

東京大学大学院新領域創成科学研究科
人間環境学専攻

修士論文

A New Framework for CAD Education with
Workflow-based Document Management System

2007年9月5日提出

指導教員 大和 裕幸 教授 印

学生証番号 56875

Piroon Rojanakamolсан

Contents

List of Figures	iv
List of Tables	vii
Chapter 1. Introduction	1
1.1 Objective	1
1.2 Background	1
1.3 Organization of Thesis	4
Chapter 2. Relevant Studies	5
2.1 Computer-Aided Design (CAD)	5
2.1.1 Introduction to CAD	5
2.1.2 CAD Applications	5
2.1.3 Education in CAD	8
2.2 e-Learning	12
2.2.1 Basic Concept of e-Learning	12
2.2.2 Categorization	13
2.2.3 Advantages and Disadvantages	14
2.3 Workflow	16
2.4 Semantic Web Technology	16
2.4.1 Introduction	17
2.4.2 The Semantic Web Layer Cake	17
2.5 Industrial Engineering	20
2.6 Summary and Targets of This Research	21
Chapter 3. CAD Educational Support Framework Using ShareFast	23
3.1 Overview of the Framework	23
3.2 ShareFast's Basic Features and Concepts	24
3.2.1 System Architecture	25
3.2.2 ShareFast Client User Interface	26
3.2.3 ShareFast Client Software Functionality	27
3.2.4 ShareFast Server User Interface	31
3.2.5 Server Management	32

3.2.6 RDF Metadata and Schema Used in ShareFast	36
3.3 ShareFast's Functions for the Framework	38
3.3.1 Creating Workflows with Related Documents	39
3.3.2 Student-Teacher Communication by Discussion Threads.....	39
3.3.3 Document Search Engine.....	39
3.3.4 Student-based Data Management System.....	40
3.3.5 Student Behavior Capture Using Log File.....	40
Chapter 4. New Features for the Framework.....	42
4.1 Class Analysis and Improvement System.....	42
4.2 Real Time Operation Monitoring System.....	43
4.2.1 Basic Concepts and System Overview	43
4.2.2 System Components and How They Work.....	44
4.2.3 System Functionality	49
Chapter 5. CAD Software Experimental Classes	53
5.1 Objective	53
5.2 Scenario.....	53
5.3 Tribon M3 Initial Design	54
5.3.1 Introduction to Tribon M3 Initial Design	54
5.3.2 Module 1: Project Creation.....	55
5.3.3 Module 2: Lines Design.....	58
5.3.4 Module 3: Patch and Curve.....	65
5.3.5 Module 4: Compartment.....	68
5.3.6 Module 5: Calc/Hydro	74
5.4 Experimental Class 2006	77
5.4.1 Objective	77
5.4.2 Conditions	77
5.4.3 Approach.....	79
5.4.4 Class Analysis and Improvement.....	81
5.4.5 Results.....	84
5.5 Experimental Class 2007	86
5.5.1 Objective	86
5.5.2 Conditions	86

5.5.3 Approach.....	87
5.5.4 Real Time Operation Monitoring System.....	88
5.5.5 Results and Results Analysis	89
Chapter 6. Discussion	96
Chapter 7. Conclusion.....	100
Acknowledgements.....	101
References.....	102
Appendix A. Newcastle Protocol.....	106
Appendix B. Learning Material (Original)	110
Appendix C. Learning Material (Revised).....	112
Appendix D. Experiment Questionnaire.....	116

List of Figures

Figure 1-1 Tribon M3 class at Newcastle University	3
Figure 2-1 An AutoCAD model	6
Figure 2-2 Newcastle University approach to providing software support	10
Figure 2-3 e-Learning categorization.....	13
Figure 2-4 Semantic Web layer cake	18
Figure 2-5 Knowledge and skills necessary for industrial engineering	21
Figure 3-1 CAD educational support framework using ShareFast.....	23
Figure 3-2 ShareFast system architecture	25
Figure 3-3 Interface between the client and server programs.....	26
Figure 3-4 ShareFast client software interface	27
Figure 3-5 Reconnect.....	28
Figure 3-6 Edit mode toolbar.....	29
Figure 3-7 Retrieve document from workflow	30
Figure 3-8 Search function.....	31
Figure 3-9 ShareFast server user interface.....	32
Figure 3-10 Server Administrator Tools page	33
Figure 3-11 Organization Administration Tools page	35
Figure 3-12 Metadata using RDF format.....	37
Figure 3-13 RDF presentation using XML.....	37
Figure 3-14 RDF structure used in ShareFast.....	38
Figure 3-15 Student-based data management	40
Figure 4-1 Class analysis and improvement process	43
Figure 4-2 Extract log file to generate operation monitoring report.....	44
Figure 4-3 Contents of log file.....	45
Figure 4-4 Learning schedule file created by teachers	47
Figure 4-5 Example of individual log file records filtering.....	48
Figure 4-6 Converting start time to duration	48
Figure 4-7 Real time operation monitoring system interface	49
Figure 4-8 Real time report before the students begin.....	50

Figure 4-9 Real time operation report during the class.....	51
Figure 4-10 Real time operation report after the class is finished	52
Figure 5-1 Tribon M3 Initial Design System.....	55
Figure 5-2 Tribon M3 Initial Design Project Tool.....	56
Figure 5-3 Workflow of Project Creation.....	57
Figure 5-4 New Project dialog	57
Figure 5-5 Design Defaults dialog.....	58
Figure 5-6 Workflow of Lines Design.....	59
Figure 5-7 Screen capture of Lines Design module.....	60
Figure 5-8 New Design dialog	60
Figure 5-9 Import curve points information	61
Figure 5-10 Edit stern curve	62
Figure 5-11 Edit stem curve.....	62
Figure 5-12 Edit FOS curve.....	63
Figure 5-13 Parelle MidBody dialog	63
Figure 5-14 Design tab of Create Curve dialog	64
Figure 5-15 Firing section curve.....	64
Figure 5-16 Distortion dialog.....	65
Figure 5-17 Workflow of Patch and Curve.....	66
Figure 5-18 Patch Options dialog	67
Figure 5-19 Completed surface.....	67
Figure 5-20 Release hull form	68
Figure 5-21 Workflow of Compartment.....	70
Figure 5-22 Start Surface/Compartment module.....	71
Figure 5-23 Internal Surface Editor dialog	71
Figure 5-24 Hull form with envelope, upper deck and bulkhead and tank top deck set ..	72
Figure 5-25 Compartments General dialog.....	73
Figure 5-26 Compartment Editor.....	73
Figure 5-27 Releasing calculation geometry	74
Figure 5-28 Workflow of Calc/Hydro	75
Figure 5-29 Calculate function	76
Figure 5-30 Calc/Hydro results.....	77

Figure 5-31 Overview of the Tribon M3 class.....	79
Figure 5-32 Work with Lines Design module	80
Figure 5-33 Working with ShareFast.....	81
Figure 5-34 Patch and Curve (class one) result	83
Figure 5-35 Class one duration result	83
Figure 5-36 Analysis of student three.....	84
Figure 5-37 Class two duration result.....	84
Figure 5-38 ShareFast as CAD operation navigator	87
Figure 5-39 CAD operations captured and monitored.....	89
Figure 5-40 Results of class one	90
Figure 5-41 Results of class two.....	90
Figure 5-42 Results of class three.....	91

List of Tables

Table 3-1 Example of log file contents.....	41
Table 5-1 Training class 2006 conditions.....	78
Table 5-2 Some messages from the discussion threads of Patch and Curve module	83
Table 5-3 Section 1 result (2006): Knowledge of Tribon M3 Initial Design	85
Table 5-4 Section 2 result (2006): Questions about ShareFast software application	85
Table 5-5 Section 3 result (2006): Class evaluation	85
Table 5-6 Training class 2007 conditions.....	86
Table 5-7 Question and answer messages in the discussion thread of class 2007.....	91
Table 5-8 Section 1 result (2007): Knowledge of Tribon M3 Initial Design	94
Table 5-9 Section 2 result (2007): Questions about ShareFast software application	94
Table 5-10 Section 3 result (2007): Class evaluation	95

Chapter 1. Introduction

1.1 Objective

This thesis presents a new CAD educational support framework using a document management system called ShareFast, an open source, client/server application based on workflow. The objective of the framework is to help

- Make it easy to maintain and improve learning materials
- Establish a faster and more efficient (on time with correct design output) education for CAD software operation

Furthermore, the thesis explains the experiments conducted on the framework to provide enhanced design assistance to aid students undertaking design coursework. The empirical evaluation of the experiments and potential improvements of the framework will finally be stated.

1.2 Background

Engineering design has been a human activity for many centuries. It aims to produce the documentation for manufacturing a useful product that can fulfill some of the needs of mankind [1]. Design is a central activity to all types of engineering [2]. Mechanical, civil and electrical engineers attempt to solve very different types of problems, but they all design some solution to the problem at hand. In engineering design industry, works that are related to product design and manufacturing have very high visual content [3]. Computer innovations, consequently, have been used as tools to help ease complications in design process.

Computer aided design (CAD) software, for instance, have become central to process from the earliest design phase to final production [4]. However, the engineers need not have any knowledge of the sophisticated mathematics and computer science upon which CAD systems depend. CAD enables creation and control of product information. It allows virtually instant visual, and most importantly, accurate communication for design, development, analysis and manufacturing.

As a result, it is not surprising that the educational field of CAD software has responded strongly. Since the beginning of CAD in the 1960s, CAD technologies have found their way into colleges and universities [5]. From an early availability of one or two computer terminals for post-graduate students or research workers, it is now becoming common for educational departments to have several terminals and in some cases their own computing power [6]. Regardless of how the CAD industry evolves, students in colleges and universities want to learn technologies that can best serve their future careers.

One example of CAD education is at the School of Marine Science and Technology, Newcastle University, United Kingdom. A commercial ship design CAD software, which performs as a tool for modeling an initial ship hull form, the internal arrangement and performing naval architectural analysis upon it, has been used to support large design projects undertaken by undergraduates in the teaching of ship design using CAD as part of the Marine Design module since 1995 for the Naval Architecture degree programs [7]. Figure 1-1 shows the Tribon M3 learning class at the university. It has been used to allow students to develop a hull form, generate the arrangement and then evaluate their preliminary design. In doing so, the CAD software allows the students to become familiar with the ship design process and the use of industry standard ship design software.

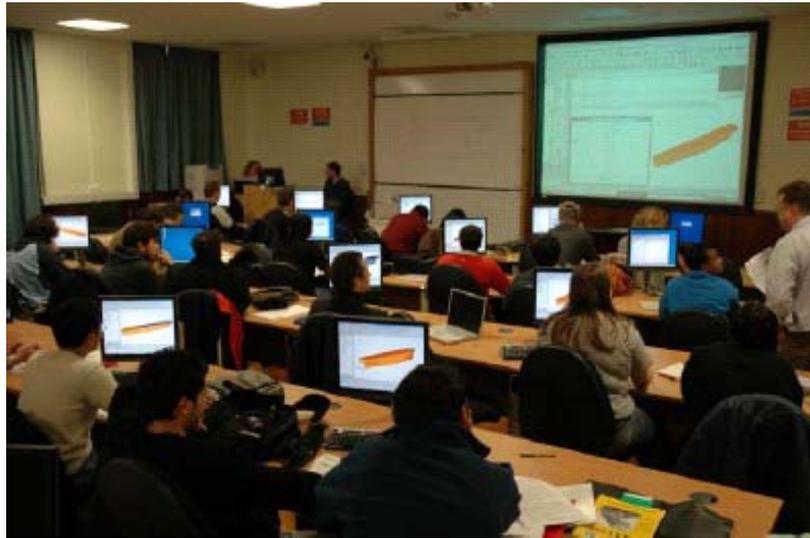


Figure 1-1 Tribon M3 class at Newcastle University

Not only using commercial software for teaching CAD that has been growing rapidly, but in-house educational design software packages developed by academic institutes has also been implemented widely. A software package, AccomDesign, has been developed by a research team as a tool for teaching functional volume design approach [8]. The primary purpose of the software is as a training tool to acquaint students and designers with this design approach in ship design process.

Those in education have double motives for introducing computing into their courses. Firstly, an awareness of the need to educate students for careers in which computers will play a well-accepted part, and secondly, the attractions of using computers to assist and improve the education process itself.

However, CAD education using computer is not very simple. Students have to learn both design process and the use of CAD software. Moreover, instructors find it difficult to manage the class that involves many information technology aspects. Wright [9] stated that one of the main problems that he encountered in teaching the CAD software was helping students to manage the learning materials and files associated with the separate modules at each stage of the design process.

According to these difficulties, an e-learning framework for CAD software education is necessarily developed to help instruct students for the overall design procedure. e-Learning systems play a key role in education as an environment for improving learner autonomy, multimedia instructional content and problem-solving skills, with teachers as assisted tutors [10]. The framework should, at least, be able to simplify the design learning processes, manage learning materials, support student-teacher interaction and keep track of students during the class for class evaluation [11].

1.3 Organization of Thesis

The outline of this thesis is as follows. Chapter 2 discusses the relevant research studies of this thesis, such as CAD and its applications, e-learning system, workflow, etc. Chapter 3 explains the CAD educational framework based on the document management system called ShareFast, and ShareFast's concepts and functions. The newly developed features of ShareFast for the educational framework, class analysis and improvement system, and real time operation monitoring system, will be presented in Chapter 4.

Chapter 5 discusses the experimental classes conducted on the framework, including the experiment objective, approach, scenario, etc. Finally, discussion and conclusion of the research will be explained in Chapter 6 and Chapter 7, respectively.

Chapter 2. Relevant Studies

2.1 Computer-Aided Design (CAD)

2.1.1 Introduction to CAD

Computer-aided design (CAD) is the use of a computer-based software tools to assist engineers, architects and other design professionals in their design projects. Applicable fields include architecture and construction, various engineering fields (civil, mechanical, electronic/electrical, etc.), industry and product design, fashion and textile design, etc [12]. It is used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. CAD is also extensively used in the design of tools and machinery used in the manufacture of components. Current CAD packages range from 2D vector based drafting systems to 3D parametric surface and solid design modelers [13].

2.1.2 CAD Applications

There are many CAD software products currently on the market. More than half of the market is however covered by the four main PLM corporations Autodesk, Dassault Systemes, PTC, and Siemens UGS, but there are many other CAD packages with smaller user bases or covering niche user areas.

CAD packages can be classified into three types: 2D drafting systems (e.g. AutoCAD, General CADD Pro, VectorWorks, AllyCAD, MicroStation); mid-range 3D solid feature modelers (e.g. Inventor, TopSolid, IronCAD, SolidWorks, SolidEdge,

Alibre Design, [[VariCAD]); and high-end 3D hybrid systems (e.g., CATIA, NX, Pro/ENGINEER).

However these classifications cannot be applied too strictly as many 2D systems have 3D modules, the mid-range systems are increasing their surface functionality, and the high-end systems have developed their user interface in the direction of interactive Windows systems. Some high-end systems such as NX support Windows, LINUX, UNIX and Mac OSX.

Here is some detailed information of the commercial CAD software widely used in the industries nowadays.

a) AutoCAD

AutoCAD is a computer program, produced by Autodesk, Inc., for making drawings of different kinds. It is perhaps the most popular and powerful CAD program for personal computers and has revolutionized the way in which engineers, architects, and other people make drawings [14][15]. Figure 2-1 shows a model produced by AutoCAD.

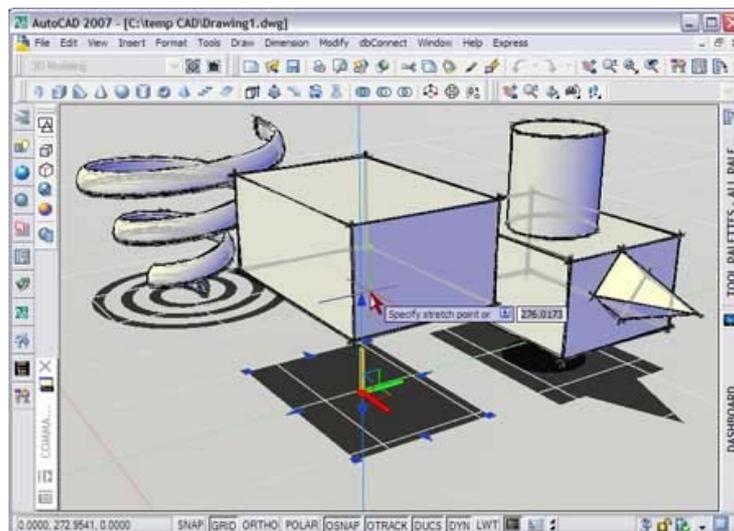


Figure 2-1 An AutoCAD model

Modern AutoCAD includes a full set of basic solid modeling and 3D tools, but lacks some of the more advanced capabilities of solid modeling applications. AutoCAD can be used as a platform for other products such as Bentley AutoPLANT and COADE CADWORX. AutoCAD is a vector graphics drawing program. It uses primitive entities — such as lines, polylines, circles, arcs, and text — as the foundation for more complex objects.

AutoCAD supports a number of application programming interfaces (APIs) for customization and automation. These include AutoLISP, Visual LISP, VBA, .NET and ObjectARX. ObjectARX is a C++ class library, which was also the base for products extending AutoCAD functionality to specific fields, to create products such as AutoCAD Architecture, AutoCAD Electrical, AutoCAD Civil 3D, or third-party AutoCAD-based applications.

b) CATIA

CATIA is a multi-platform CAD commercial software suite marketed by IBM. It can be used by all manufacturing organizations, from OEMs through their supply chains to small independent producers. The range of its capabilities allows CATIA to be applied in a wide variety of industries, such as aerospace, automotive, industrial machinery, electrical, electronics, shipbuilding, plant design, and consumer goods, including design for such diverse products as jewelry and clothing [16].

c) Tribon

The Tribon system has been specifically designed to provide a structured way to develop and improve the information flow between the different tasks within the shipbuilding process, where many design development tasks are performed in parallel. The requirements of the complete information flow have been considered and so the system is not just a computerisation of a conventional manual process.

The Tribon system is based on the use of a Product Information Model (PIM) database, which has been designed to handle in an efficient way all of the structural and outfit objects found in the shipbuilding industry. The information in the Product Information Model contains all the technical data that is needed to define the final product. It addresses all phases in the design and production process. Information from one stage can be used in the next stage. All types of drawings and reports can be derived from the model [17].

2.1.3 Education in CAD

CAD is the union between two complex subjects: design and computer science. Education and training for CAD, therefore, involve some exposure to both of these subjects. The amount of exposure depends upon particular organizational environments and their staffing mix [18].

a) CAD Education in Universities

Since the beginning of CAD in the 1960s, CAD technologies have found their way into colleges and universities. Currently, in the colleges and universities, CAD technologies have been taught in different disciplines with different focuses. Some colleges and universities offer stand-alone CAD courses. These courses may focus on the whole picture of CAD, or special aspects of CAD (e.g. geometric modeling), while others focus on the use of some particular CAD systems or application development. Other universities and colleges, on the other hand, introduce some aspects of CAD technologies in courses such as Computer Graphics or Engineering Design [19].

Tribon Initial Design, a CAD software package, for example, has been used to support large design projects undertaken by undergraduates in the teaching of ship design as part of the Marine Design module since 1995 for the Naval Architecture degree programs at Newcastle University. It is used to allow students to develop a hull form, generate the arrangement and then evaluate their preliminary design. In doing so, the

software allows the students to become familiar with the ship design process and the use of industry standard ship design software [7].

The examined taught program is made up of 48 hours of lectures over Semesters 1 and 2 and includes invited lectures from industry on contemporary design projects and related experiences. The Semester 1 syllabus particularly provides lectures in support of the ship design project addressing topics such as: the design spiral as a strategic model of ship design process; understanding the ship design problem; initial point design methods; dimensional ratios and form relationships; adaptive and variant hull form design; linear distortion of a basis form, including the Lackenby method [20]; influence of parameters on design performance; bow and stern design; arrangement design; weight estimation. In Semester 2 the topics of engineering economics, optimization, design for optimal sea keeping and resistance are included as well as the guest lectures from industry. An additional 52 hours of private study are expected to accompany the taught program to provide a total of 100 hours of study by each student.

The key teaching strategies developed and found to be effective in supporting the students in the use of the software include:

- Providing a thorough overview and introduction to the functionality of the relevant modules of Tribon Initial Design and clearly identifying the connectivity with other design activities.
- The student design workflow is carefully managed by tailoring specific sessions to each of these analysis and evaluation tasks and mapping these to the appropriate modules of Tribon Initial Design.
- Student orientated software user notes in support of each session. These Student User Notes are distilled from the actual Tribon M3 Initial Design User's Guide, but structured in a specific way to relate to the tasks required in each session and written purely for use by undergraduate students in this course:
 - Session 1 – Hull Form Definition and Hydrostatics;
 - Session 2 – Hull Form Refinement and Compartmentation; and
 - Session 3 – Loading and Intact Stability.

- Each session includes demonstrating the software to the group via a data projector and working through the notes for each session with the students in real time, addressing student questions as the tutorial progresses and allowing them to follow the procedure at their own workstations. Additional individual and group tutorials with experienced users to address problems as the students work with the software are also provided.
- In the Calc/Hydro module 'cut-down' functionality is provided through a tailored tree structure so the students only see the required functionality. However, the full tree is also available to demonstrate the full potential of the software for later more demanding use in personal and group project work.
- Prescription of output to be reported (e.g. information for a Tank Plan and Trim and Stability Booklet is available from Tribon Initial Design in .HTML) to provide structure to how the students present their results.

To provide this support, the most effective way was found to be to bring together the requirements of teaching with the experience of the software developer and an expert industry user, Figure 2-2. This synergy has provided the fundamental basis for the success of using Tribon Initial Design in the ship design coursework of the Marine Design module and has resulted in a number of teaching strategies being developed.

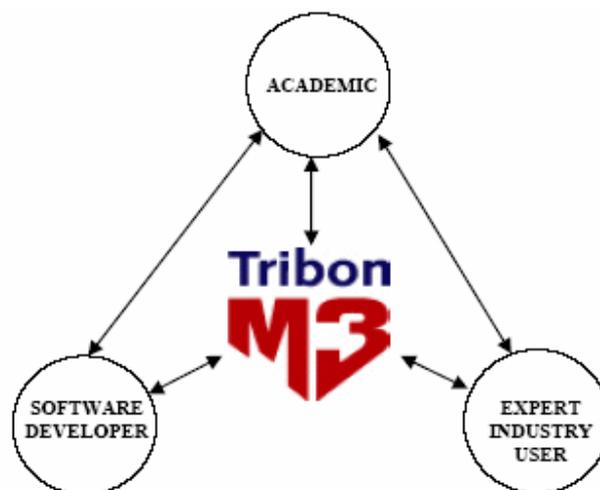


Figure 2-2 Newcastle University approach to providing software support

b) CAD Education in Industries

Not only in schools and universities, but CAD education is also becoming an important thing in industries. For example, in automotive industry, since continuous improvements and technological breakthroughs have powered CAD into the central role it enjoys these days, an increasing percentage of designers, formerly called draftsmen, have acquired some formal education in CAD beyond high school and many now have college degrees. With respect to CAD, the intertwining of training and education in the automotive industry continues to increase.

Industry initiated CAD learning platform is also rapidly increasing. For instance, a software development company called Formation Design Systems has launched a web-based learning platform for Maxsurf, naval architecture and ship construction software [21]. The platform is dedicated to supporting learners of naval architecture and the providers of naval architecture programs. From there it is possible to download Maxsurf Academic, this being a fully functioning three surface version of the commercially available program. Some other developers offer entry level versions of their software free of charge to learners. Two areas in particular are worth noting, these being the provision of databases of hull forms, and provision of help and tutorials. Each of these areas will be described in some detail.

New releases of software and an increasing number of CAD-related applications software required commitments to continued training. The ensuing organizational structure for training enabled introductions to CAD not only for designers, and the engineers they interacted with but also for a very broad cross section of engineers. This broad new audience included product, manufacturing, release and power train engineers, just to name a few. Out of this ubiquitous contact with CAD, additional small cohorts of engineers, along with mainly mathematicians and computer scientists, contributed expertise that converged to make CAD happen.

2.2 e-Learning

This section explains the basic concept of e-learning and e-learning categorization as well as its advantages and disadvantages.

2.2.1 Basic Concept of e-Learning

e-Learning is the unifying term to describe the fields of online learning, web-based training, and technology-delivered instruction [22]. It is an educational or training situation in which the instructor and students are separated by time, location, or both. Education or training courses are delivered to remote locations via synchronous or asynchronous means of instruction, including written correspondence, text, graphics, audio- and videotape, CD-ROM, online learning, audio- and videoconferencing, interactive TV, and facsimile. e-Learning does not preclude the use of the traditional classroom. It tries to improve traditional classroom. It must be ideal educational condition if conventional classroom type and e-learning type are integrated in total educational and training system [23].

The Internet and the Web are incredibly popular at public domains and they have provided unprecedented opportunities of conducting e-learning for learning and training purposes. The development of e-learning has revolutionized content delivering and social communication in learning activities. Essentially, e-learning systems should include multiple formats and various resources. It needs to also support collaboration, offer interaction, implement Web-based activities as part of learning framework, and assist both novices and experts [24]. With these characteristics, e-learning is capable of creating a wealth of online and distance learning opportunities to users that is not readily available in textbooks or faculty lectures. Rosenberg [25] stated that e-learning had the following benefits. First, it lowers costs. Second, its content is more timely and dependable. Third, it is a just-in-time learning approach. Fourth, it builds universal communities. And finally, it provides an increasingly valuable learner service.

