementation of a modular ISE, is the sheer number of vendors and products involved. Larger companies especially will want to work with a single vendor who is ultimately responsible for the success of the project. To ensure the smooth adoption of a modular ISE each of the vendors involved must be working towards the same goals and actively engaged in the integration process.

This collaboration must be transparent to the client and not hamper the overall integration effort. Through experience we have discovered that the most effective approach is for the vendor of the core CAD/CAM offering in the ISE to present the proposed modular ISE as if it were their own proprietary solution. To do this effectively requires a relationship with each vendor on two fronts: sales and software development.

6.2(a) Sales

To ensure that each component of the modular ISE is properly represented and judged fairly according to its suitability for inclusion in the ISE, the sales team for the CAD/CAM vendor should have a strong understanding of how to sell each product offering. The most effective way we have yet found of accomplishing this is to establish the CAD/CAM vendor as a reseller of the companion products. Under the reseller agreement the sales team will be required to be knowledgeable about the product. This also helps to mitigate the likelihood of the CAD/CAM vendor developing a competing product simply to increase sales revenues.

6.2(b) Software Development

The second area where a strong relationship between the software vendors must be established is around development of the various avenues of integration. To make the modular ISE concept feasible requires an effective, repeatable way of bringing new software vendors into the fold and teaching them how to exploit the various methods available to integrate with the core of the ISE.

At SSI we have developed a program to manage these relationships called the ShipConstructor Developer Network (SCDN). The SCDN is designed to educate 3rd party software developers about the various ways they can gain access to the ShipConstructor 3D Marine Information Model (MIM) and when to use each. The SCDN provides a consistent approach to working with each vendor whose products are involved in a modular ISE.

7. CASE STUDY – AUSTAL SHIPS

Austal commenced operations in 1988 with a vision to build high quality commercial vessels for the international market. By the company's fifth anniversary, Austal had become the world's leading manufacturer of 40 metre passenger catamarans and the dominant supplier to Asia.

Today, Austal is the world's largest builder of fast ferries and lists amongst its customers many of the world's leading fast ferry and shipping operators.

7.1 ADVANCED SHIPBUILDING PROGRAM

Austal Ships lives in an extraordinarily competitive business environment. Significant penalties are included in every Austal contract for both delivery delays and failure to meet performance specifications.

Within this environment Austal is designing and building some of the most complex aluminium vessels in the world. When designing a 127m trimaran hull, like the US Navy Littoral Combat Ship (LCS) that is capable of over 40 knots, having best-of-breed solutions for tasks like weight control and FEA is critical. In each area Austal has hand-selected the tool that will have the greatest benefit on efficiency during design and constructions, as well as the quality and performance of the end product.

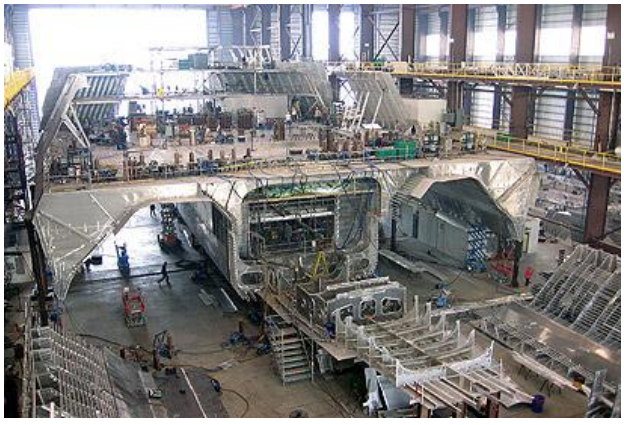

Figure 2 - The LCS under construction at Austal

7.2 THE AUSTAL ISE

Austal has selected, developed and combined a significant number of different technologies as part of their Advanced Shipbuilding Program (ASB). Many of the approaches and technologies discussed in this paper were used to integrate the pieces of the resultant ISE. The core pieces of the ISE developed at Austal include:

- ShipConstructor
- MaxSurf
- HydroMax
- Workshop
- Hull Speed
- Autodesk Navisworks
- AutoCAD
- StarCD
- Comet
- Shipflow
- SWAN
- MathCAD
- Pipenet
- Ansys
- Pytha

In addition to a wide range of application modules, the Austal ISE ties engineering directly into production. As an example, Austal has developed a communication link between automated profile-cutting robots and the Microsoft SQL Server database at the heart of the ShipConstructor Marine Information Model (MIM). This communication link was performed onsite by Austal IT staff without any specialized training.

8. CONCLUSIONS

In response to some recent trends in how software vendors are creating their product offerings and an increasing number of products in each of the domains required to complete shipbuilding or offshore projects, the modular ISE is gaining traction in the global shipbuilding and offshore industries.

With the ever increasing pace of technological change and the rise in capabilities of software products around integration, the opportunities and advantages inherent in a modular, best-of-breed approach to shipbuilding solutions are becoming more and more accessible. At the same time, due to the trends discussed in this paper primarily around the use of relational databases and the Microsoft .NET framework, these systems are becoming easier to implement.

To effectively implement a modular ISE requires significant changes in how software vendors and their clients do business. Understanding the changes required and the benefits that can be achieved are the keys to successfully adopting a modular ISE.

While the approach outlined here may not be appropriate for all clients it has been shown that it can be truly effective for some clients. In an increasingly competitive industry any option that can increase effectiveness should be considered.

9. AUTHORS BIOGRAPHY

Mr. Darren Larkins is currently the Chief Technology Officer at ShipConstructor Software Inc. (SSI). He is responsible for all aspects of product management, product development, IT, client implementation, and client training at ShipConstructor. Mr. Larkins also takes an active role in product marketing and technical sales at SSI.

Mr. Larkins combines over 10 years experience in the development, marketing, sales and implementation of marine systems with the knowledge gained from onsite visits to more than 30 of the world's leading shipbuilders and offshore experts. This experience is applied to the implementation and development of marine specific Integrated Shipbuilding Environments (ISE).