2.2.2 Categorization

Figure 2-3 shows the major methodologies of e-learning categorized by “interactivity” and “synchronous /asynchronous means of instruction”.

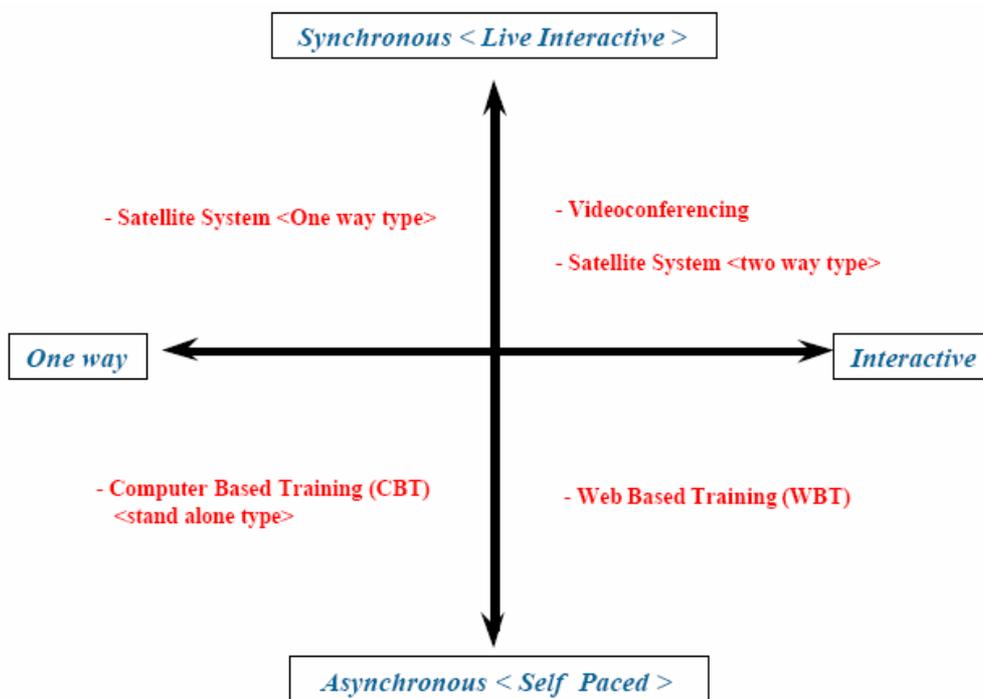


Figure 2-3 e-Learning categorization

e-Learning systems have evolved since computers were first used in education. There is a trend to move toward blended learning services, where computer-based activities are integrated with practical or classroom-based situations.

a) Computer-based Training

Computer-based training (CBT) services are where a student learns by executing special training programs on a computer relating to their occupation. CBT is especially effective for training people to use computer applications because the CBT program can be integrated with the applications so that students can practice using the application as they learn. Historically, CBTs growth has been hampered by the enormous resources

required: human resources to create a CBT program, and hardware resources needed to run it. However, the increase in PC computing power, and especially the growing prevalence of computers equipped with CD-ROMs, is making CBT a more viable option for corporations and individuals alike. Many PC applications now come with some modest form of CBT, often called a tutorial.

b) Web-based Training

Web-based training is a delivery of educational content via a Web browser over the public Internet, a private Intranet, or an extranet. WBT provides links to learning resources outside of the course, such as references, e-mail, bulletin boards, and discussion groups. It provides the advantages of computer-based training while retaining advantages of instructor-led training. WBT is used synonymously with Internet-based training and online training.

2.2.3 Advantages and Disadvantages

Key advantages of e-learning are flexibility, convenience and the ability to work at any place where an internet connection is available and at one's own pace. e-Classes are asynchronous which allows learners to participate and complete coursework in accordance with their daily commitments. This makes an e-learning education a viable option for those that have other commitments such as family or work or cannot participate easily e.g. depending on a disability. There are also transportation cost (and time) benefits with not having to commute to and from campus.

The cost benefits of e-learning to large corporate organizations are difficult to ignore. When using e-learning to train users of corporate computer systems, normally achieved by way of simulation-based learning content, the learner find himself in a software environment that is exactly like the real one but which does not carry the same error risk. Unlike classroom training, users may repeat the e-learning course without duplicating the cost. It is commonly accepted that the initial cost of an e-learning

implementation is expensive (once-off development cost), but that the cost of training (per user) goes down exponentially as more learners use the e-learning course material. When using e-learning simulations to assess learning progress, the instructor is assessing the actual competence of the user to perform a transaction and not merely knowledge of the system.

Other advantages of e-learning are the ability to communicate with fellow classmates independent of metrical distance, a greater adaptability to learner's needs, more variety in learning experience with the use of multimedia and the non-verbal presentation of teaching material. Streamed video recorded lectures and MP3 files provide visual and audio learning that can be reviewed as often as needed. For organizations with distributed and constantly changing learners (e.g. restaurant staff), e-learning has considerable benefits when compared with organizing classroom training.

Disadvantages of e-learning include the lack of face-to-face interaction with a teacher. Critics of e-learning argue that the process is no longer "educational" in the highest philosophical sense (for example, as defined by RS Peters, a philosopher of education). Supporters of e-learning claim that this criticism is largely unfounded, as human interactions can readily be encouraged through audio or video-based web-conferencing programs, threaded discussion boards, of fact, many in K12 would support e-learning if it was not associated with the more extreme versions that attempt to cut out the directed teacher-student relationship.

The feeling of isolation experienced by distance learning students is also often cited, although discussion forums and other computer-based communication can in fact help ameliorate this and in particular can often encourage students to meet face-to-face, although meeting face-to-face is often not possible due to the disarray of student's physical locality. Discussion groups can also be formed on-line. Human interaction, faculty-to-student as well as student-to-student, should be encouraged in any form.

e-Learning tends to work better for the student when the topic matter consists of self-learned items. When much group collaboration is required, e-learning can cause lag

times in collaborative feedback if the students are not disciples. For example, some student's may only check their online agenda once a week, or even less, making it impossible to achieve goals. Web and software development can be expensive as can systems specifically geared for e-learning. The development of adaptive materials is also much more time-consuming than that of non-adaptive ones.

2.3 Workflow

A workflow is a reliably repeatable pattern of activity enabled by a systematic organization of resources, defined roles and mass, energy and information flows, into a work process that can be documented and learned. Workflows are always designed to achieve processing intents of some sort, such as physical transformation, service provision, or information processing.

In 1993, the Workflow Management Coalition (WfMC) was found. It is a global organization of adopters, developers, consultants, analysts, as well as university and research groups engaged in workflow. The WfMC creates and contributes to process related standards, educates the market on related issues, and is the only standards organization that concentrates purely on process [26].

Workflow normally comprises a number of logical steps, each of which is known as an activity. An activity can involve manual interaction with a user or workflow participant, or the activity might be executed using machine resources. Delivering work to users does increase efficiency. Automating the actual work provides huge increases in efficiency, and provides managers with the facilities to create the Virtual Organization, and to participate effectively in the ecommerce revolution [27].

2.4 Semantic Web Technology

2.4.1 Introduction

The Semantic Web is an evolving extension of the World Wide Web in which web content can be expressed not only in natural language, but also in a form that can be read and used by software agents, thus permitting them to find, share and integrate information more easily [28][29]. It derives from W3C director Tim Berners-Lee's vision of the Web as a universal medium for data, information, and knowledge exchange.

At its core, the Semantic Web comprises a philosophy, [30] a set of design principles, [31] collaborative working groups, and a variety of enabling technologies. Some elements of the Semantic Web are expressed as prospective future possibilities that have yet to be implemented or realized. Other elements of the Semantic Web are expressed in formal specifications [32]. Some of these include Resource Description Framework (RDF), a variety of data interchange formats (e.g. RDF/XML, N3, Turtle, N-Triples), and notations such as RDF Schema (RDFS) and the Web Ontology Language (OWL) [33]. All of which are intended to provide a formal description of concepts, terms, and relationships within a given knowledge domain.

2.4.2 The Semantic Web Layer Cake

The W3C has been a leader in developing technologies for the Web. The organization is headed by Tim Berners-Lee, who, not resting on his earlier accomplishments in relation to the Web, has also been promoting the development of the Semantic Web. Many of the apparently foundational technologies, such as XML and RDF, have been developed by the W3C [34].

The W3C web pages on the Semantic Web include a diagram labeled Architecture. This diagram, sometimes called the “Semantic Web layer cake,” has been reproduced often. The Semantic Web layer cake is illustrated in Figure 2-4.

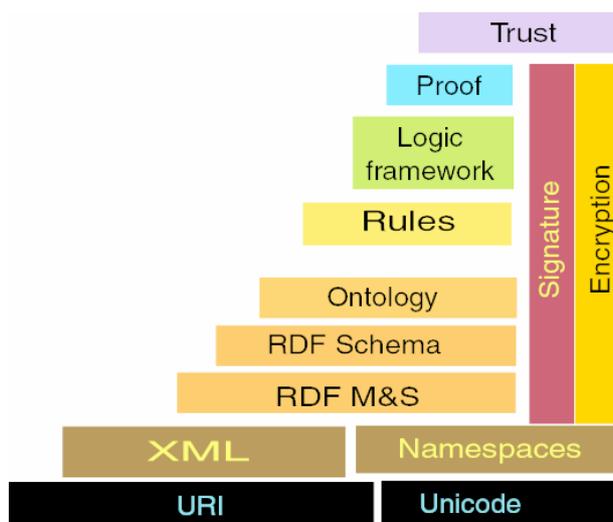


Figure 2-4 Semantic Web layer cake

a) URI

A Uniform Resource Identifier (URI) is a compact string of characters used to identify or name a resource. The main purpose of this identification is to enable interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols. URIs are defined in schemes defining a specific syntax and associated protocols [35]. URI is managed by IANA (International Assigned Number Authority).

b) Resource Description Framework (RDF)

The RDF [36] metadata model is based upon the idea of making statements about resources in the form of subject-predicate-object expressions, called triples in RDF terminology. The subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object. For example, one way to represent the notion "The sky has the color blue" in RDF is as a triple of specially formatted strings: a subject denoting "the sky", a predicate denoting "has the color", and an object denoting "blue".

This mechanism for describing resources is a major component in what is proposed by the W3C's Semantic Web activity: an evolutionary stage of the World Wide Web in which automated software can store, exchange, and use machine-readable information distributed throughout the web, in turn enabling users to deal with the information with greater efficiency and certainty. RDF's simple data model and ability to model disparate, abstract concepts has also led to its increasing use in knowledge management applications unrelated to Semantic Web activity.

c) RDF Schema

RDF Schema is an extensible knowledge representation language, providing basic elements for the description of ontology, otherwise called RDF vocabularies, intended to structure RDF resources. The first version was published by W3C in April 1998, and the final W3C recommendation was released in February 2004. Main RDFS components are included in the more expressive language OWL [37].

d) OWL: Web Ontology Language

OWL is intended to be used when the information contained in documents needs to be processed by applications, as opposed to situations where the content only needs to be presented to humans. OWL can be used to explicitly represent the meaning of terms in vocabularies and the relationships between those terms. This representation of terms and their interrelationships is called an ontology. OWL has more facilities for expressing meaning and semantics than XML, RDF, and RDF-S, and thus OWL goes beyond these languages in its ability to represent machine interpretable content on the Web. OWL is a revision of the DAML+OIL web ontology language incorporating lessons learned from the design and application of DAML+OIL [38].

e) Logic and Proof

Logical reasoning is used to establish the consistency and correctness of data sets and to infer conclusions that aren't explicitly stated but are required by or consistent with a known set of data. Proofs trace or explain the steps of logical reasoning.

f) Trust

Trust is a means of providing authentication of identity and evidence of the trustworthiness of data, services, and agents.

2.5 Industrial Engineering

Industrial Engineering (IE) is a field that integrates the technical, human, and management aspects of today's sophisticated products and processes [39]. It is a branch of engineering that concerns the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, material and process. Industrial engineering draws upon the principles and methods of engineering analysis and synthesis, as well as mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.

Industrial engineers deal with systems. They can design, implement or improve integrated systems comprised of people, materials, information or energy. They can develop a better way of doing just about anything [40].

Industrial engineers find creative new ways to solve tough problems. From microelectronics, telecommunications, and retail to transportation, hospitals, and government, industrial engineers make it happen more efficiently.

Industrial engineering integrates knowledge and skills from several fields of science: from the Technical Sciences, Economic Sciences as well as Human Science, as illustrated in Figure 2-5. All these can also be supported with skills in Information Sciences. The industrial engineer comprehends knowledge in those sciences in order to increase the productivity of processes, achieve quality products and assures labor safety [41].

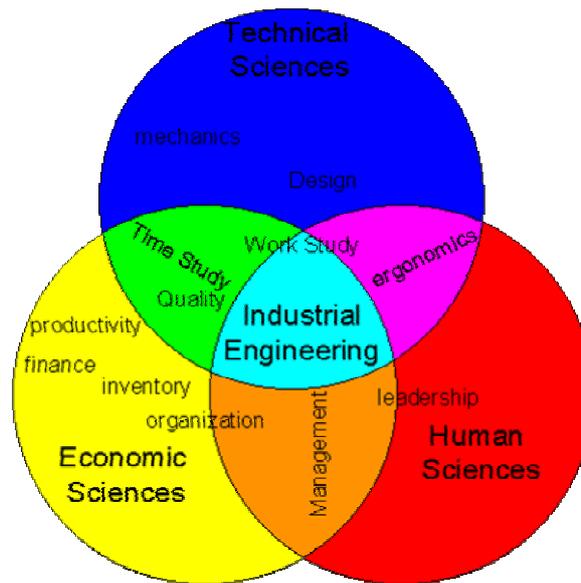


Figure 2-5 Knowledge and skills necessary for industrial engineering

2.6 Summary and Targets of This Research

The learning framework developed in this research can be categorized as an interactive and asynchronous learning system, which is in the same group as web-based training system. While most of web-based training systems offer just links to learning materials, e-mail system, bulletin boards, and discussion groups, this newly developed framework enhances those traditional systems by adding state-of-the-art features helping instructors understand student's behavior, know learning material's vulnerability, and control lesson duration. Those features include class analysis and improvement method, and real time student's operation monitoring system, which will be explained later in this thesis. In addition, this framework adopted the use of workflow, which is one of its unique characteristics. This adds benefits of using workflow to the framework as workflow helps defined roles and information flows into a work process that can be documented and learned.

It is hoped this research will provide enhanced design assistance to students by providing a further framework to aid students and design engineers undertaking design coursework and using CAD software. This would provide a system to formalize and

support the connectivities between various design activities of the coursework as well as provide automatic links with materials of design data and design methods. It is compatible with design software such as the modules of Tribon Initial Design.

Chapter 3. CAD Educational Support Framework Using ShareFast

3.1 Overview of the Framework

The CAD educational support framework using ShareFast is illustrated in Figure 3-1. The framework consists of five main components, student, teacher, ShareFast system, IT infrastructure and CAD software. Teachers use ShareFast to prepare for the class. Students learn how to use CAD software from learning materials and facilities provided by ShareFast. IT infrastructure plays a key role in supporting both ShareFast system and CAD software [42].

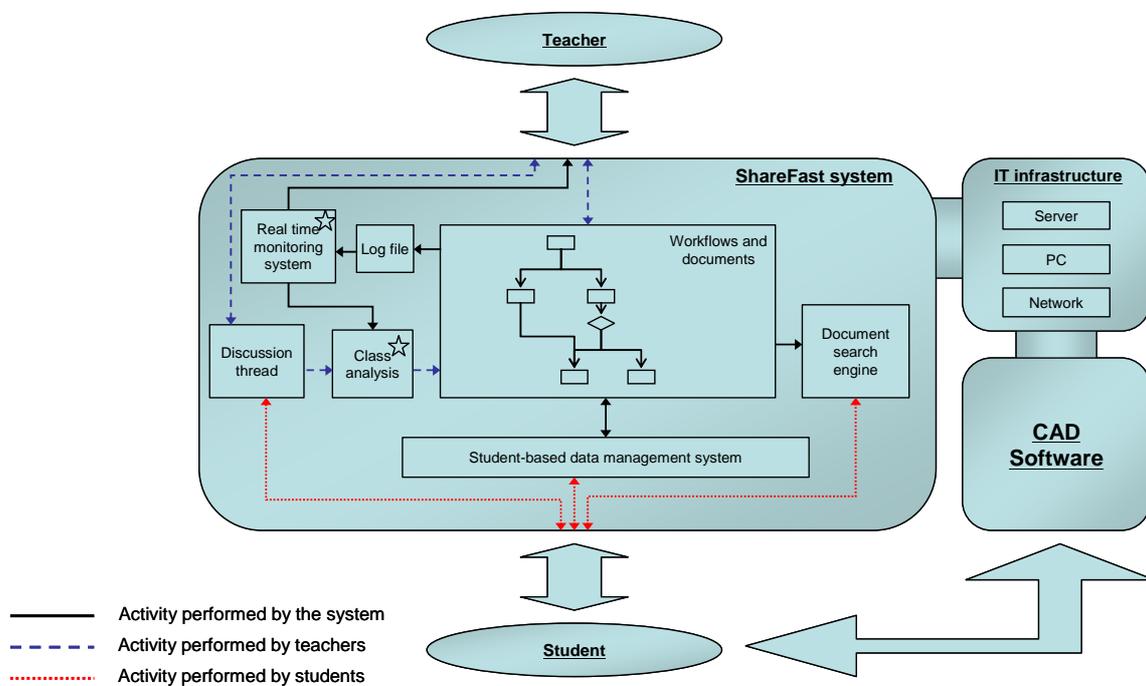


Figure 3-1 CAD educational support framework using ShareFast

ShareFast system offers many functions, as shown in the ShareFast system component in Figure 3-1, which can powerfully facilitate teachers and students in CAD design learning activities. The dash lines are the activities involved with teachers, while the dot lines and the normal lines are the activities of students and ShareFast system, respectively. The star-marked boxes, Real time monitoring system and Class analysis, are the functions that have been newly developed to support this educational framework. These two functions will be explored in detail in Chapter 4.

To use ShareFast system to prepare for a CAD class, teachers need to create workflows describing how to work with CAD software, and add learning materials to the created workflows. A ShareFast user account is also needed to be created for each student. Moreover, teachers have to set the expected learning duration for each task in the workflows via the real time monitoring system. After the class starts, teachers monitor students' operation using real time monitoring system, and communicate with students using discussion thread function.

3.2 ShareFast's Basic Features and Concepts

ShareFast, formally known as UT-ESS (University of Tokyo Educational Software for Shipbuilding) [43], has been developed by the members of Design Engineering Laboratory, the University of Tokyo. ShareFast is an open source, client/server application for document management system based on workflow. The association between design documents and workflow is described by metadata based on Semantic Web technology. The client software offers a workflow editor to create and edit workflow and then upload the created workflow to the server. It also allows users to browse the workflow and associated documents.

ShareFast software consists of two main parts, ShareFast client and ShareFast server. This section explains system architecture and basic functions of the both parts.

3.2.1 System Architecture

ShareFast is an open source, client/server application for document management based on workflow using RDF metadata on Jena framework. The software system architecture is shown in Figure 3-2. The client program, developed using C# technology, provides a workflow editor for users to create workflows and relate any documents to each task node in the workflows. It also provides the Tree Explorer to browse the workflows hierarchically. Workflows will be stored as XML with their metadata (e.g. creator, create date etc.) in RDF format. The client program uploads them together to the server.

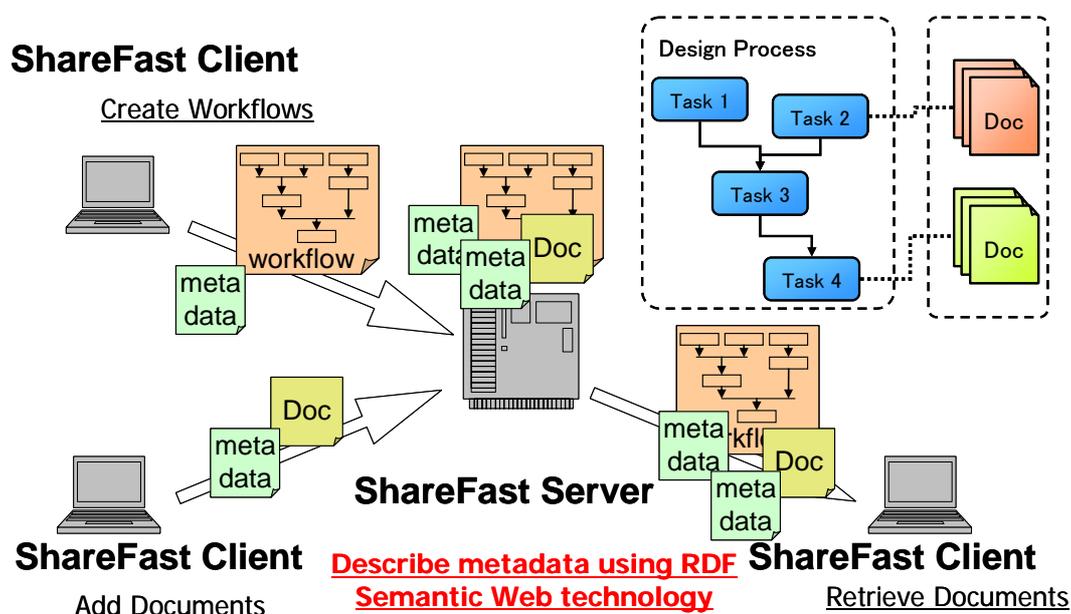


Figure 3-2 ShareFast system architecture

The server program, developed using Java Servlet technology, on the other hand, is responsible for managing documents. It keeps all workflows, workflow's hierarchy structure, metadata and documents created by the client program. The server program also provides an interface for handling data and metadata. The client program uses the interface, illustrated in Figure 3-3, to manage the data in the server. The engine for RDF metadata is Jena developed by HP, and the engine for text search is Lucene developed by Jakarta Project.

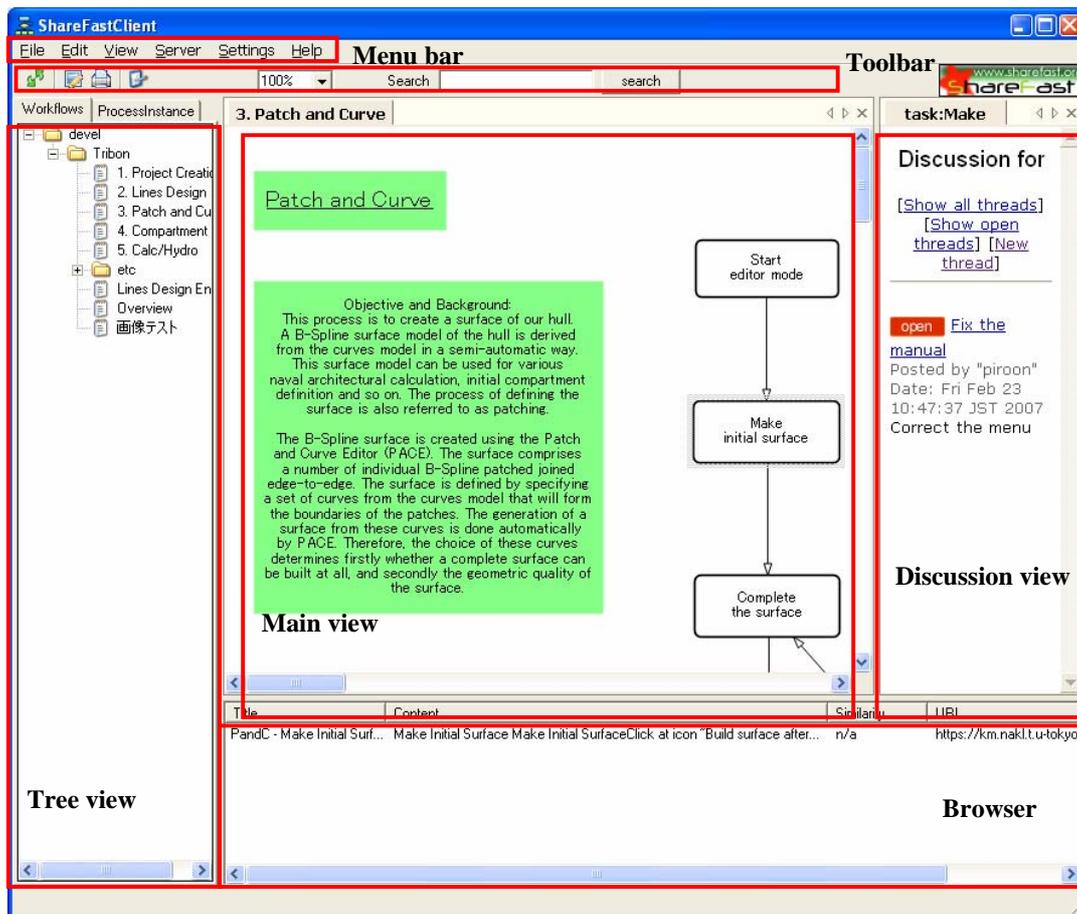


Figure 3-4 ShareFast client software interface

- Menu Bar: Contains all functional commands for this application. The detailed information of each function will be described in the next section.
- Toolbar: Contains view size box, and search box.
- Tree View: Shows all the hierarchies (folders) and workflows/process instances kept in the server.
- Main View: The display area of workflow.
- Discussion View: Shows discussion for each workflow/task.
- Browser: Shows uploaded files related to tasks.

3.2.3 ShareFast Client Software Functionality

ShareFast is a software application for document and knowledge management. By using workflow, with document files added, to represent work process, users can understand what should be done for each task easily.

This section explains the range of functions that ShareFast client can perform.

a) Server Configuration

- 1) On the menu bar, click 'Server' → 'Reconnect'.

Figure 3-5 Reconnect

- 2) Input user account and host details the Figure 3-5 box. Click OK button to finish.

b) Operating with Hierarchies and Workflows

(1) *Creating and Editing New Hierarchies*

Hierarchies are folders that contain workflow files or sub-hierarchies. Users can create, rename or delete by using right click at the tree view and choose the relevant command.

(2) Creating and Editing New Workflows

Right click the hierarchy that users want to make a new workflow, and click ‘New Workflow’. After that, the application will lead users to the workflow edit mode on the main view.

On the top of the main view in workflow edit mode, the tool bar, shown in Figure 3-6, will be displayed.



Figure 3-6 Edit mode toolbar

Users can double click on the Normal Node, Mail Node and Comment Box to edit their name and other contents. To customize font and color of the node, click ‘Format’ → ‘Font’, or ‘Format’ → ‘Color’ from the menu bar.

(3) Saving Workflows

- 1) Save to server: In the workflow edit mode, click ‘Save Workflow in Server’ icon. The workflow will be saved to your server, and appear on the tree view under the hierarchy it belongs to. Users may be required to input the workflow name in case it is new workflow.
- 2) Save to local: In the workflow edit mode, click ‘Save to Local’ icon. After inputting the file name and clicking Save button, the workflow will be saved to the local PC, and not appear on the tree view. Users can later open the workflow file on your local PC by choosing ‘File’ → ‘Open’.

(4) Editing Existing Workflows

Click the workflow on the tree view that users want to edit, then right-click and choose ‘Edit Workflow’.

c) Adding Documents to Workflows

First, click the workflow from tree view that users want to add documents to. The chosen workflow will be displayed on the main view. Next, drag the desired document from other windows, and drop it into the node of the workflow. The document will be automatically uploaded to the server.

Users can view the uploaded documents by clicking at the node that they have already added some documents. After clicking, the document details will be shown at the Browser view.

d) Retrieving Added Documents from Workflow

In order to retrieve the documents added to a task node, users can click on the task node. Then, all added document name links of that task node will be shown in the browser panel. Users can click the name link at the browser to launch the document file. Figure 3-7 shows how to retrieve document from task node.

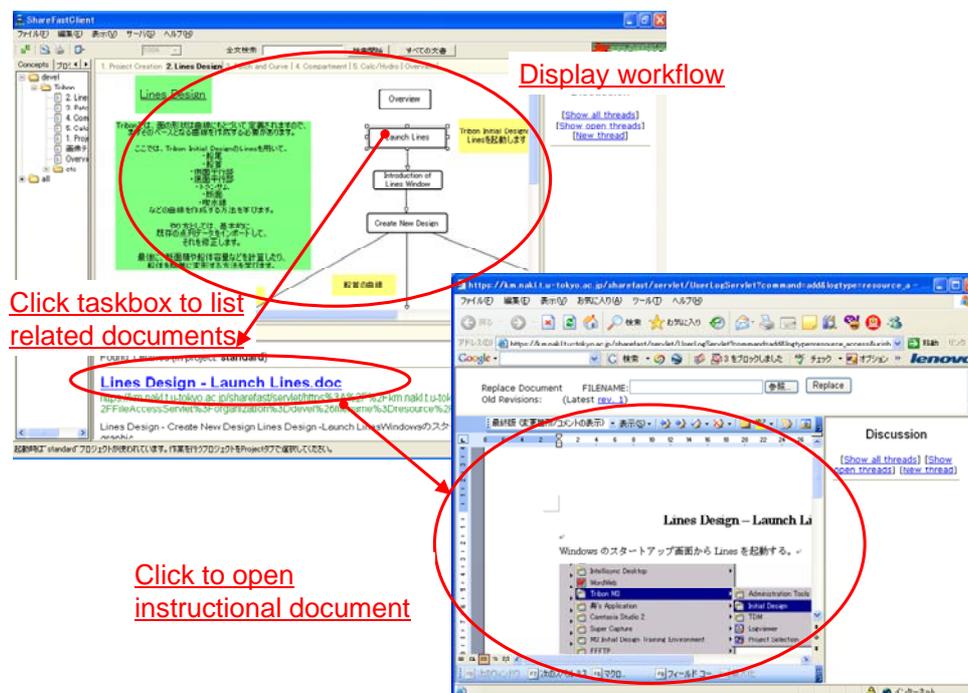


Figure 3-7 Retrieve document from workflow

e) Workflow/Task Discussion

Users can add discussion related to each workflow/task. Discussion view is on the right hand side of the application screen.

f) Searching Uploaded Documents

The software provides search function to look for the uploaded documents. From the tool bar, input the keyword to the search box (Figure 3-8), and click 'Search' button. The software will show all documents related to the keyword at the browser view. Users can also open/download/search similar documents/delete the listed documents by right-clicking on the file name on the browser view and choose the relevant menu.



Figure 3-8 Search function

3.2.4 ShareFast Server User Interface

The application interface is shown in Figure 3-9.

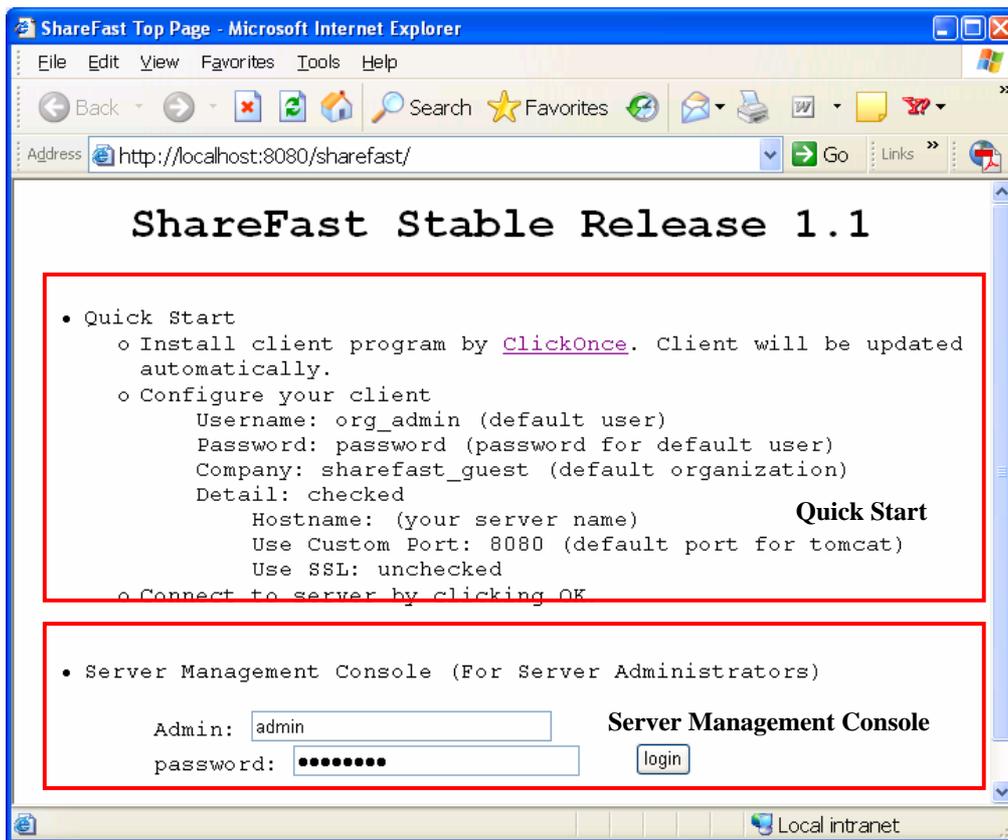


Figure 3-9 ShareFast server user interface

- Quick Start: briefly describes how to install and configure ShareFast Client to use with this ShareFast Server.
- Server Management Console: contains ‘Show Log’, ‘Create New Organization’, ‘List Organizations’, and ‘Real Time Monitoring Tools’ functions.

3.2.5 Server Management

This section will explain about server management functions.

a) Server Management Console Tool

At the top page, input admin username and password at ‘Server Management Console’ section. Click ‘start’ button. The application will link to the Server Administrator Tools page shown in Figure 3-10.

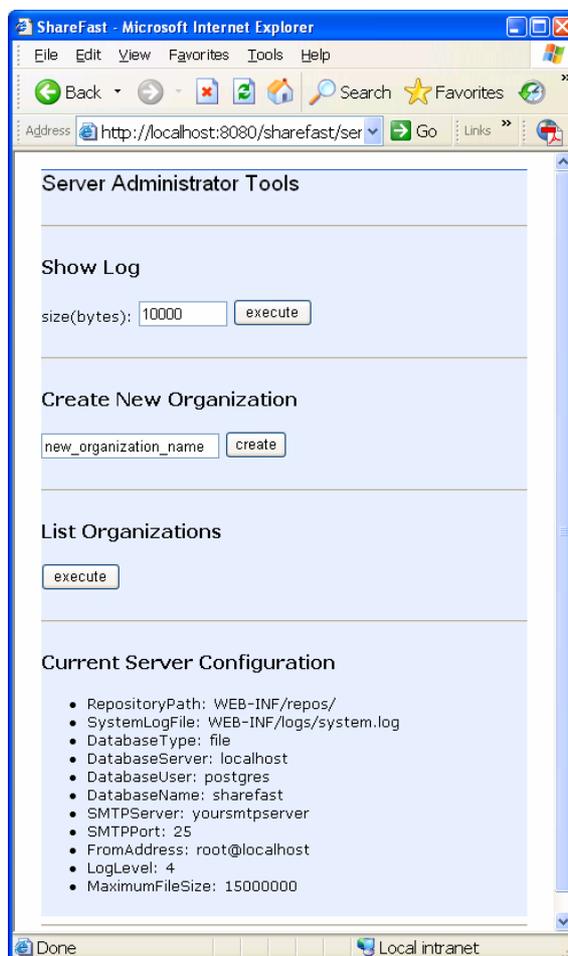


Figure 3-10 Server Administrator Tools page

From this page, users can perform server administration functions. ‘Show Log’ function is to display log content keeping track of users’ activities. ‘Create New Organization’ function is used to make new Organization. After performing ‘Create New Organization’ function, restarting Tomcat is required. ‘List Organizations’ function is to show all existing organizations. After performing ‘Create New Organization’ function, users can login to the ShareFast Client, for user account management, using this newly created organization by:

UserName: org_admin

Organization: <your created organization>

Password: password

After creating new organization, users are required to e-mail information in <WEB-INF\repos\organization name)\conf\organization-config.xml>. This information will be used by mail node and discussion feature.

‘Real Time Monitoring Tools’ will be explored in Chapter 4.

b) Organization Administration Tool

This tool is necessary for creating new users for existing organization. To use this tool, select ‘Server’ → ‘User’ menu from ShareFast Client’s menu bar, and input administrator account information. The organization administration tool page is shown in Figure 3-11.

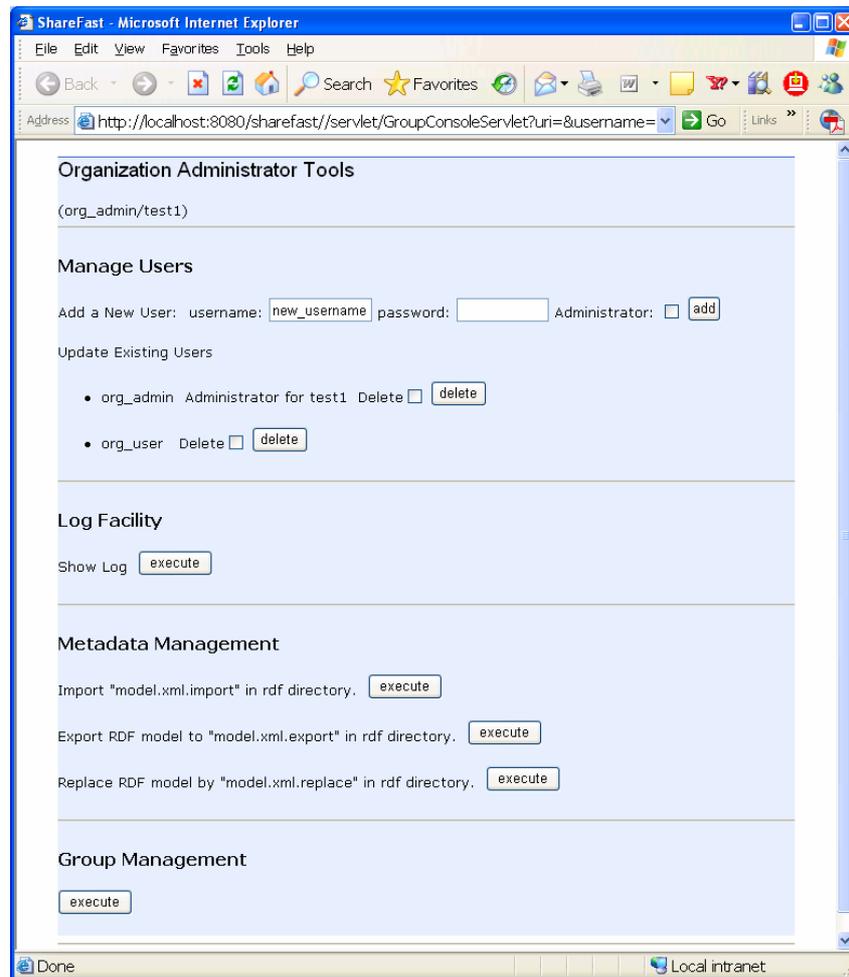


Figure 3-11 Organization Administration Tools page

(1) Manage Users

This function is to add/update/delete user account. To add new user account, input username and password and click ‘add’ button. If users want this new account to be administrator account, they can check the Administrator box. To delete existing user account, check the Delete box and click delete button.

(2) Log Facility

To show log file containing users’ activities of this organization, click ‘execute’ button at the Log Facility section.

(3) Metadata Management

Document files of organization have their own metadata in RDF format. If users are not using RDB, the metadata will be kept in <RepositoryPath>/ (organization name)/rdf/ directory specified by system.xml file. This menu can be used to manage metadata when any troubles occurred.

[Import]: click 'execute' button to add file content of model.xml.import contained in the rdf directory mentioned above to the current metadata.

[Export]: click 'execute' button to begin writing file content of model.xml.import contained in the rdf directory mentioned above to the current metadata.

[Replace]: click 'execute' button to replace file content of model.xml.import contained in the rdf directory mentioned above to the current metadata.

3.2.6 RDF Metadata and Schema Used in ShareFast

Here is a simple example of RDF metadata used in the ShareFast system. Figure 3-12 shows the metadata using RDF format. XML and graph are often used to represent RDF. Figure 3-13 shows the XML that represents the RDF of Figure 3-12. RDF has three entities, i.e. resource, property and literal. In this case, the RDF graph shows, "creator" of a homepage is "Piroon R.", and "update information" of specified page is "update.html". Complicated information can be described by using iteration and combination of this graph.

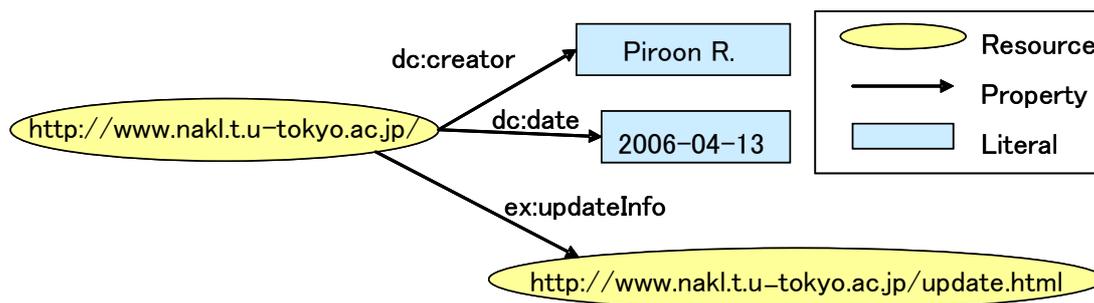


Figure 3-12 Metadata using RDF format

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.1/">
  <rdf:Description rdf:about="http://www.nakl.t.u-tokyo.ac.jp/">
    <dc:creator>Piroon R.</dc:creator>
    <dc:date>2006-04-13</dc:date>
    <ex:updateInfo rdf:resource="http://www.nakl.t.u-tokyo.ac.jp/update.html"/>
  </rdf:Description>
</rdf:RDF>

```

Figure 3-13 RDF presentation using XML

The RDF schema used in this software is illustrated in Figure 3-14. Each workflow, task and document is represented as resource and defined as class. Workflow, task and document are class instances of `sf:Workflow`, `sf:Task` and `sf:Document`, respectively. `sf:taskInWorkflow` explicitly describes that a task is in a workflow, while `sf:relatedTask` property is defined for describing relationships between tasks and documents. For example, “relatedTask” of “DocumentA” is “TaskA”, and “type” of “TaskA” is “Task”. Using this approach, all the workflows, tasks and documents can be identified.

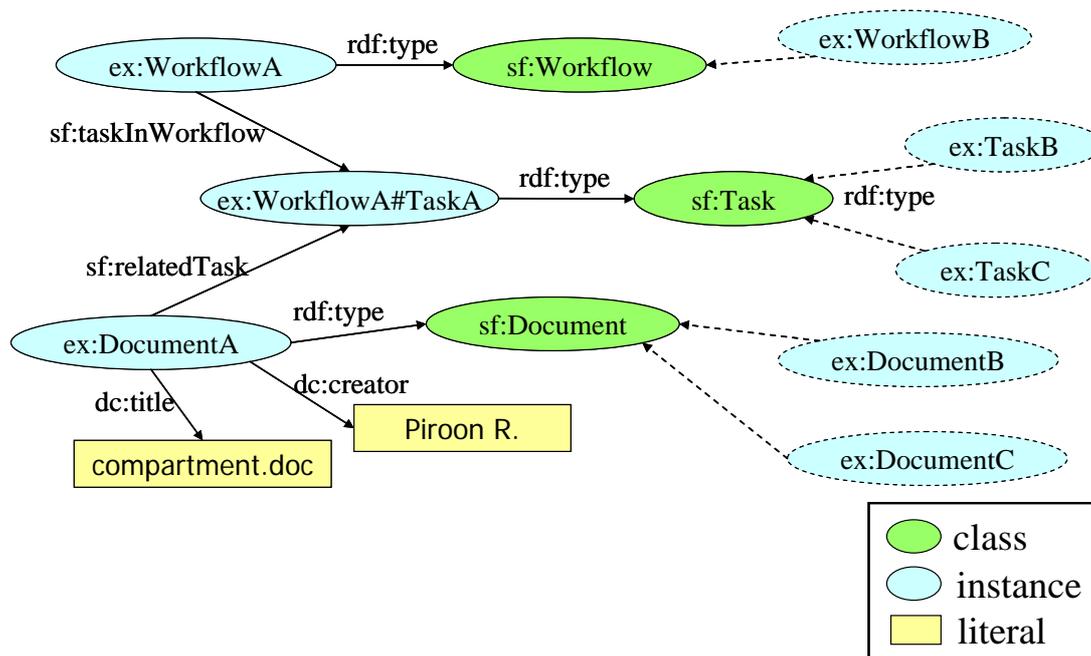


Figure 3-14 RDF structure used in ShareFast

3.3 ShareFast's Functions for the Framework

Since its development, ShareFast has been applied for many aspects, such as knowledge management, information sharing environment and design support system. However, one of the very first reasons to develop ShareFast is to use it as a component of a framework for supporting design education, such as CAD software learning.

To ensure its competence and ease of use, the ShareFast system has been developed as a complement to CAD software to incorporate many of the principles of Newcastle Protocol (See Appendix A). The Newcastle Protocol, finalized together by a group of software developers and teaching institutions during a series of Student Friendly software workshops, aims to provide a guide to the requirements of truly Student Friendly Software, and to provide the framework for the development of such software in a way that will ensure compatibility between different developers and users [44].

Here is the explanation of the ShareFast functions which are necessary during the class and class preparation.

3.3.1 Creating Workflows with Related Documents

ShareFast offers the teachers the workflow editor tool, which can be used to create workflow process of CAD design, and add documents such as calculation sheets, design manuals to the related tasks in the workflow. Students can learn CAD design by following each task in the workflow with related documents. Workflow helps students understand the design processes more easily as it allows students to know the whole learning process before going deeper in detail of each task. This concept coincides with Bruner's theory [45] stating that clear indication of picture of whole task results in efficient education.

3.3.2 Student-Teacher Communication by Discussion Threads

Student-teacher communication and collaboration among students are important for every educational framework. ShareFast allows students and teachers to add discussion threads to any workflow or task. Discussion thread, shown by clicking the workflow or task node, is a message board for students and teachers to discuss a particular subject at process level (workflow) and task level (task node).

3.3.3 Document Search Engine

Students and teachers can search for the learning materials added to the workflow using this function. They can input some key words to the search box, and the materials related to the key words will be listed. The user can choose to open, delete, save the listed documents, or search for other documents that are similar to the selected document.

3.3.4 Student-based Data Management System

Students are able not only to get documents from workflow's tasks, but also to put their documents to the tasks. With this feature, together with student-based data management system, as illustrated in Figure 3-15, the teachers can put standard learning document, e.g. CAD template file, to standard space, where every student has access. Each student works on one's own individual space. Documents added to individual space can be seen in the particular space only. This helps the teachers manage each student's learning material more efficiently.

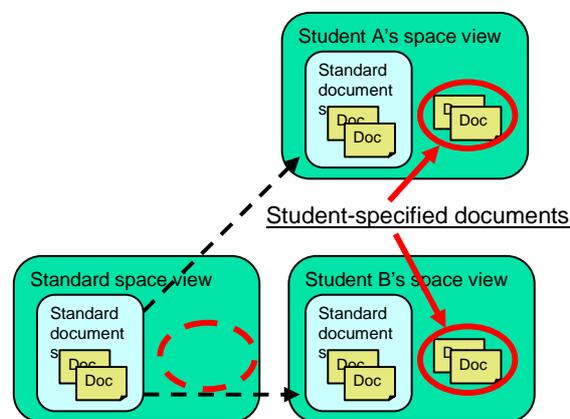


Figure 3-15 Student-based data management

3.3.5 Student Behavior Capture Using Log File

ShareFast keeps track of student's actions after they log in to the system by writing to log file, shown in Table 3-1. It can tell the time that the students log in to the system, click and download learning materials of each workflow and task. This is useful for the teachers to monitor student's learning activities.

Table 3-1 Example of log file contents

User	Time	Session	Task
Student 1	4:55:15	login	
Student 2	4:55:43	login	
Student 3	4:56:22	login	
Student 1	5:03:16	start_task	Launch CAD
Student 2	5:03:17	start_task	Launch CAD
Student 3	5:03:17	start_task	Launch CAD
Student 1	5:03:21	start_task	Create new project
Student 1	5:03:42	start_task	Import parameter
Student 2	5:04:06	start_task	Create new project

Chapter 4. New Features for the Framework

This chapter explains the two new key features of the ShareFast system specifically developed for using in the educational framework. These two features are expected to fulfill the framework's objectives, making it easy to maintain and improve learning materials, and establishing faster and efficient education for CAD operation.

4.1 Class Analysis and Improvement System

This feature was designed to help the instructor to understand how to improve class content and learning materials based on the analysis of the results from the previous classes. Using this feature, it is expected that the students would be able to operate CAD software more smoothly, and have less questions and problems that will cause the quality of the class and the class delay.

Figure 4-1 displays the process of the class analysis and improvement system. From students' query messages in discussion threads and students' behavior captured by log file, the instructor can evaluate and analyze the class quality. The instructor will know the task that students spend too much time on, frequently ask questions, or the task that students have to get back to read its document many times. The instructor can consequently check the task material and improve it for the next class.

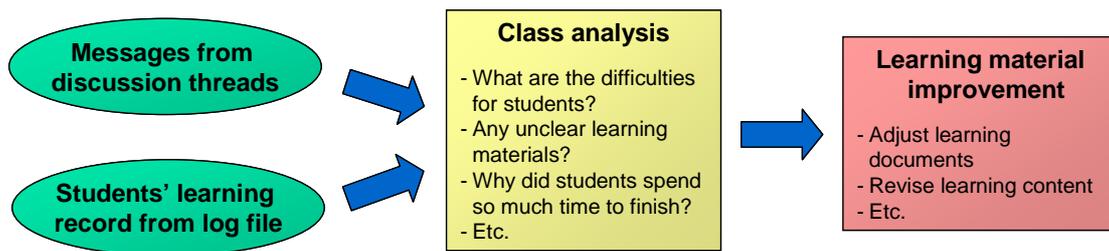


Figure 4-1 Class analysis and improvement process

4.2 Real Time Operation Monitoring System

This feature aims to help the instructor to monitor students' learning progress in real time in order to understand students' problem and control the class to be finished within the expected time. It is expected to help the framework to achieve establishing a faster and more efficient CAD education. This section presents its system overview and system components as well as how to use it.

4.2.1 Basic Concepts and System Overview

This monitoring system helps instructors to monitor the student's learning progress by extracting and transforming the information kept in log file to be the student's graphical progress report. As described before, the log file keeps track of students' actions after they log in to the system, including time stamp, student name, name of the task being performed, and so on.

Figure 4-2 shows how the system transforms the organization (class) log file to the report after instructors perform this function.

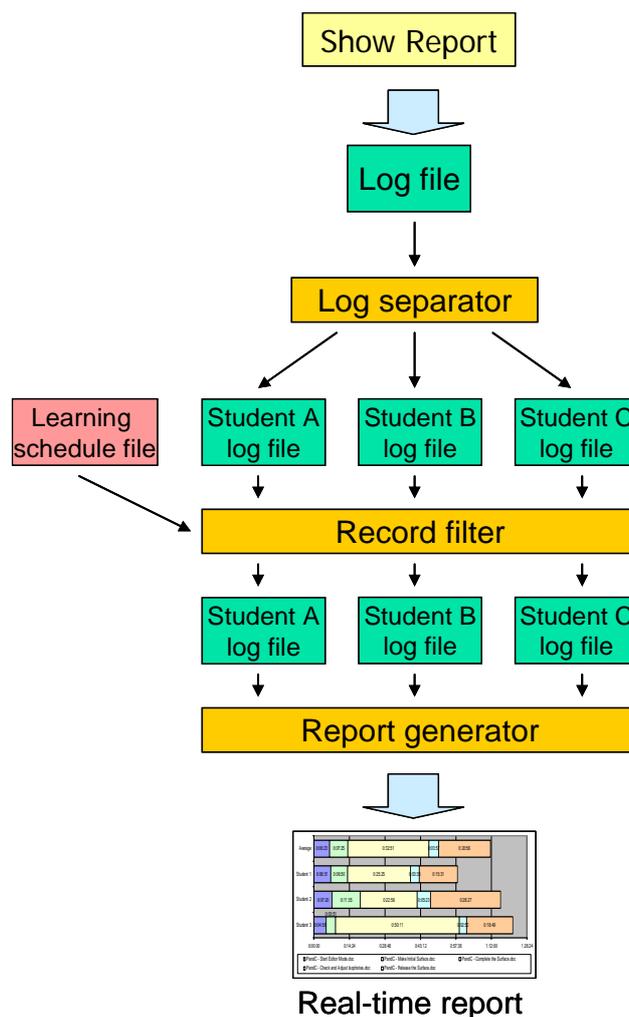


Figure 4-2 Extract log file to generate operation monitoring report

The log separator component will read the log file and generate an individual log file for each student. Then, the individual log files will be read and eliminated the duplicate or un-used records as well as reformed by the record filter component. Finally, the report generator will read all the reformed individual log files and generate the real time graphical report in HTML format and show to the user (instructor).

4.2.2 System Components and How They Work

This section explains each component of the monitoring system displayed in the Figure 4-2.

a) Log File

The ShareFast system writes the student actions' information to the log file. It will write to the file one line per one action (session). Below is the format of the file per one line.

session name, file name, user (student) name, ShareFast version, date and time

Session name is the name of the action that students perform. The list of the session names is shown below.

- login: written when a user (student) logins to the ShareFast system
- start_class: written when a user (teacher) clicks “execute” in the Start Class function of the monitoring system interface. (see 4.2.3 System Functionality)
- readfile: written when a user (student) launches a file (learning material) added in a task node.
- start_task: written when a user (student) clicks on a task node.

Figure 4-3 displays an example of the contents of a log file.

```

'login', '', 'hiekata@157.82.251.145', 'ShareFastClient Ver.1.0.2587.28032', 'Thu May 31 13:42:50'
'readfile', 'https://km.nakl.t.u-tokyo.ac.jp/20070521144807931.sfw', 'hiekata', '', '', 'Thu May 31 13:42:56'
'start_class', '', '', '', 'Thu May 31 13:45:54 JST 2007'
'start_task', 'https://km.nakl.t.u-tokyo.ac.jp/20070521144807931.sfw#0', 'hiekata', 'ShareFastClient', 'Thu May 31 13:49:38'
'readfile', 'https://km.nakl.t.u-tokyo.ac.jp/20070522105008413.doc', 'hiekata', 'Ver.1.0.2587.28032', '', 'Thu May 31 13:51:00'
'readfile', 'https://km.nakl.t.u-tokyo.ac.jp/20070521144807931.sfw.lock', 'hiekata', '', '', 'Thu May 31 13:51:09'
'start_class', '', '', '', 'Thu May 31 15:23:19'
'login', '', 'piroon@157.82.251.145', 'ShareFastClient Ver.1.0.2587.28032', 'Thu May 31 16:03:43'
'readfile', 'https://km.nakl.t.u-tokyo.ac.jp/20070521144807931.sfw', 'piroon', '', '', 'Thu May 31 16:05:52'
'start_task', 'https://km.nakl.t.u-tokyo.ac.jp/20070521144807931.sfw#0', 'piroon', 'ShareFastClient', 'Thu May 31 16:05:55'

```

Figure 4-3 Contents of log file

b) Log Separator

In this step, the system will read through the organization log file, and generate an individual log file for each student performing the session “readfile” in the class. Each

individual log file contains the list of task names that the student has launched and read the learning materials, and the time when the materials were launched. The individual log file after this step will be sorted by launch time. Therefore, it might still contain some duplicate task names but various time stamps, or the task names are not in the correct order, as the students might not launch the learning materials in the right order.

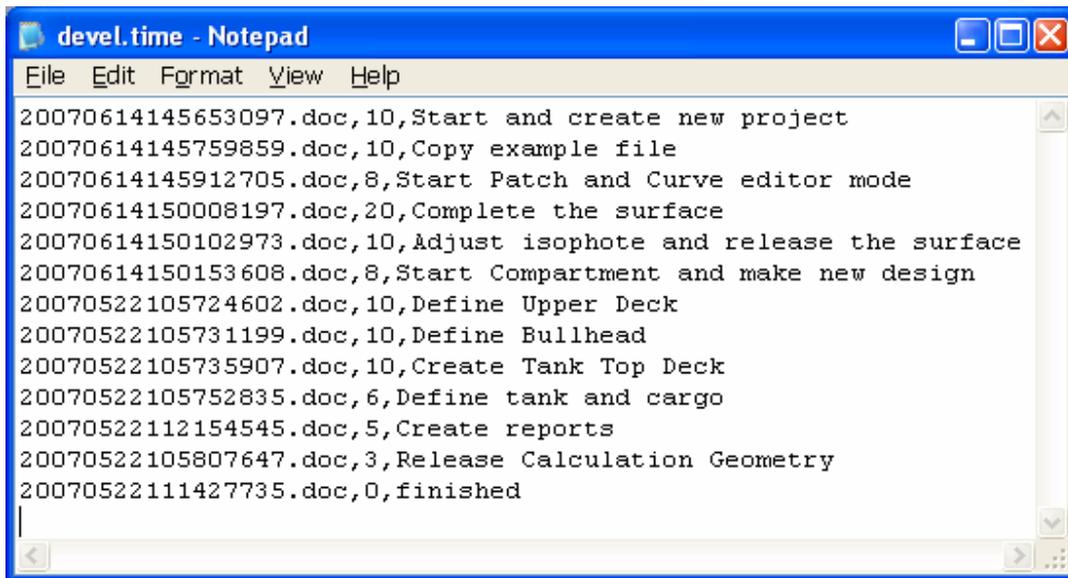
The log separator will delete all the individual log files it has created if a record in the log file containing “start_class” session name is read.

c) Learning Schedule File

Learning schedule file is used as an input file by the record filter. It keeps the information of the expected learning duration of all tasks specified by teachers. Each line of the file contains one task name and its expected learning duration per one task in order from the first line to the last line. The format of each line is shown below.

XXX.XXX,YY,ZZZ

XXX.XXX is the file name of this task’s learning material kept in the ShareFast system, while *YY* and *ZZZ* represent the expected learning duration (minute) and task name, respectively. Figure 4-4 illustrates an example of learning schedule file created by a teacher.



```

devel.time - Notepad
File Edit Format View Help
20070614145653097.doc,10,Start and create new project
20070614145759859.doc,10,Copy example file
20070614145912705.doc,8,Start Patch and Curve editor mode
20070614150008197.doc,20,Complete the surface
20070614150102973.doc,10,Adjust isophote and release the surface
20070614150153608.doc,8,Start Compartment and make new design
20070522105724602.doc,10,Define Upper Deck
20070522105731199.doc,10,Define Bullhead
20070522105735907.doc,10,Create Tank Top Deck
20070522105752835.doc,6,Define tank and cargo
20070522112154545.doc,5,Create reports
20070522105807647.doc,3,Release Calculation Geometry
20070522111427735.doc,0,finished

```

Figure 4-4 Learning schedule file created by teachers

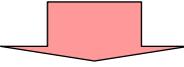
d) Record Filter

Record filter reads the individual log files generated from log separator and performs two main functions, eliminating un-used, duplicate task records and convert time stamp into duration (minute).

First, the record filter will read the learning schedule file created and uploaded by the user (teacher) in order to know the correct sequence of the learning tasks. After that, it will read through all the records in the individual log file, and eliminate the records that contain wrong order tasks. It will then remain only one record for one task name by deleting the records keeping task names that are the same as the previously found one. The filter also delete the records containing the time stamp that is shorter than one minute from the previously selected record time stamp, as it is believed to be the record occurred by human error.

Suppose that the sequence of the tasks in the class is Task 1, Task 2, Task 3, ..., Task 6, Figure 4-5 presents an example of how the filter eliminates the un-used, duplicate task records of an individual log file.

Start time	Task name	
13:30:10	Task 3	Deleted: wrong order task
13:35:22	Task 4	Deleted: wrong order task
13:36:00	Task 1	
13:38:02	Task 1	Deleted: duplicate task
13:43:42	Task 2	
13:55:29	Task 3	
13:55:58	Task 4	Deleted: less than 1 minute from previous selected time
14:00:03	Task 4	
14:03:25	Task 6	Deleted: wrong order task



Start time	Task name
13:36:00	Task 1
13:43:42	Task 2
13:55:29	Task 3
14:00:03	Task 4

Figure 4-5 Example of individual log file records filtering

After that, the system will convert the start time into duration (minute). Suppose that the current time is 14:05:13, the individual log file from Figure 4-5 will be converted as shown in Figure 4-6.

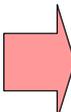
Start time	Task name		Duration (minute)	Task name
13:36:00	Task 1		7	Task 1
13:43:42	Task 2		11	Task 2
13:55:29	Task 3		4	Task 3
14:00:03	Task 4		5	Task 4

Figure 4-6 Converting start time to duration

e) Report Generator

Report generator is responsible for transforming the individual log file of each student into progress bars showing to the users on the ShareFast server screen.

4.2.3 System Functionality

a) System Interface

After the instructors (users), log in to the system via the ShareFast Server user interface, the users will see the real time monitoring tools as illustrated in Figure 4-7.

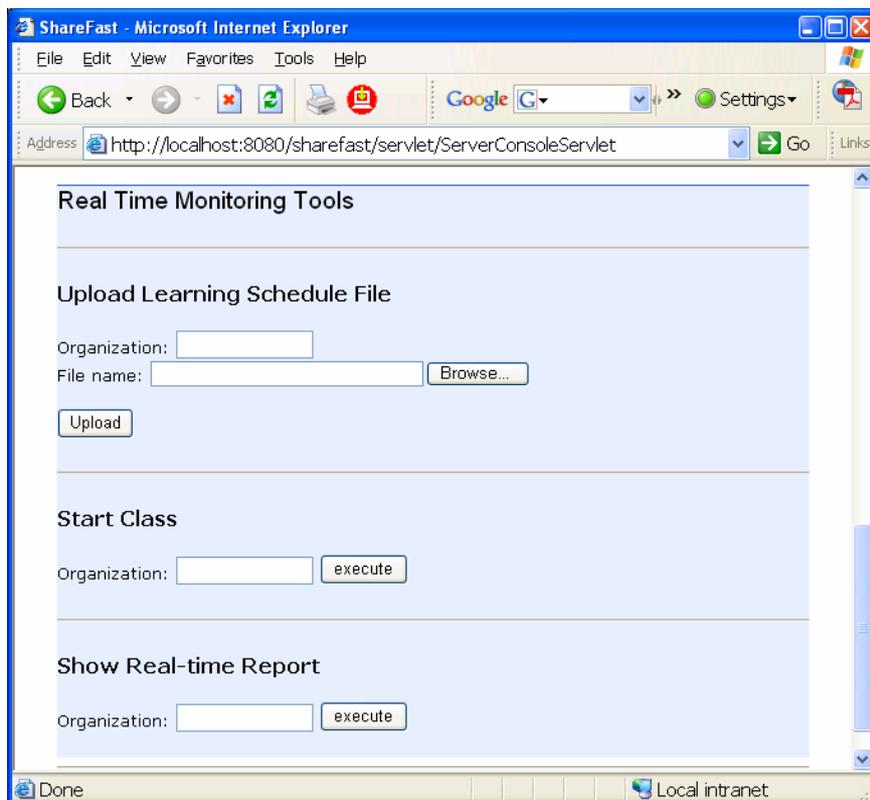


Figure 4-7 Real time operation monitoring system interface

The interface consists of three sections.

(1) Upload Learning Schedule File

Users input the class name in the “Organization” field, and input the learning schedule file name in the “File name” field. This file, created by users, contains the task names in the learning module and the expected time (minute) of each task.

(2) Start Class

Users input the class name in the “Organization” field, and click execute button to start the class. After perform this action, the ShareFast system will write a “start_class” session to the log file.

(3) *Show Real-time Report*

Users input the class name in the “Organization” field, and click execute button to show the real time operation graphical report. After perform this action, the ShareFast system will start the monitoring system functions as shown in Figure 4-2.

b) How to Use

Users will first create the learning schedule file, and upload it via the system interface. After that, users will start the class by inputting the class name and clicking the button in the “Start Class” section. If the users click on the button in the “Show Real-time Report” section before the students begin the first task, the users will see the graphical report, shown in Figure 4-8, displaying the expected time of each task in this class according to the learning schedule file uploaded before.

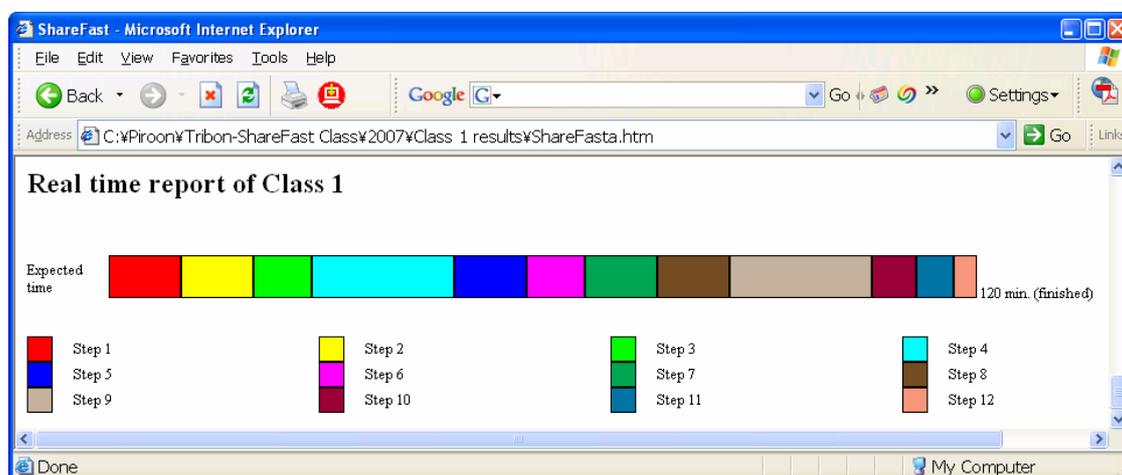


Figure 4-8 Real time report before the students begin

After the students start the class by reading the learning materials added to the workflows, the monitoring system will capture the students’ learning progress from the organization log file and show to the users, i.e. the instructors, after the “Show Real-time

Report” button is clicked. The example of the real time operation report is presented in Figure 4-9. It shows the progress bars of each student and explains the duration used in the current task.

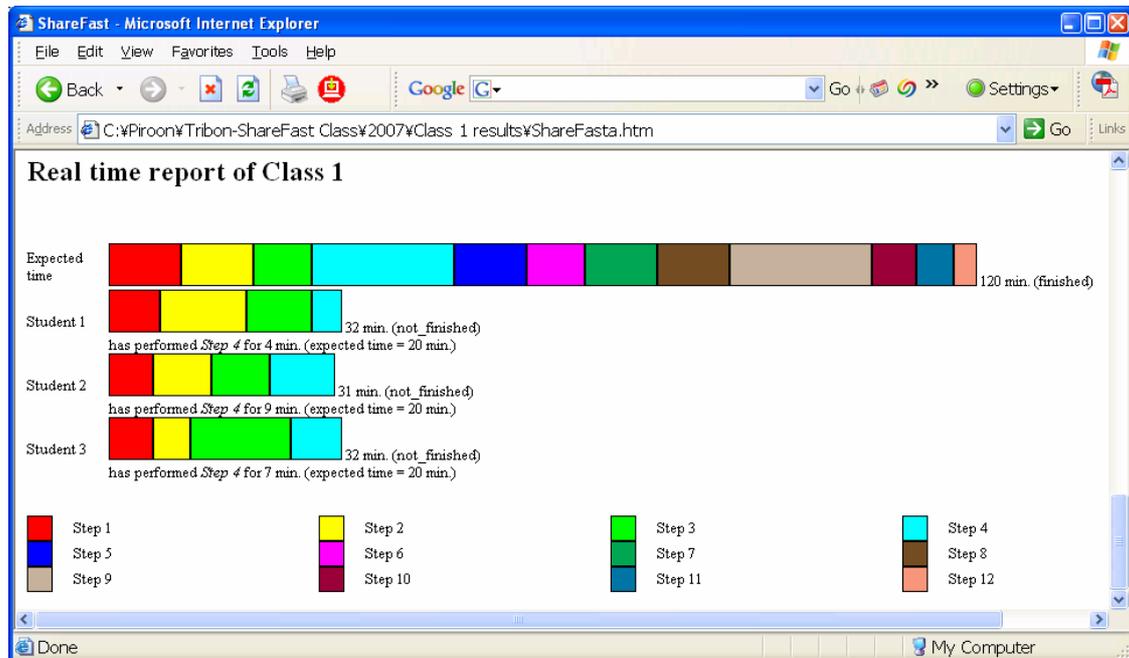


Figure 4-9 Real time operation report during the class

When all the students finish the last task of the class, the instructor will be able to see the learning duration of each student in every task as shown in Figure 4-10.



Figure 4-10 Real time operation report after the class is finished

Chapter 5. CAD Software Experimental Classes

In order to gain experience with ShareFast and to find potential for further improvement, the experimental classes were conducted on the framework to provide enhanced design assistance to aid students undertaking design coursework. This chapter presents the experiment objective, approach, scenario, and explains the CAD software used in the experiment. The experiment results will finally be stated.

5.1 Objective

The objective of the experimental classes was to teach the Master's Degree students from the Department of Environmental & Ocean Engineering, the University of Tokyo, how to work with a commercial CAD software package for ship design called Tribon M3 using ShareFast as e-learning system in the CAD educational framework. The two main features of the framework, to help instructors improve learning materials, and monitor students to control the class to be finished within the expected time, will be evaluated during the experiment.

5.2 Scenario

The scenario was to conduct the classes for two years, 2006 and 2007. All the features of the system will be verified during the classes. The results from the first year class will be analyzed to find the weak points of the system. Then, the system will be refined, fixed, and added some more features if necessary. The system, together with the

whole framework, will be evaluated again in class 2007. The results from year 2006 and 2007 will be compared again to measure the effectiveness of the system after revising.

5.3 Tribon M3 Initial Design

This section briefly explains the basic concept of Tribon M3 Initial Design, the CAD software used in this experiment, and its functions of the five modules that were used to teach the students. It also presents the learning objectives and contents of each module that the students had to achieve.

5.3.1 Introduction to Tribon M3 Initial Design

The commercial software package, Tribon M3 Initial Design, from AVEVA [46], is a tool for modeling an initial ship hull form, the internal arrangement and performing naval architectural analysis upon it. It consists of a number of functional modules that are based on a combination of mathematical methods and widely accepted empirical techniques. It is part of the integrated CAD/CAM shipbuilding system, Tribon M3. However, the Initial Design suite is used within the experimental classes as a stand alone system for conceptual and preliminary ship design [47][48].

Features of Tribon M3 Initial Design are illustrated in Figure 5-1 and include:

- Parametric generation of new hull forms and modification of existing basis vessels, production fairing, manipulation and enhancement;
- Modeling of compartments, openings and appendages;
- Output of lines plan and loft book data;
- Calculation of hydrostatics, including form and stability calculations, tank calibrations, loading, intact and damage stability (including water on deck and probabilistic), longitudinal strength, launching, freeboard, tonnage etc.; and

- Calculation of hydrodynamics, including powering, maneuvering, dynamic positioning and sea keeping.

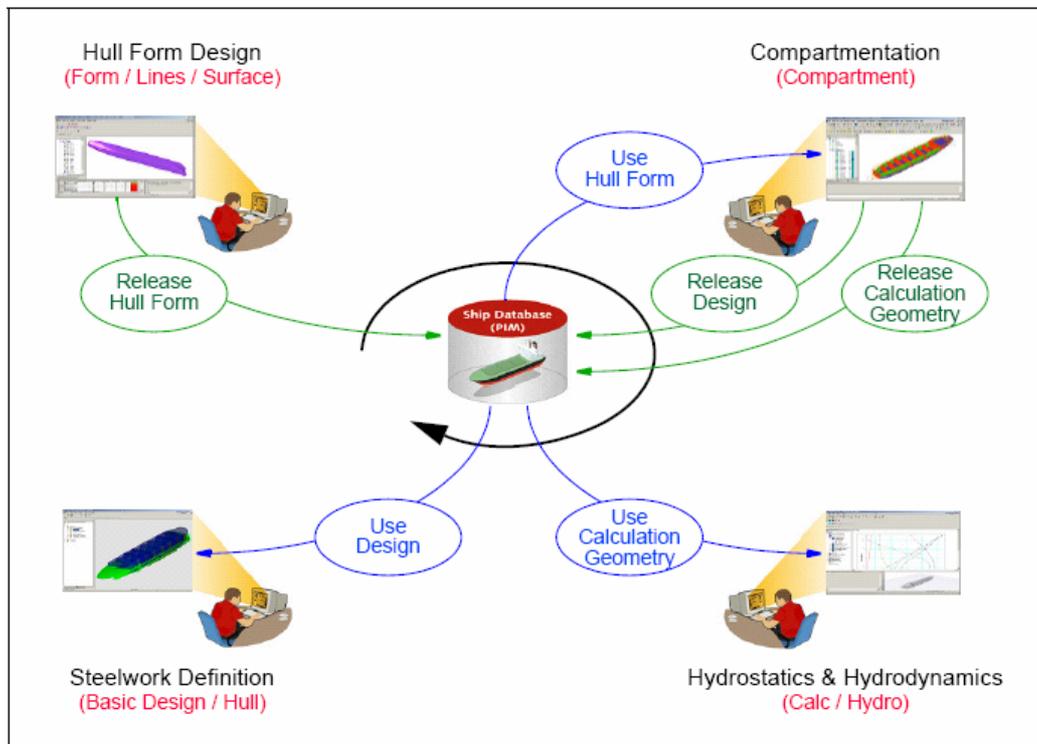


Figure 5-1 Tribon M3 Initial Design System

5.3.2 Module 1: Project Creation

The objective of this module is to create a new Tribon M3 Initial Design project using Project Tool, shown in Figure 5-2. The Initial Design Project Tool is used to create and manage projects. A project is established to represent a proposed tender or investigation and so may contain design variants; although in general represents a single set of design targets, length, draught, displacement, block coefficient, beam etc [48].

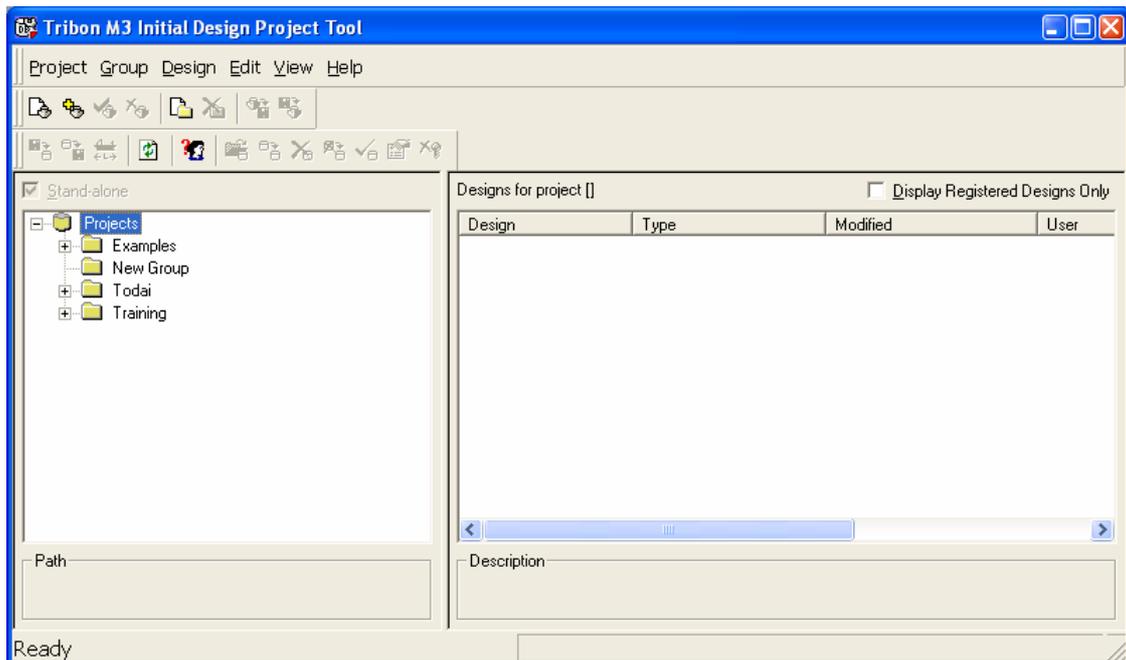


Figure 5-2 Tribon M3 Initial Design Project Tool

Initial design objects (curves, patches, longitudinals, compartments, hydrostatics, trim tables, etc.) are stored within Designs pertinent to Initial Design processes (Hull Form design, Compartmentation, Hydrostatic calculations). Design data is shared between design processes by releasing design data to the Project and using it in downstream processes.

For the needs of the Ship Design Coursework, the students will simply create a new project with the design parameters that need to be met.

Figure 5-3 shows the workflow of this module.

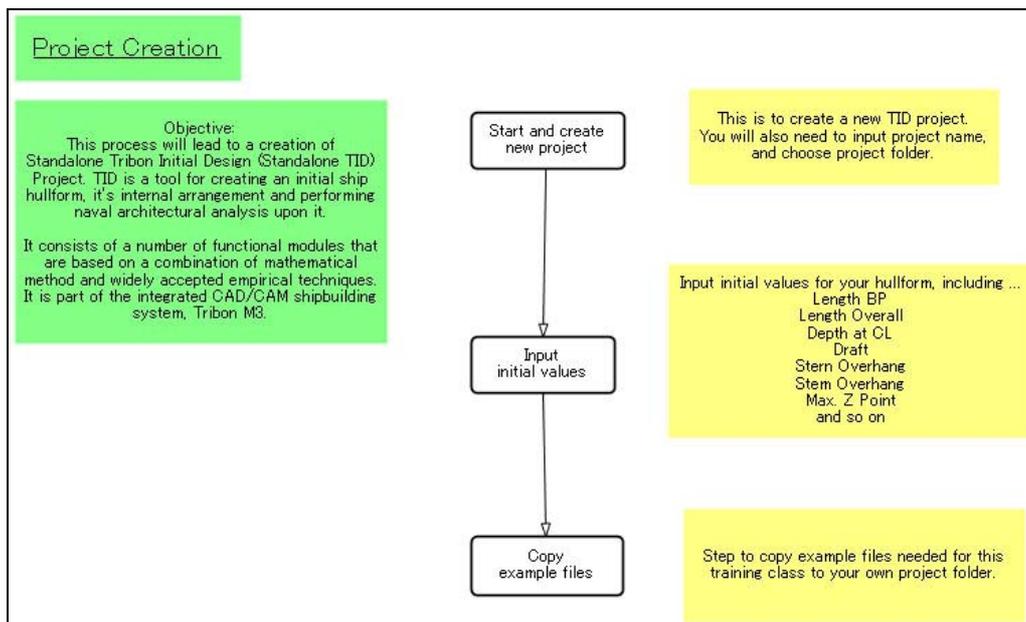


Figure 5-3 Workflow of Project Creation

- **Start and create new project:** To create a new project, simply select the Projects tree node, or any previously defined group and then select PROJECT > NEW from the main menu. The New Project dialog, Figure 5-4, is displayed.

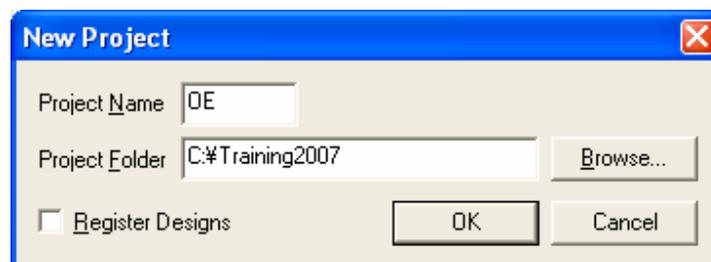
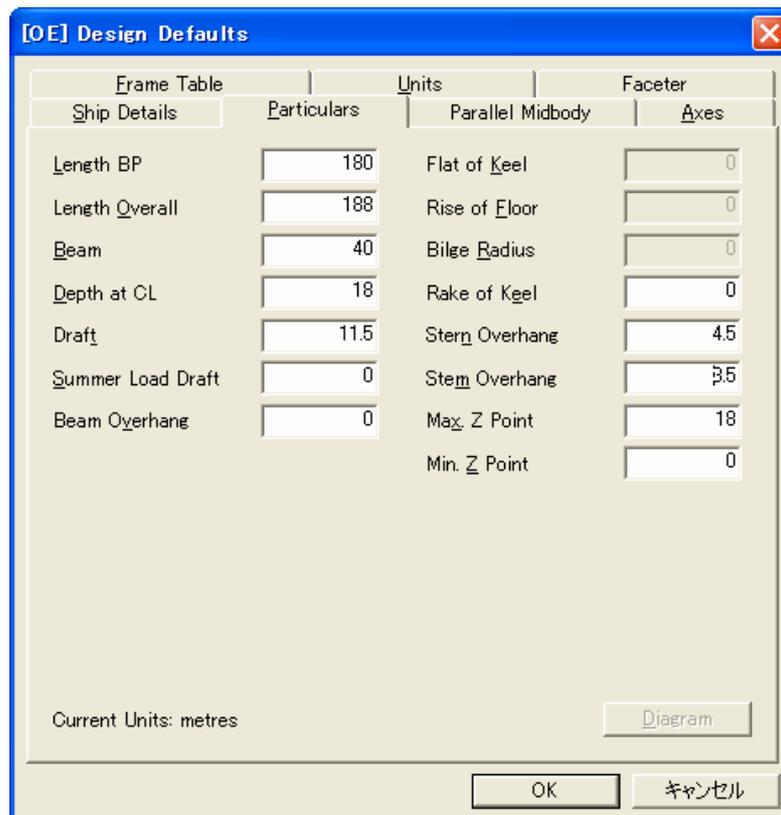


Figure 5-4 New Project dialog

- **Input initial values:** To provide some design defaults, input values to the Particulars tab in Design Defaults dialog, displayed in Figure 5-5.



Frame Table		Units		Faceter			
Ship Details		Particulars		Parallel Midbody		Axes	
Length BP	180	Flat of Keel			0		
Length Overall	188	Rise of Floor			0		
Beam	40	Bilge Radius			0		
Depth at CL	18	Rake of Keel			0		
Draft	11.5	Stern Overhang			4.5		
Summer Load Draft	0	Stem Overhang			3.5		
Beam Overhang	0	Max. Z Point			18		
		Min. Z Point			0		

Current Units: metres

Diagram

OK キャンセル

Figure 5-5 Design Defaults dialog

- Copy example files: Copy the files used in this training class to the project folder.

5.3.3 Module 2: Lines Design

The main objective of this module, illustrated in Figure 5-6, is to create lines of ship shape form. Tribon M3 Lines is a sophisticated hull form design system which enables Naval Architects to define and fair a hull form by means of a series of orthogonal and 3D space curves. Figure 5-7 displays screen capture of this module. Lines Design is capable of defining virtually any form of marine vessel including multi-hulls chinned and asymmetrical hulls.

Input to the system is generally via an offset file, digitization of a preliminary lines plan, or from the Tribon M3 Form program. Once inserted, the hull form and its

appendages can be developed by the progressive refinement of frame, Waterline, Buttock, 3-D angle curves and stem/stem profiles, which between them provide a complete three-dimensional wire frame definition of the hull form. Fairness can be checked by viewing these curves in the traditional manner, supplemented with several special features to assist in measuring fairness. The rapid development of hull forms is also aided by features such as 3-D curves, contracted fairing, special Waterline endings and hull distortion techniques, including sectional area curve transformations and parallel mid-body insertion [17].

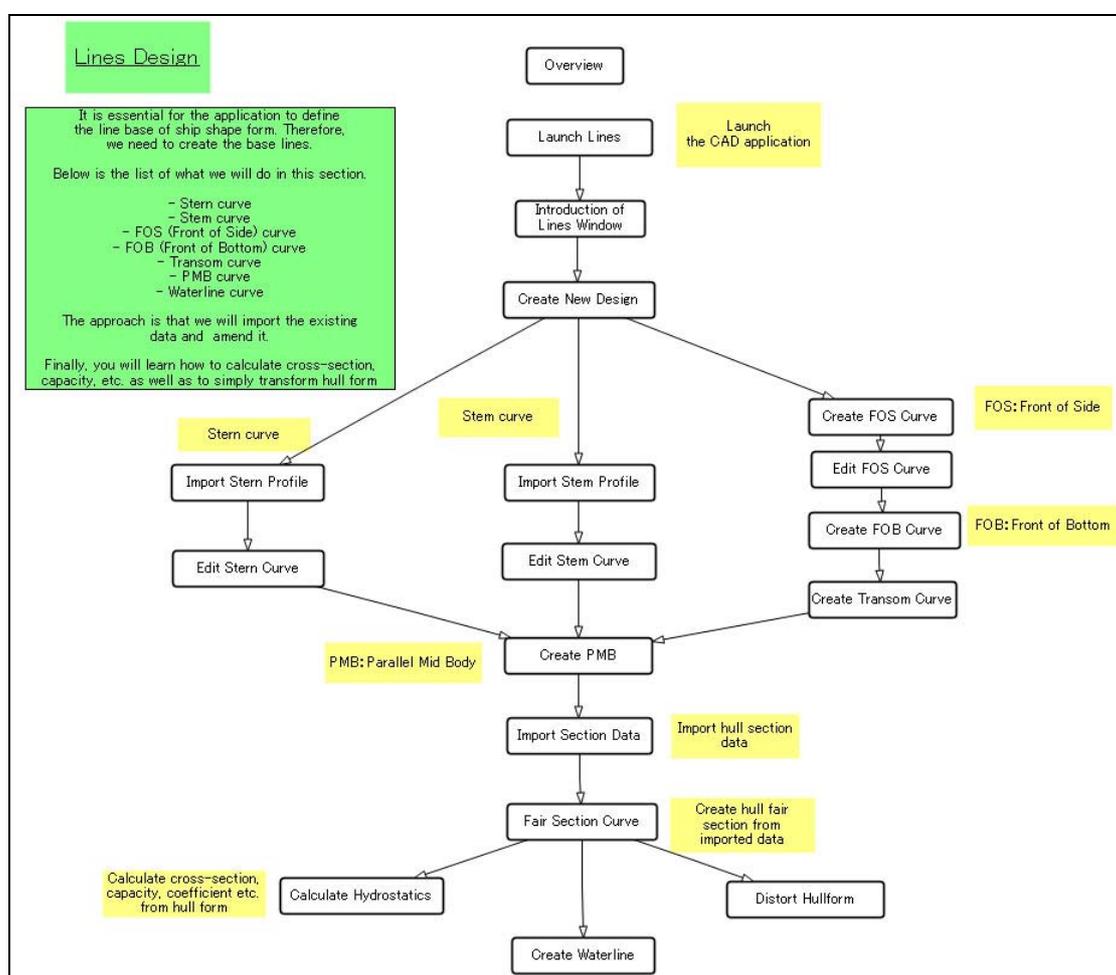


Figure 5-6 Workflow of Lines Design

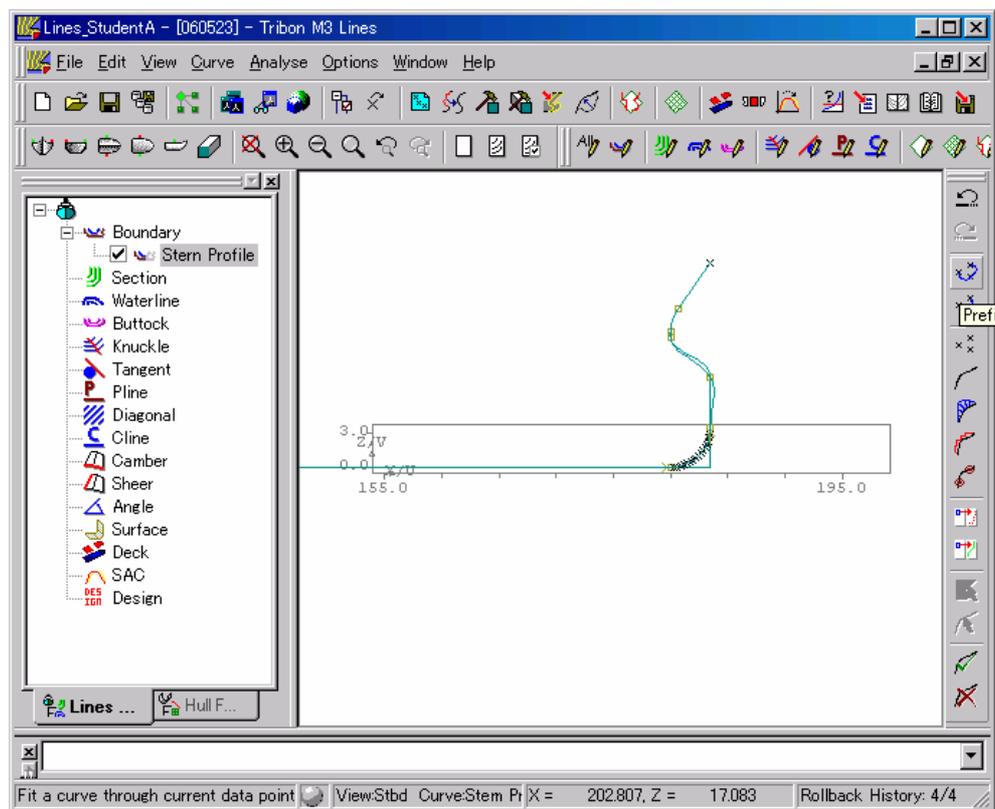


Figure 5-7 Screen capture of Lines Design module

- Launch lines, Introduction of Lines window, Create new design: These three tasks explain how to launch the Lines dialog (Figure 5-7), and the dialog components as well as to launch New Design dialog, illustrated in Figure 5-8, from New icon to create new Lines design.

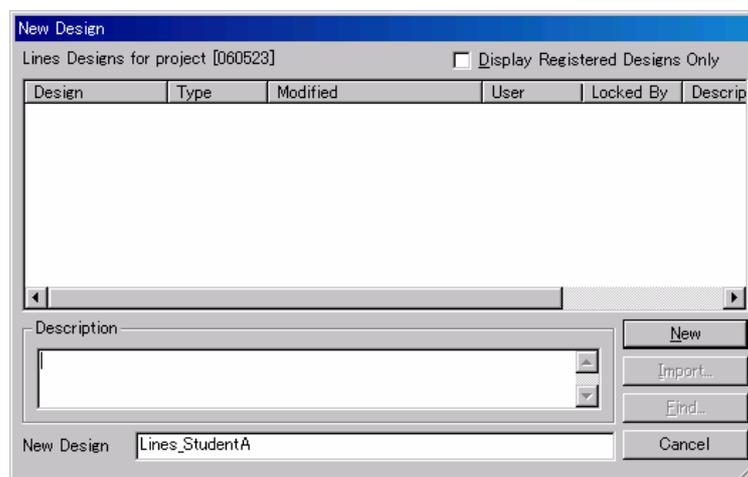


Figure 5-8 New Design dialog

- Import stern/stem/FOS/FOB/Transom profile and edit stern/stem/FOS/FOB/Transom curve: First, click Create icon to import and create curve points information, shown in Figure 5-9, from stern.dat, stem.dat, fos.dat, fob.dat and transom.dat copied to the project before. Then edit the stern, stem and FOS curves, as shown in Figure 5-10, Figure 5-11 and Figure 5-12, respectively, using edit tools provided in the Lines dialog.

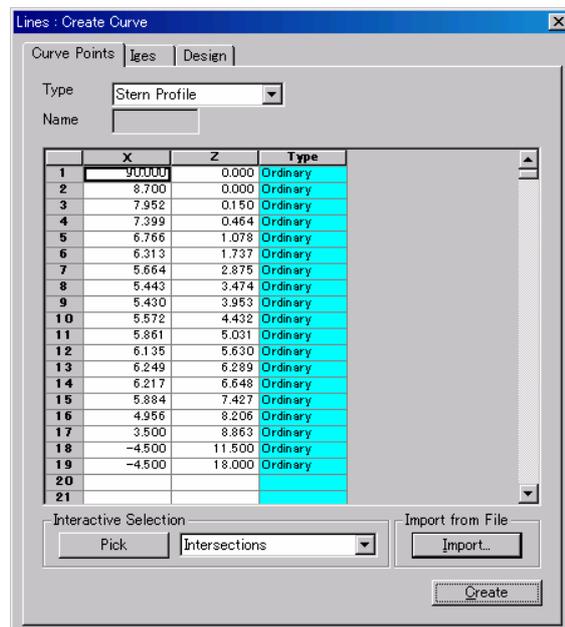


Figure 5-9 Import curve points information

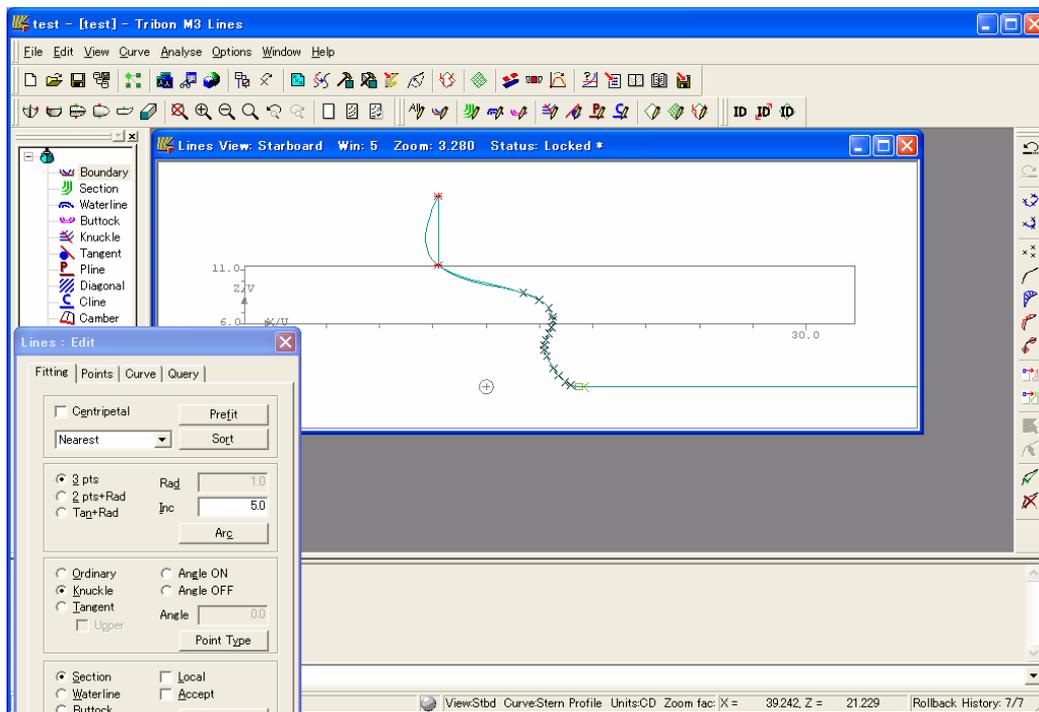


Figure 5-10 Edit stern curve

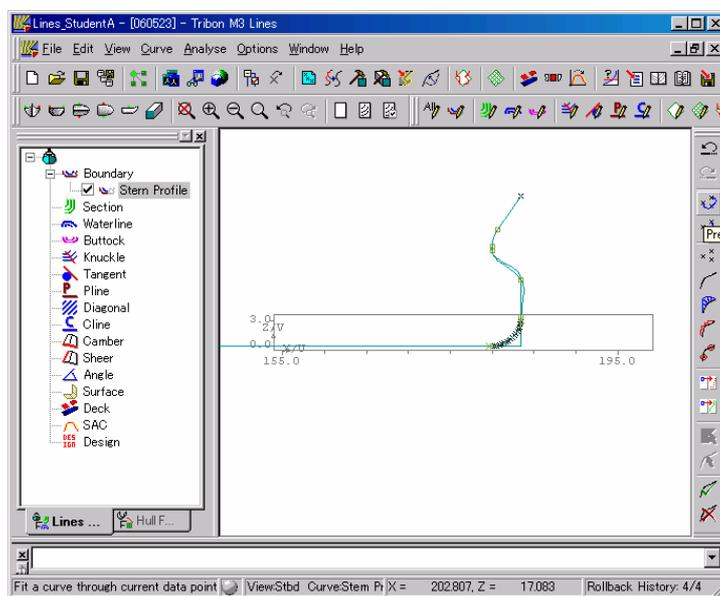


Figure 5-11 Edit stem curve

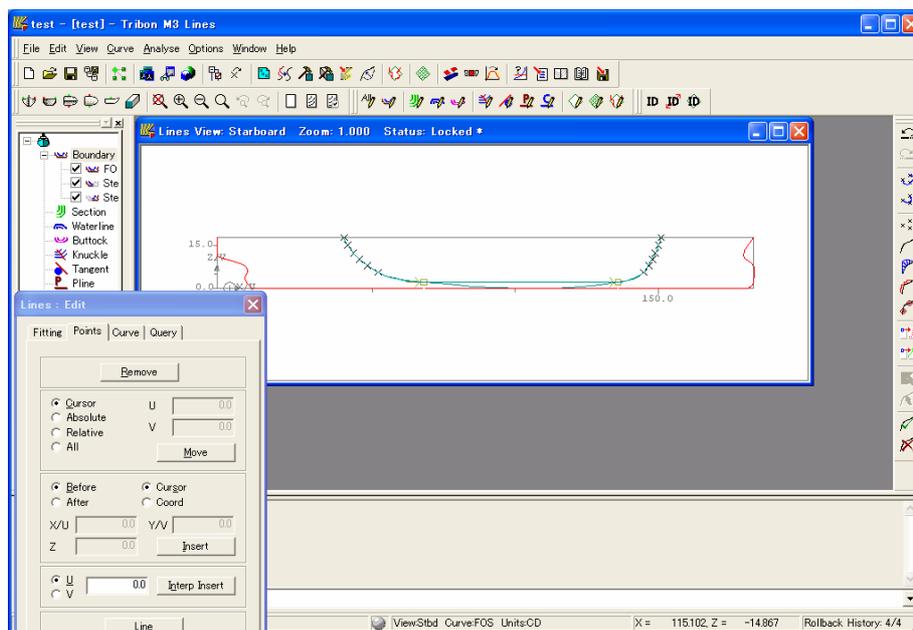


Figure 5-12 Edit FOS curve

- Create PMB, Import section data, Fair section curve: To create PMB (Parallel Mid Body), click PMB icon and input values to Parallel MidBody dialog, shown in Figure 5-13. Then, import section data by clicking on Create icon and import data via Design tab of Create Curve dialog (Figure 5-14). After that, click Fairing icon to fair section curve (Figure 5-15).

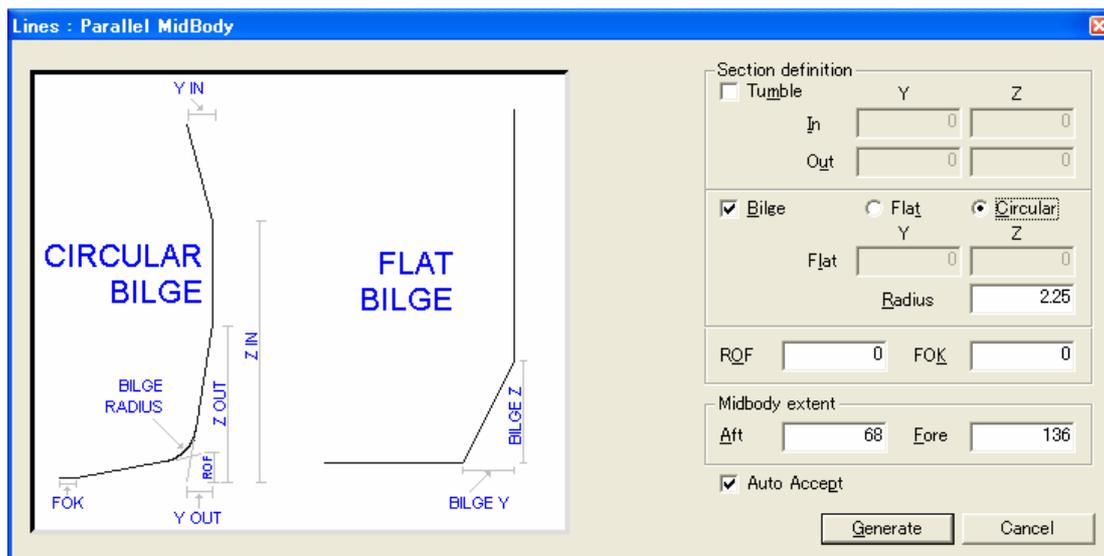


Figure 5-13 Parelle MidBody dialog

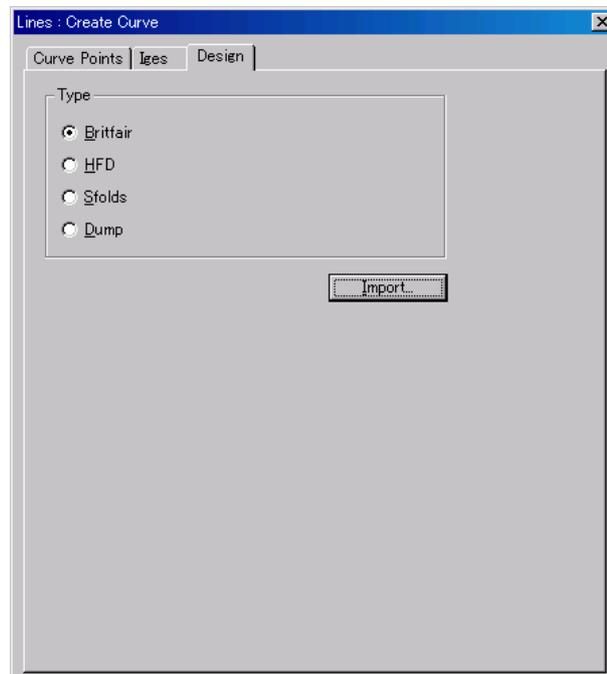


Figure 5-14 Design tab of Create Curve dialog

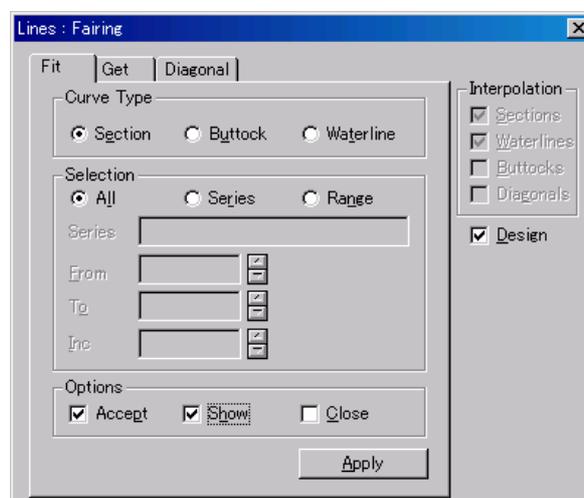


Figure 5-15 Firing section curve

- Calculate hydrostatics, Create Waterline, Distort hullform: Click Distort icon to open Distortion dialog (Figure 5-16) to perform calculating hydrostatics and distort hullform and click on Fairing icon to perform creating waterline.

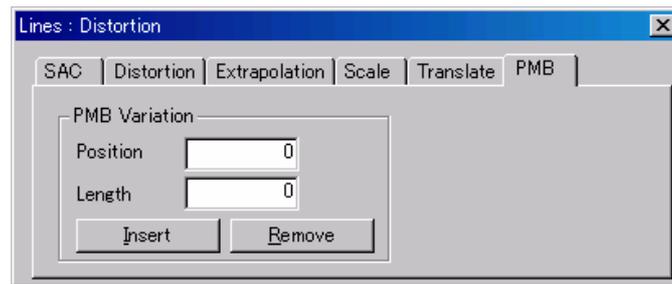


Figure 5-16 Distortion dialog

5.3.4 Module 3: Patch and Curve

This section presents a suggested methodology for using Patch and Curve Editor (PACE) to generate a surface from a set of curves. For clarity, references to various menus and dialogs are kept brief.

The best methodology to be applied when using PACE depends on the initial data and the desired end result. There are many ways in which PACE can be used. Two extremes of methodologies arise from having either:

- a complete and fair set of lines which require only patching, or
- when there are a few, or even no, construction curves with the intention of creating a set of surface patches but not necessarily a full set of curves.

The workflow of this module is illustrated in Figure 5-17.

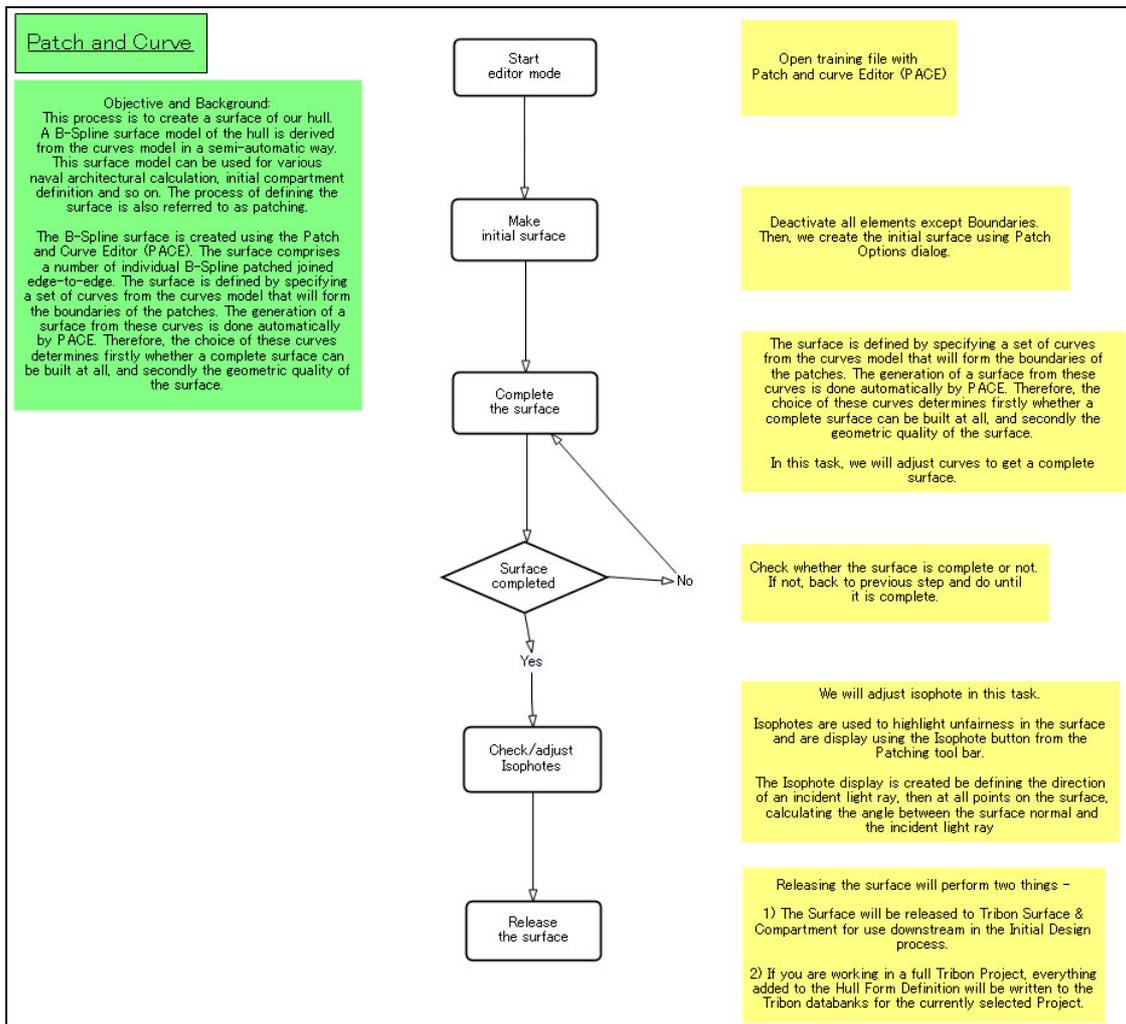


Figure 5-17 Workflow of Patch and Curve

- Start editor mode: To open the training file with Patch and Curve Editor (PACE)
- Make initial surface: To create an initial surface using Patch Options dialog (Figure 5-18).

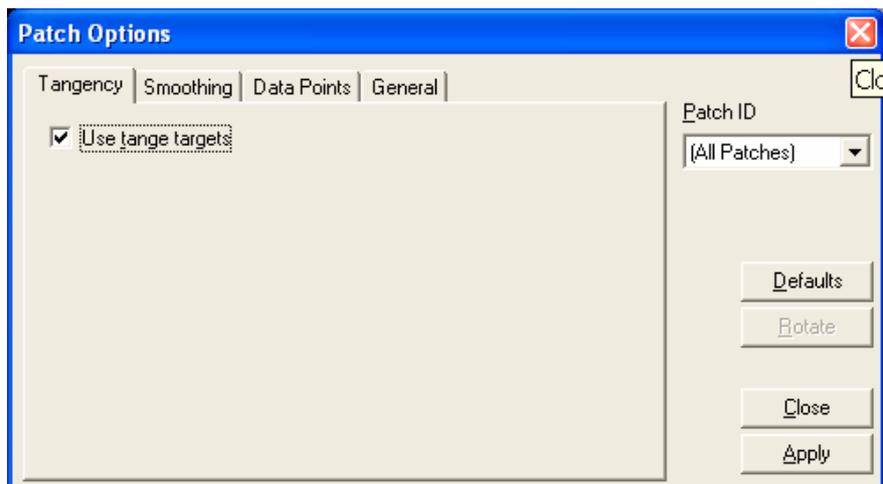


Figure 5-18 Patch Options dialog

- Complete the surface: To adjust curves to complete a surface (see Appendix B for the learning material of this task). The completed surface is shown in Figure 5-19.

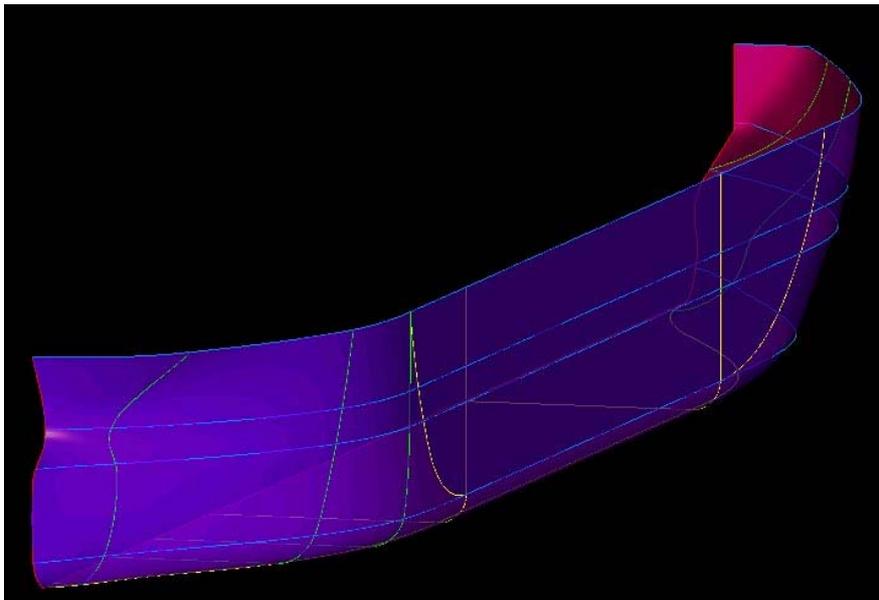


Figure 5-19 Completed surface

- Check/adjust isophotes: Isophotes are used to highlight unfairness in the surface. Click on Isophotes icon and adjust Isophotes by “Data Points” tab after clicking “Build surface after setting options” icon.

- Release the surface: To release all hull forms, select File → Release → Release Hull Forms from the main menu (Figure 5-20).

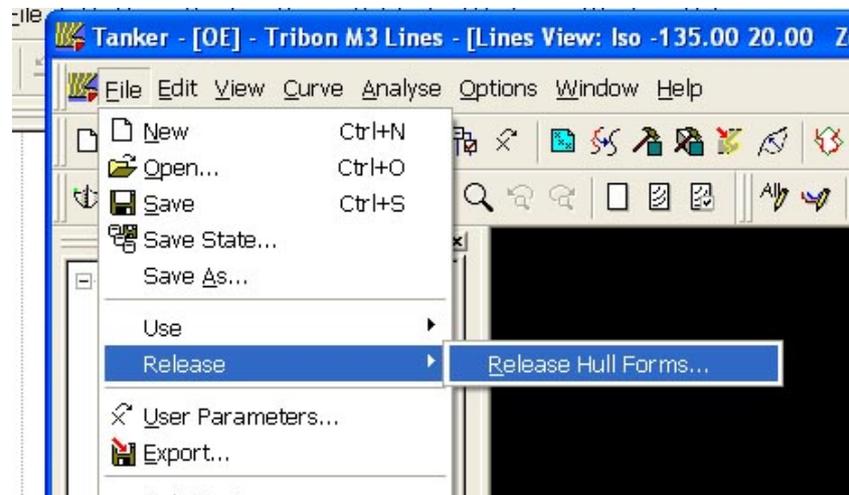


Figure 5-20 Release hull form

5.3.5 Module 4: Compartment

The vessel has been subdivided using decks, transverse and longitudinal bulkheads; with a mind to these being the extents of spaces (compartments), e.g. a cargo hold within the vessels hull form (or envelope). It is worth noting that compartments are defined as notional spaces constrained by six boundaries (top, bottom, aft, forward, port and starboard). Thus, the simplest compartment representation is a box, if all boundaries are planar. The increased complexity of the internal boundaries and the fact any of the boundaries can be the external envelope (the hull form definition we have been producing) leads to complex shapes. However, it is not possible to define the most complex compartments through this method. Therefore the facility is available to build up a more complex compartment by the merging of several other 'base' compartments. Whether the method of merging compartments is required will depend on the specific internal arrangement of each design [49].

Before creating any compartments, compartment categories (and their associated content types) are defined as a compartment's category can be selected prior to creation. If categories are not defined at this stage it is still possible to edit a compartment and set the required category at a later date. Content types are the actual contents loaded into compartments in a particular loading condition. Compartment Categories are used to group compartments according to their operational function.

The method followed to generate a basic compartment, is to specify a point within the compartment and let Surface/Compartment automatically select the nearest limits. This speeds up the process of defining the compartment. Note however, that in the event that Surface/Compartment 'guesses' a boundary incorrectly, we can edit the definition of the compartment by selecting the appropriate limit.

Besides the geometry of the compartments, some information required in the assessment of Stability, for instance, is based on the envelope's geometry. It is therefore useful to obtain the basis information (modifications will be required for regulations and items not modeled at any early design stage) from the true geometry model. Thus prior to releasing the calculation geometry the profile points and deck edge points are generated. The profile points are used in Tribon Calc to determine the wind profile, which is used by some of the stability criteria, when performing loading calculations and deterministic calculations. Deck edge points are used in Tribon Calc when performing loading calculations and deterministic calculations (as is required by some of the stability criteria), and when performing floodable length calculations.

In order to carry out the detailed naval architectural analysis in Tribon Calc/Hydro, the envelope, compartments and main internal surfaces must be released for use. As well as the geometry of items marked for release, the defined content types, compartment categories, profile and deck edge points are also included.

The steps that the students had to perform are shown in Figure 5-21 Workflow of Compartment.

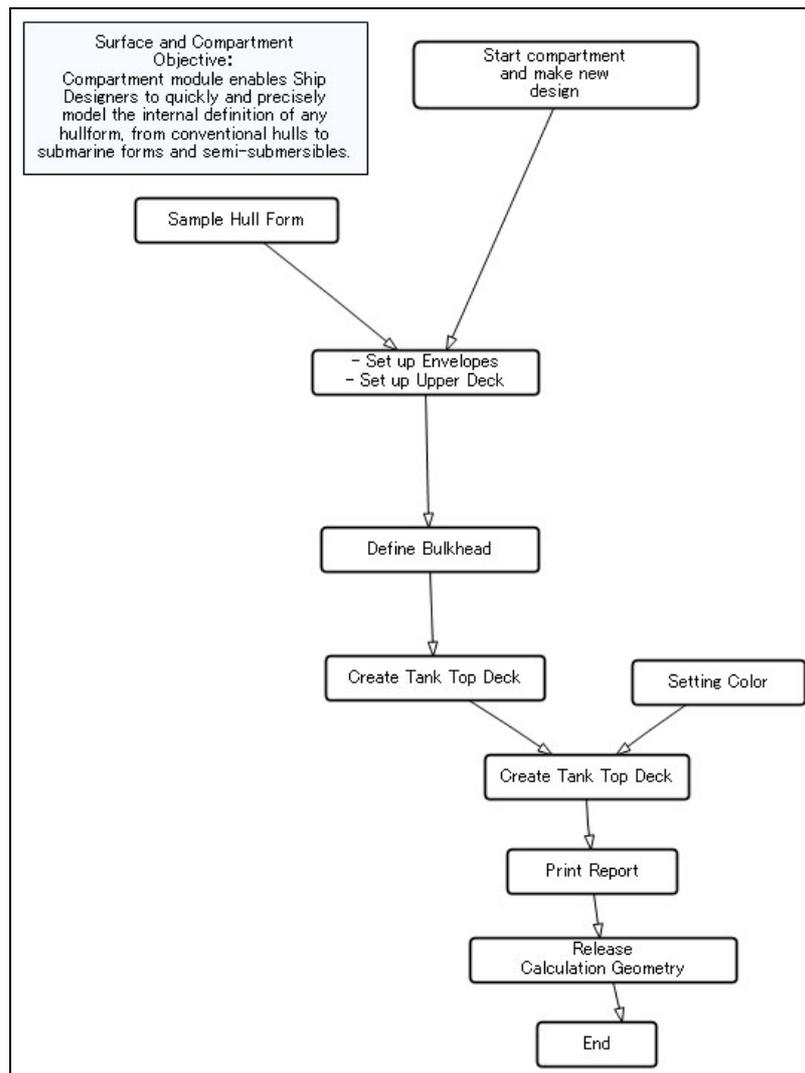


Figure 5-21 Workflow of Compartment

- Start compartment and make new design: Launch Surface & Compartment module and open the hull form created from the previous module. After finishing this task, users will see the screen displayed in Figure 5-22.

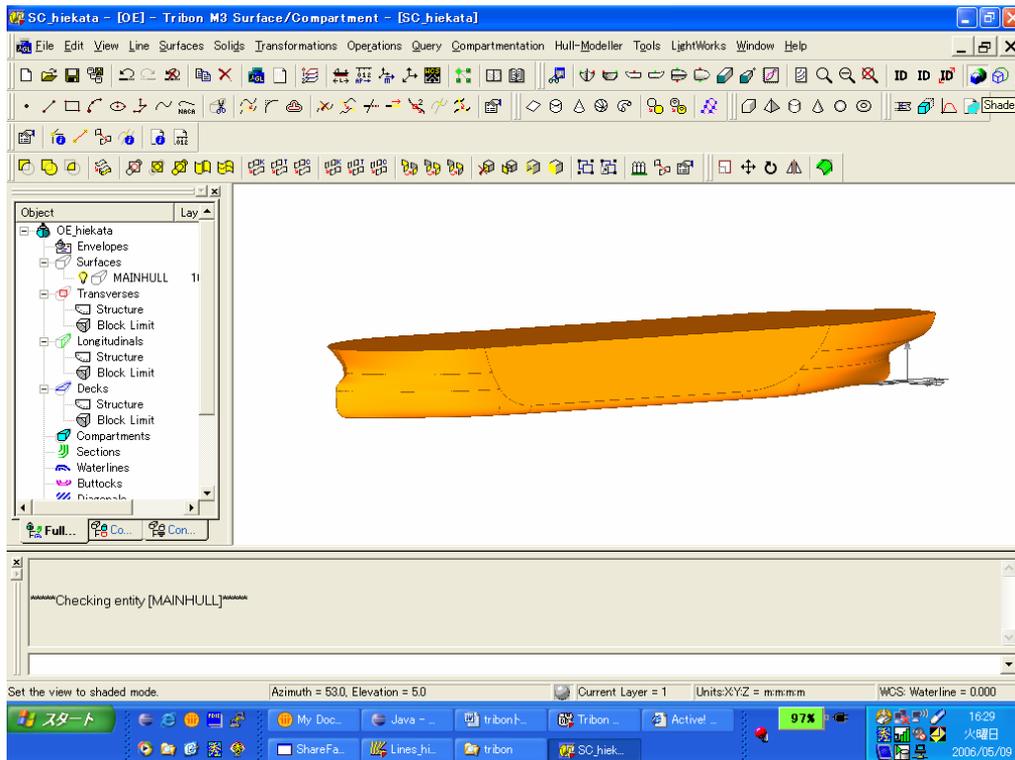


Figure 5-22 Start Surface/Compartment module

- Set up envelopes/upper deck and define bulkhead/tank top deck: Use Internal Surface Editor dialog, Figure 5-23, to set up envelopes/upper deck and define bulkhead/tank top deck. Figure 5-24 shows the final result of the tasks.

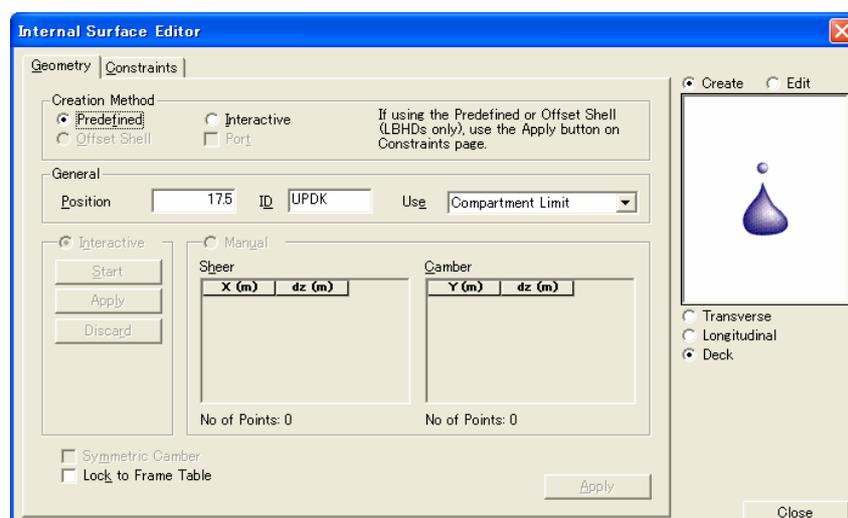


Figure 5-23 Internal Surface Editor dialog

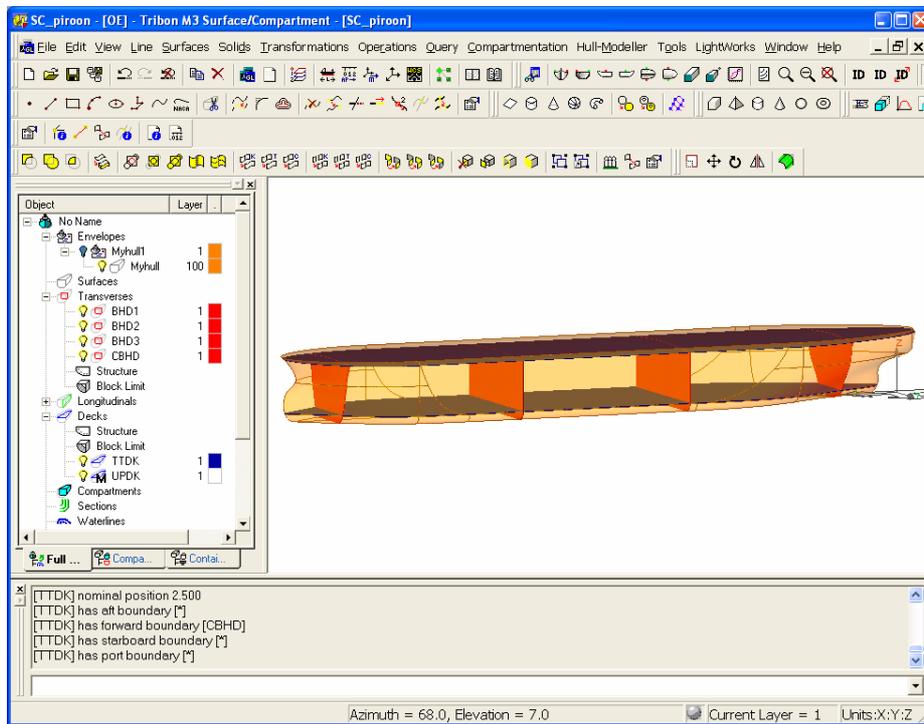


Figure 5-24 Hull form with envelope, upper deck and bulkhead and tank top deck set

- Setting color, print report and release calculation geometry: To set the color to the tank, click **Compartmentation** → **Compartments** → **General ...** to launch **Compartments General** dialog, shown in Figure 5-25 to set colors. Then, use the **Compartment Editor** to edit compartments (Figure 5-26). After that, print out the report using **Compartmentation** → **Report ...**, and release calculation geometry by clicking **File** → **Release** → **Calculation Geometry** (Figure 5-27).

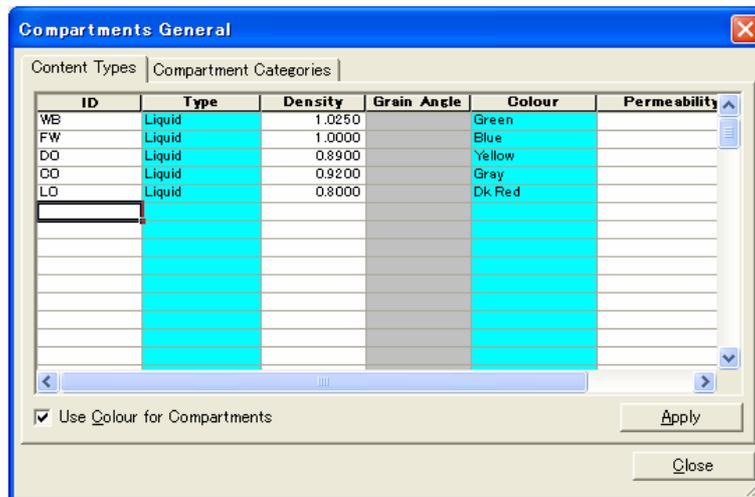


Figure 5-25 Compartments General dialog

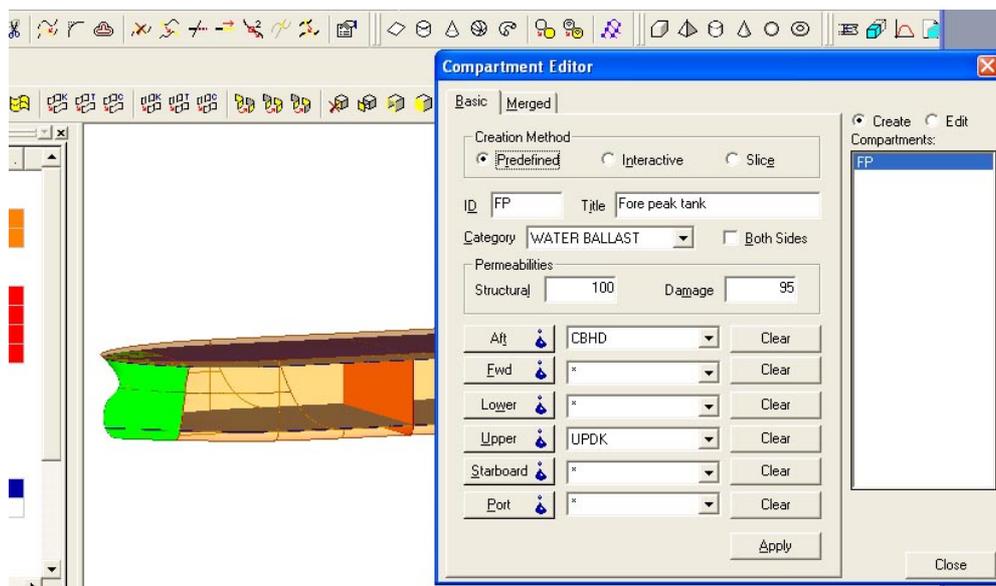


Figure 5-26 Compartment Editor

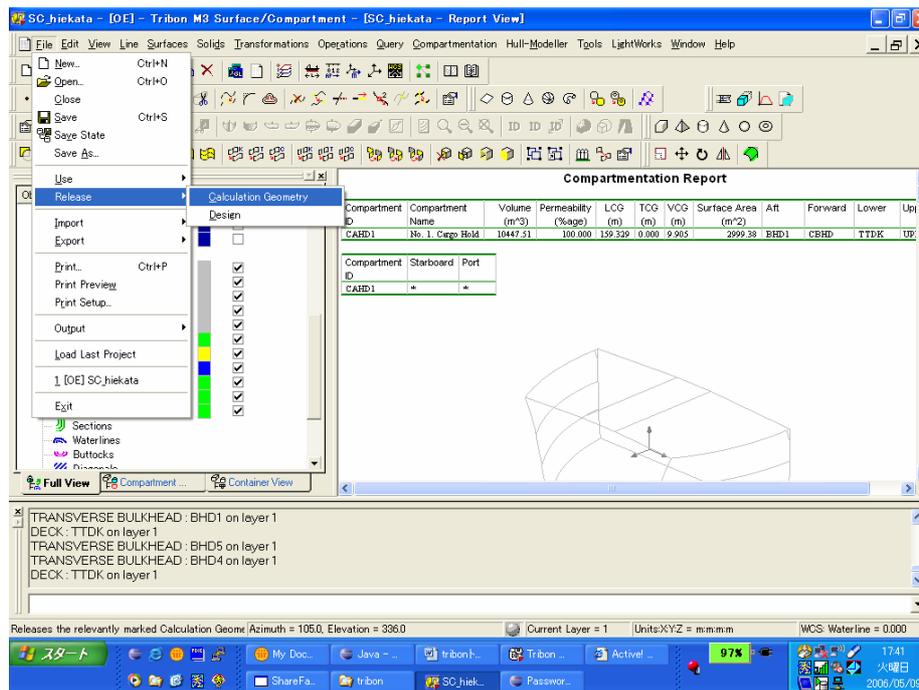


Figure 5-27 Releasing calculation geometry

5.3.6 Module 5: Calc/Hydro

Tribon M3 Calc offers the ship designer a comprehensive toolkit of Naval Architectural assessment routines including the calculation of hydrostatics, tank calibration, loading conditions, intact and damage stability, critical KGs, longitudinal strength, freeboard, tonnage and launching. Particularly sophisticated routines are included for damage stability assessment, using both deterministic and probabilistic methodologies, as well as more specialised calculations covering grain stability. Tribon M3 Calc also contains a routine that takes data collected during an inclining experiment and assembles and evaluates it in order to produce a report for submission to the authorities [48].

Comprehensive graphical and tabular output is available throughout Tribon M3 Calc in a form directly applicable to obtaining both owner and regulatory approval for a new design and for use in standard documentation such as tender responses, Stability

Booklets and damage stability assessments. Indeed a significant feature of the current version of Tribon M3 Calc is that the overall process is itself ‘report format oriented’.

The workflow of Calc/Hydro module is illustrated in Figure 5-28.

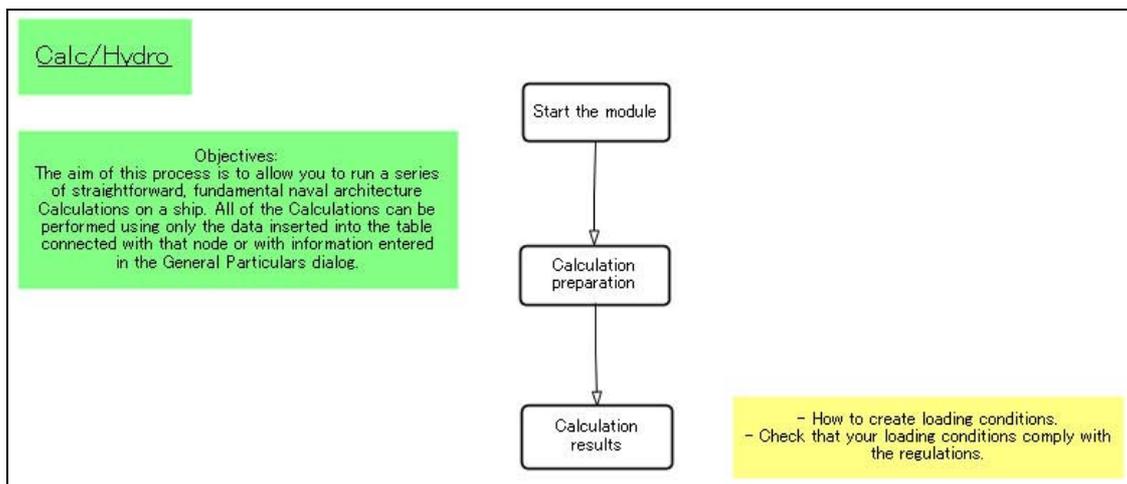


Figure 5-28 Workflow of Calc/Hydro

- Start the module: Launch Calc/Hydro module and create new Calc/Hydro Designs using the output file from the previous module.
- Calculation preparation: Right click on Visibility Check and select Calculate to start calculation (Figure 5-29).

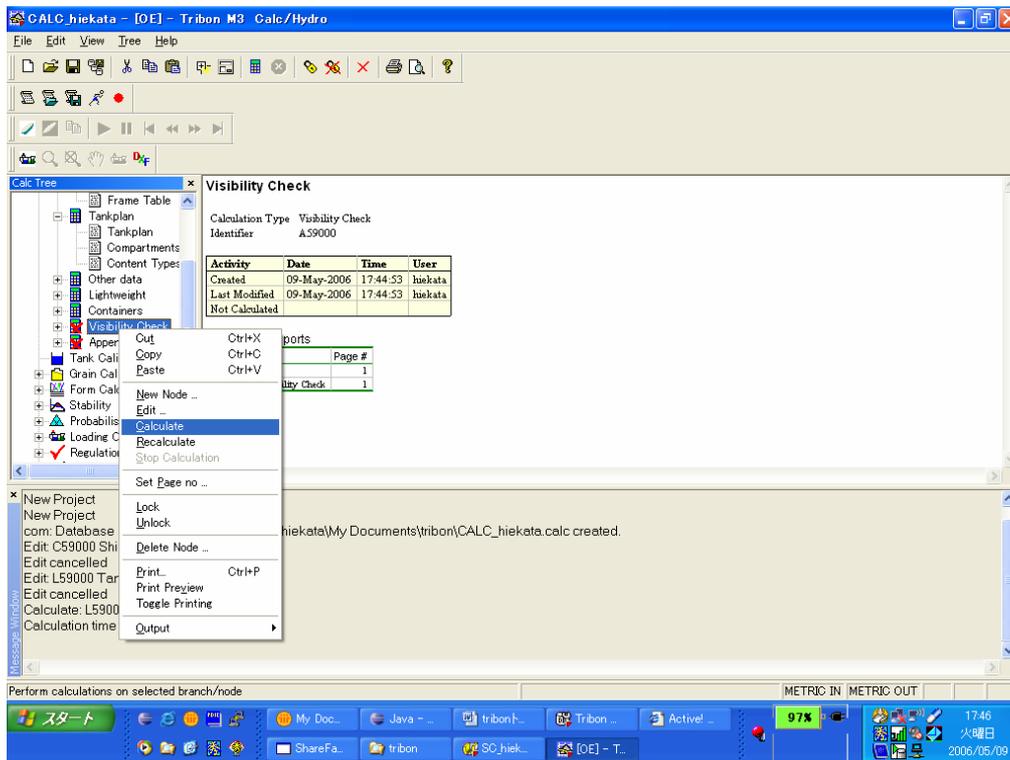


Figure 5-29 Calculate function

- Calculation results: View the results from the calculation (Figure 5-30).

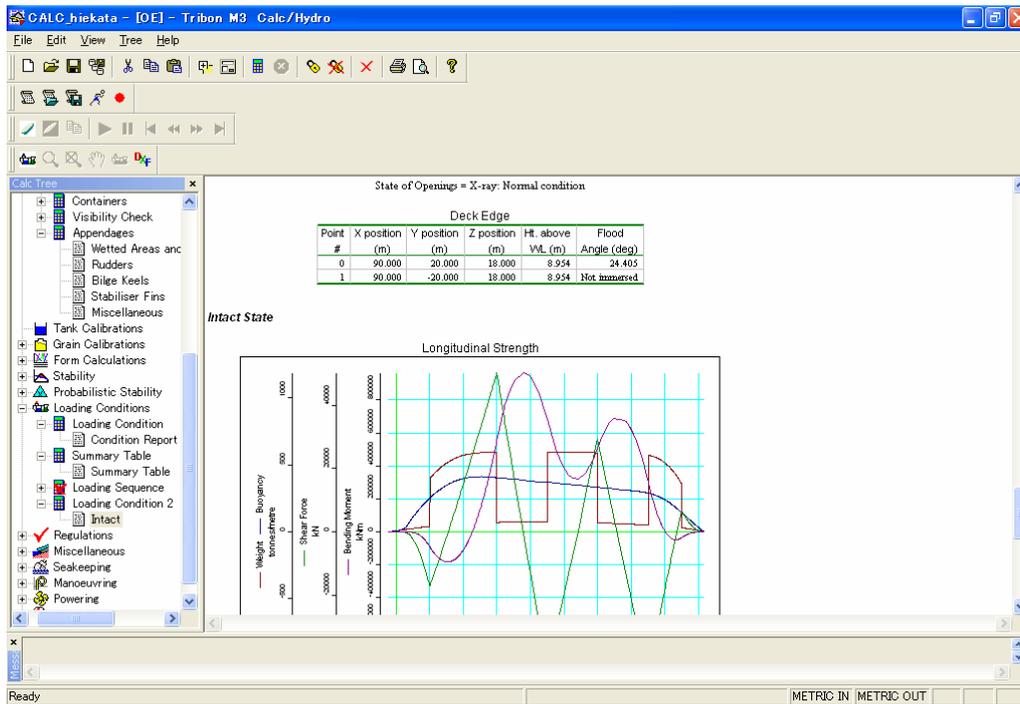


Figure 5-30 Calc/Hydro results

5.4 Experimental Class 2006

5.4.1 Objective

The objective of the experimental class 2006 was to verify the class analysis and improvement system that it can achieve one of the framework objectives, to help instructors improve class content and learning material.

5.4.2 Conditions

The conditions of this class are summarized in the Table 5-1.

Table 5-1 Training class 2006 conditions

	Student Group 1	Student Group 2
Training date	May 26, 2006	June 2, 2006
Number of students	3	3
Training module	- Project Creation - Lines Design - Patch & Curve - Compartment - Calc/Hydro	- Project Creation - Lines Design - Patch & Curve - Compartment - Calc/Hydro
Performing class analysis and improve method after class	Yes	No
Using real time monitoring system	No	No
Learning materials	Original version	New version improved from original version

This case study was arranged where the students used ShareFast for ship design learning with Tribon M3, a commercial CAD software package. Six students participated in this experiment. They were divided into two groups, three students each. In order to gather and analyze the class result of the first group to improve class efficiency of the second group, the class for the second group was conducted one week after the first group. The content of the classes is to teach students how to use Tribon M3 Initial Design in five modules of ship design, i.e. Project Creation, Lines Design, Patch & Curve, Compartment and Calc/Hydro, as illustrated in Figure 5-31. The real time monitoring system was not used in this experiment. The instructor was in the same room as the students to observe them learning CAD software using ShareFast system.

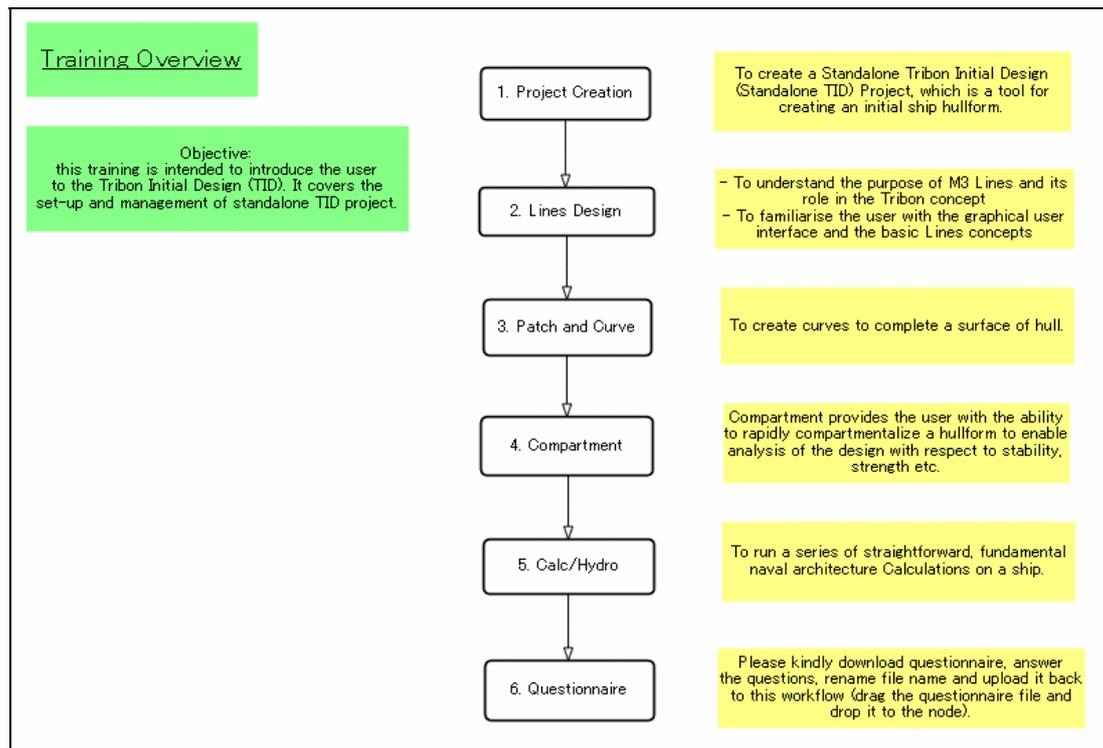


Figure 5-31 Overview of the Tribon M3 class

5.4.3 Approach

The approach was that the instructor created a workflow for each module, and added instruction documents and other necessary files to the related task nodes in the workflows. Students started learning from the first task of the first module, and moved to the next module after finishing the current module. Figure 5-32, for example, shows the workflow of Lines Design module. The students read the objective of the module written in the workflow first. Then, the students started the module by clicking each task node to retrieve instruction material describing how to work with the CAD software in the module. They were also able to add discussion thread to the workflows (modules) and task nodes (tasks) that they had problems with and needed to discuss with the teacher and other students. After each class, students were asked to fill in a questionnaire (see Appendix B) for class evaluation.

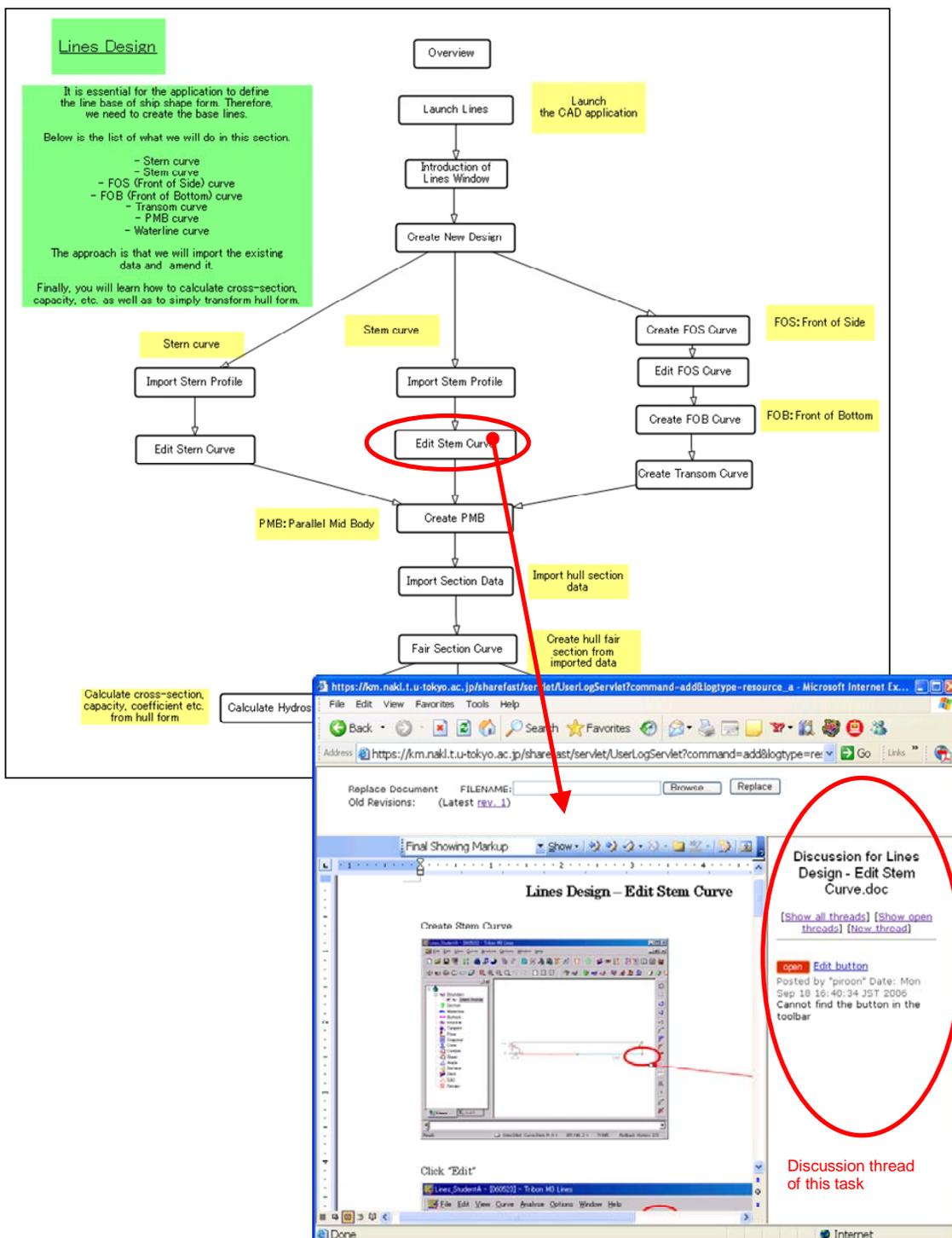


Figure 5-32 Work with Lines Design module

The first class was begun by briefly explaining to the students how to use ShareFast software in this learning experiment. Then, the instructor let the students follow the instruction via the workflows, and observed them in the same room. Instead of

answering the questions, the students were encouraged to put their query messages to ShareFast system via discussion threads.

Figure 5-33 shows how to work with ShareFast. The students, acting as knowledge recipient, learned design process through ShareFast workflows created by the instructor, and posted questions and errors messages to the instructor. The instructor, performing as knowledge distributor, analyzed those questions in order to improve the learning contents.

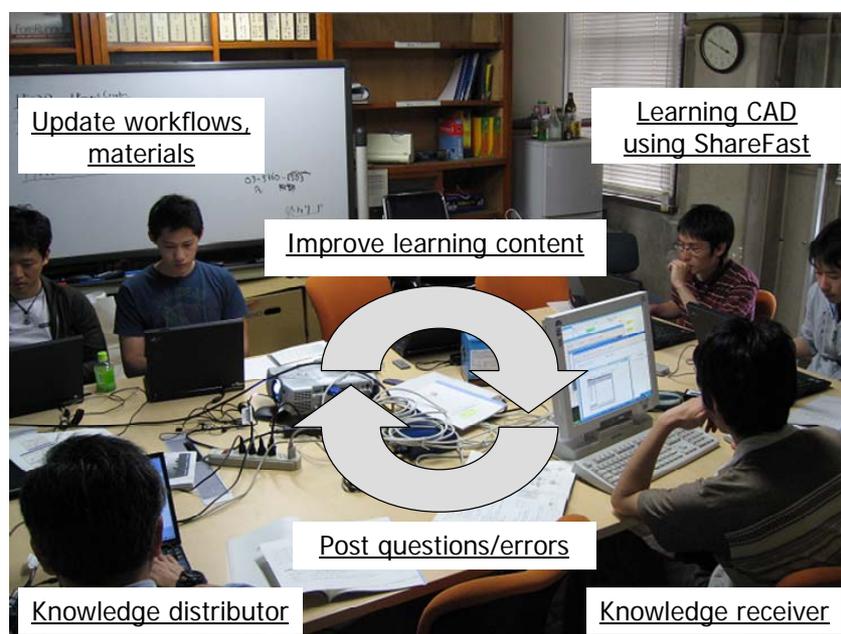


Figure 5-33 Working with ShareFast

5.4.4 Class Analysis and Improvement

After the class, the instructor conducted class analysis from log file keeping tracks of student's activities. From this log, it was possible to make graphs showing the time duration that students spent on each task and module. Figure 5-34 shows the time duration of each task of Patch and Curve module, while Figure 5-35 describes the result of each module of this class. From the graphs, it was able to know the tasks that students spent too much time on than is necessary. This log, additionally, could tell us some

students' learning behaviors. For instance, the instructor found from log file, illustrated in Figure 5-36, that student 3 performed the tasks "Complete the surface", "Check/adjust Isophotes" and "Release the surface" of the Patch & Curve module, and continued to the task "Surface and compartment" of the Compartment module. After that, he had to go back to perform the tasks of Patch & Curve module again. Later on, the student was asked about this and he said that it was because he could not continue the task of the Compartment module as the previous tasks of the Patch & Curve module had not been finished yet. This kind of behavior can indicate that student was unclear about the learning material, and consequently, it should be simplified.

Furthermore, it was ensured that discussion threads were helpful not only to handle class communication, but also to store students' question and answer messages during the class. It was later on valuable for instructor to understand the weak points of the class, and how to solve them.

From all of the analytical techniques mentioned above, the instructor carefully refined the learning materials of trouble-causing tasks, and polished some unclear and time-consuming module workflows. For example, in Patch & Curve module, there were seven problems posted by students to discussion threads. The instructor tried to find the causes of those problems and fix them to improve the class. Table 5-2 shows some messages in discussion threads of Patch & Curve module and their causes as well as how the problems were responded.

For example, the learning material in the "Complete the Surface" task of Patch and Curve module was added more detailed information of how to make a new curve and where it should be made. (See Appendix B for the learning material of this task before revising and Appendix C for the one after revising)

After that, this revised content was used to conduct the second ship design learning class in the following week, which it was also applied the same teaching approach as the previous class. The outcome revealed, as expected, that students in the latter group posted less query messages using discussion threads than the previous group

of students did. Moreover, the graph from the second class log file, illustrated in Figure 5-37, indicates that the average class duration was cut from the first class by 17 minutes, partly resulting from the time duration in Patch and Curve module that was significantly reduced from 1 hour 11 minutes to 42 minutes.

Table 5-2 Some messages from the discussion threads of Patch and Curve module

Message	Cause	Response
Cannot complete the surface	Students didn't know where to add new curves	Explain more about where to add curves to complete surface in the material
Don't know the meaning of icons	No explanation in the learning material	Add description of accept, edit and profit icons to the material
Don't know how to import hull form	No explanation in the learning material	Add more information about how to do in the material
Cannot find the menu for 'Use Hull Form' command	No explanation in the learning material	Add 'File→Use→Hull Form' to the material

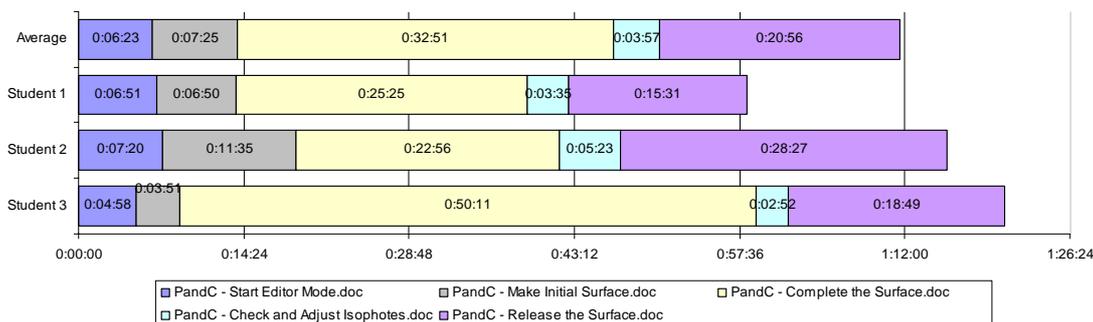


Figure 5-34 Patch and Curve (class one) result

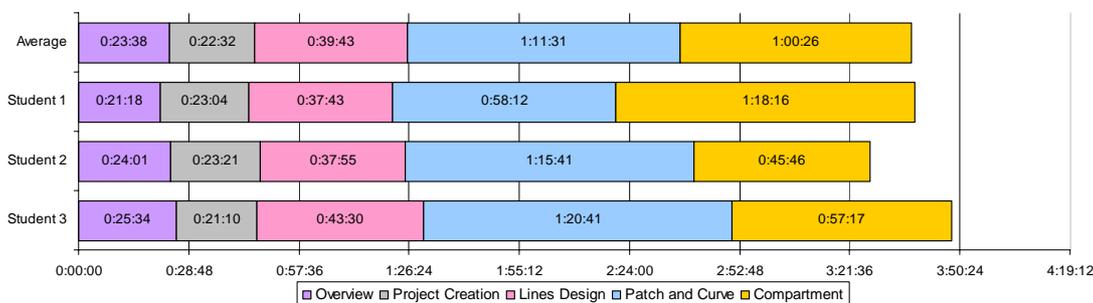


Figure 5-35 Class one duration result

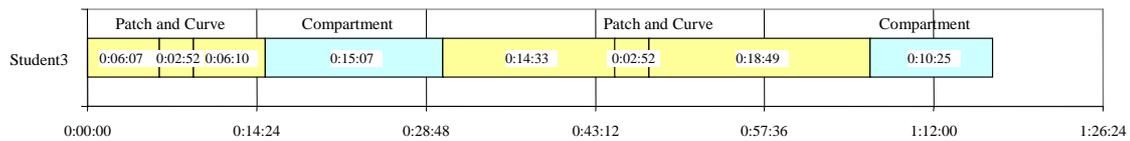


Figure 5-36 Analysis of student three

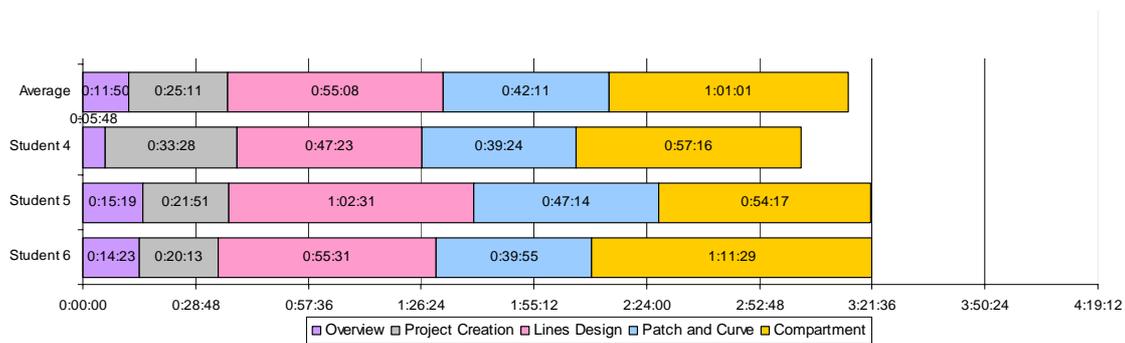


Figure 5-37 Class two duration result

5.4.5 Results

The observation result revealed that the students had no problem with how to use ShareFast even though it was their first experience with the software. However, it seemed that they tended to ask the instructor immediately after they found any difficulties of using the CAD software by the instruction materials.

Furthermore, it turned out to be crucial evidence that learning how to use CAD software for ship design based on visualized workflows was very well received. Students confirmed that workflow images did help them understand the design processes more clearly.

Although the results from the graphs made from the log files shown that the average class duration of group two students was cut from the first class by 17 minutes, resulting from the class analysis and learning material improvement method, but the results of the both classes still were not satisfying. For example, the students spent longer time than expected in the Patch & Curve and Compartment modules for group one, and

Lines Design and Compartment for group two. Moreover, the students could not complete all the tasks in Lines Design, Compartment and Calc/Hydro modules for group one, and Lines Design and Calc/Hydro modules for group two. The main reason, based on our analysis, was that there was no system to tell the instructor when the students had any problem during the classes, so they spent time longer than our expected time to solve problems without any help.

All of the students were asked to fill in a questionnaire. The outcome of the questionnaire from the both classes is summarized and shown in Table 5-3, Table 5-4 and Table 5-5.

Table 5-3 Section 1 result (2006): Knowledge of Tribon M3 Initial Design

	Before the Class	After the Class
- Overall knowledge of Tribon M3 Initial Design	0	6
- Ability to perform 'Lines Design' module	0	6.33
- Ability to perform 'Patch and Curve' module	0	5.33
- Ability to perform 'Compartment' module	0	4.83

(0 – 10; 0 = Not at all; 5 = Understand some; 10 = Understand very well)

Table 5-4 Section 2 result (2006): Questions about ShareFast software application

	Agree	Partly agree	Neither nor	Do not agree
- The software is easy to use.	33.33%	50%	0%	16.67%
- Learning ship design by workflow helps understand design process more easily.	50%	33.33%	16.67%	0%
- This software helps shorten the time to study ship design.	50%	33.33%	16.67%	0%
- Discussion function is useful for communicating with other students and instructor	16.67%	16.67%	33.33%	33.33%

Table 5-5 Section 3 result (2006): Class evaluation

	Agree	Partly agree	Neither nor	Do not agree
- This class has an appropriate content.	33.33%	50%	16.67%	0%
- Time duration of this class is appropriate.	0%	50%	33.33%	16.67%
- Student's interest for ship design using Tribon M3 raised during the class.	50%	16.67%	0%	33.33%
- The class as whole fulfilled the expectations.	33.33%	16.67%	50%	0%
- Students prefer to study Tribon M3 using ShareFast rather than normal way.	16.67%	33.33%	50%	0%

5.5 Experimental Class 2007

5.5.1 Objective

The main objective of the experimental class 2007 was to evaluate the real time operation monitoring system, newly developed and introduced in this experiment, that it can help the instructor monitor students and control the class to finish within the expected time, which is one of the framework objectives. This newly developed monitoring system is also believed to solve the problems that we previously found in the class 2006 - the students could not finish the tasks on time, and could not complete all the steps in some modules.

5.5.2 Conditions

Table 5-6 below summarized the conditions of the 2007 class.

Table 5-6 Training class 2007 conditions

	Student Group 1	Student Group 2	Student Group 3
Training date	June 1, 2007	June 6, 2007	June 15, 2007
Number of students	3	3	6
Training module	- Project Creation - Patch & Curve - Compartment	- Project Creation - Patch & Curve - Compartment	- Project Creation - Patch & Curve - Compartment
Performing class analysis and improve method after class	Yes	Yes	No
Using real time monitoring system	Yes	Yes	Yes
Learning materials	Original version	Original version	New version improved from original version

There were three groups of students in class 2007. The numbers of students are 3, 3, and 6, respectively. Only three modules of Tribon M3 Initial Design software were taught in this year - Project Creation, Patch and Curve, and Compartment. The real time operation monitoring system was introduced in this year's experiment. Class analysis and

improvement method was conducted after group one and group two classes, and the improved learning materials were used in group three class.

5.5.3 Approach

Figure 5-38 shows how the students used the ShareFast system as a CAD operation navigator. The students will read the instructions from workflows and added learning materials on the right hand side screen, and perform CAD operation on the left hand side screen.

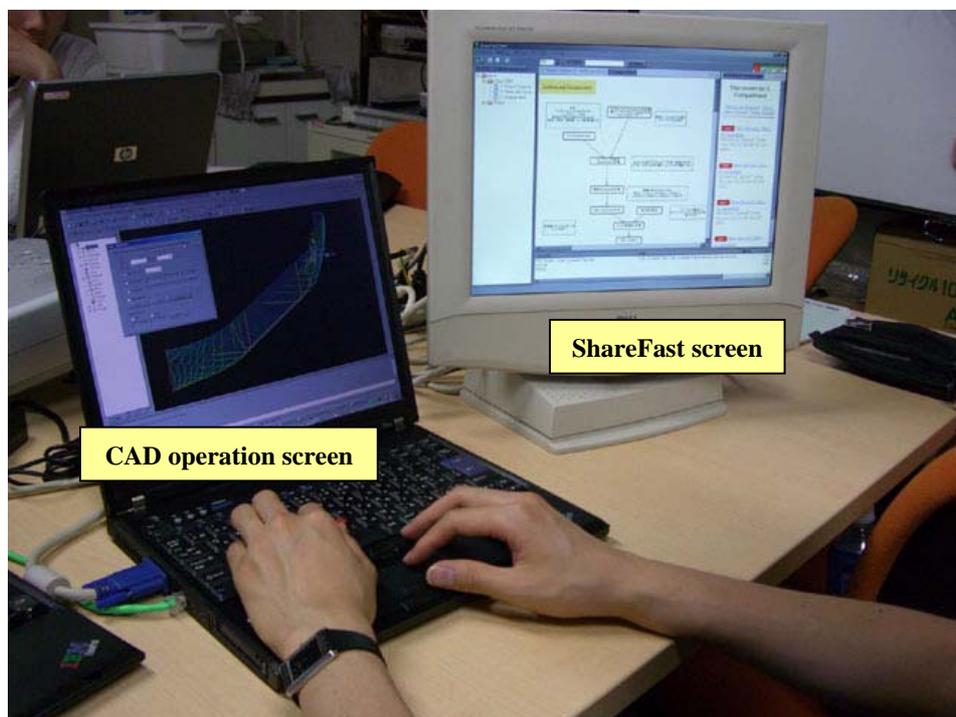


Figure 5-38 ShareFast as CAD operation navigator

The flow of the class was the same as the 2006 class. It began with CAD software and ShareFast system introduction. Then, the students performed CAD operation learning. At the end of the class, the students were asked to fill in the questionnaire.

Moreover, in order to utilize and verify the discussion thread function, the students were asked to look at the discussion messages in the system first when they have any questions. If their questions are not similar to any messages in the system, then they are allowed to ask the instructor. After the question is answered, the instructor will put that question together with its answer to the discussion thread system, so that it can be used by other students if they have the similar problems.

5.5.4 Real Time Operation Monitoring System

As mentioned before, the newly developed real time operation monitoring system was utilized in this experiment. Figure 5-39 shows how the system works. During the class, the instructor will be able to see the students' progress of CAD operations captured by the system. It can tell what tasks the students are working on, and how long they have been in those tasks, in graphical image. The instructor will know from this graph if any students are spending too long time on an operation task. Consequently, the students can get helped before they spend time any longer, and the class duration as a whole can be effectively controlled.

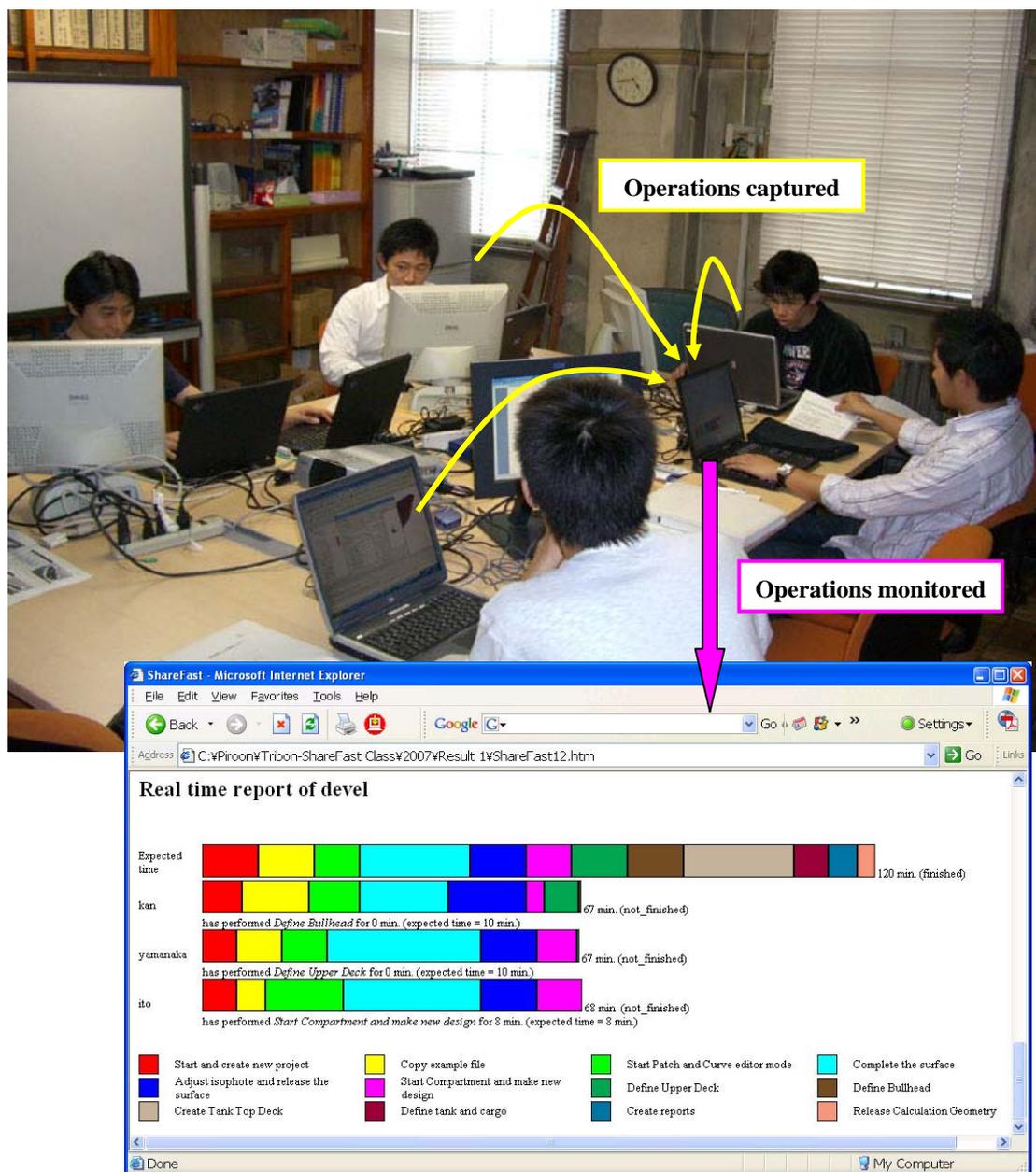


Figure 5-39 CAD operations captured and monitored

5.5.5 Results and Results Analysis

The results were satisfying as all of the students from three groups could complete every task of every module this year. Moreover, the learning duration results of the class

one, two, and three, illustrated in Figure 5-40, Figure 5-41, and Figure 5-42, respectively, show that 11 out of 12 students could finish the class within the expected time.

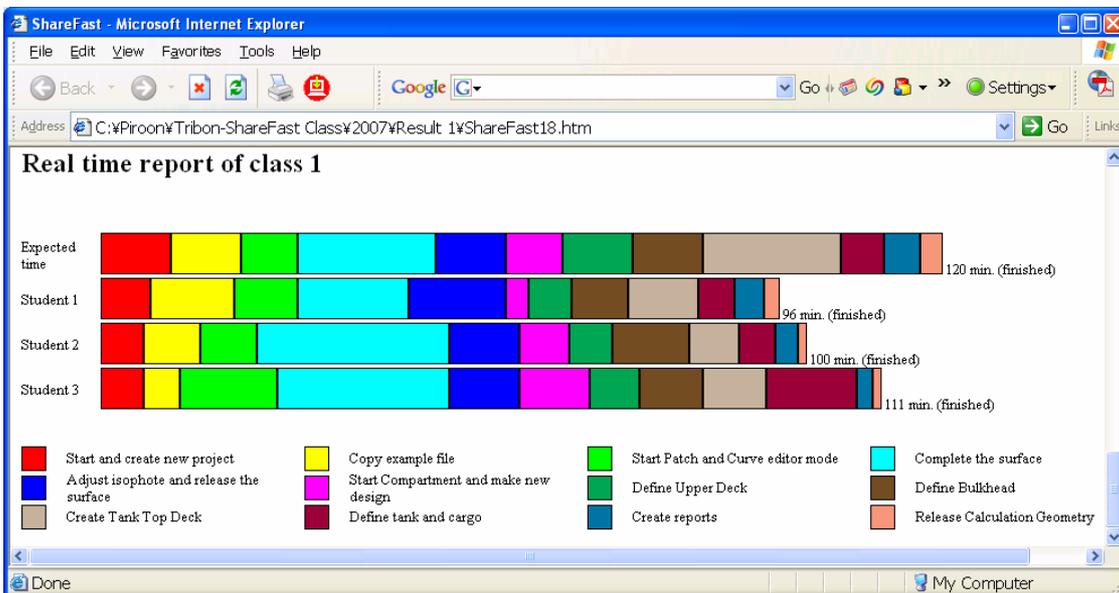


Figure 5-40 Results of class one

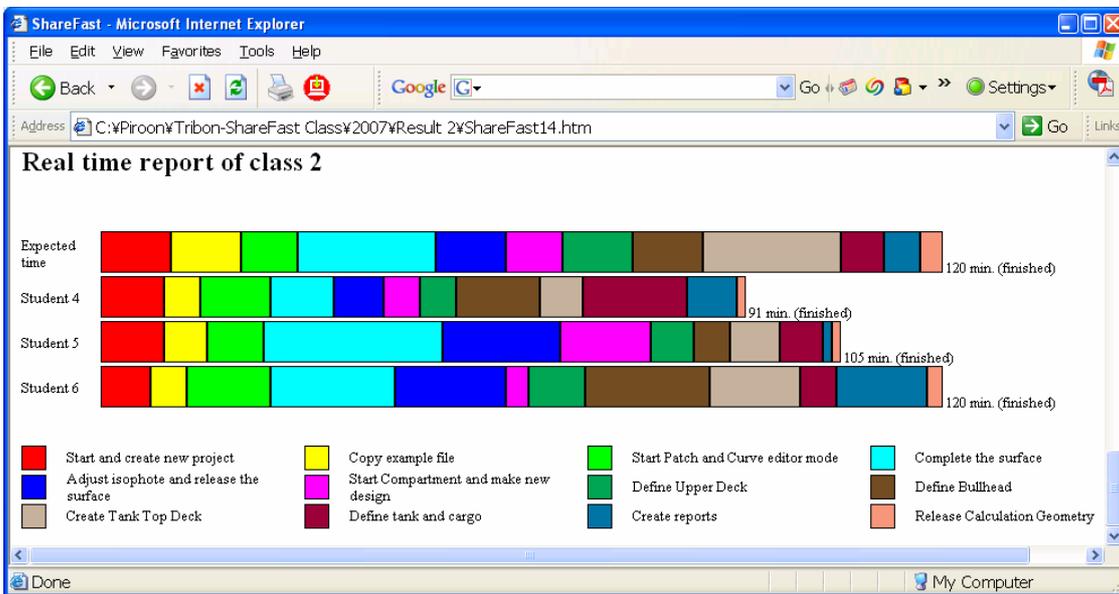


Figure 5-41 Results of class two

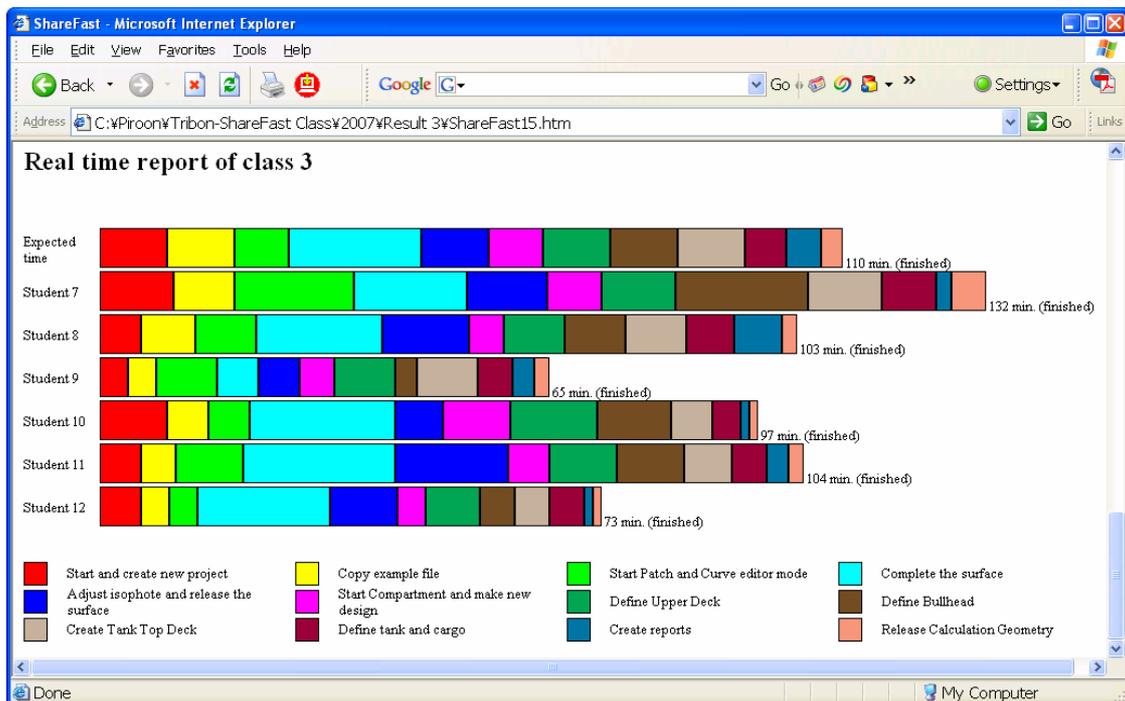


Figure 5-42 Results of class three

We also found that the number of questions asked to the instructor during the classes was decreasing from the first group to the last group of students, 22 questions in class one, 6 questions in class two, and 4 questions in class three, as shown in Table 5-7. Based on our observation, it was because, first, all the errors in the learning materials were found and fixed after the learning material improvement method performed after class and, second, the effective use of discussion thread function. When students have any question, they could look for the answer through the messages kept in the discussion thread function by themselves. This helped shorten their time to wait for the instructor to come and help them answer the question.

Table 5-7 Question and answer messages in the discussion thread of class 2007

Class no.	Module	Question no.	Question	Answer
1	Project Creation	1	Unclear number in the Stem Overhang field (8.5 or 3.5)	It's 3.5
		2	Don't know how to download and save	Right click and select "Download" menu

		3	Can't see the downloaded file	Select "Refresh" from right-click menu
	Patch & Curve	4	Error message from Tribon when importing file	Just ignore it
		5	底面が埋まっていない	底面は、水平基準面と重なっているため、パッチが貼られていないように見える場合があります。CAD の表示上の問題で、実際は貼られています。
		6	どのように切ったら面が埋まるのか分からない	基本的に、三角形か四角形になるように切ります。辺が曲線の場合、四角形でも上手くパッチが貼られない場合があります。その場合は、その曲線を含む三角形と、もう一つの四角形に切り分けてみましょう。
		7	線の消し方が分からない	左のツリービューの要素のクリックでオン・オフの切り替えができます。
		8	Can't make new curves	You have to specify a point to make new curve first
		9	Section などの線の追加の仕方が分からない	マニュアルの3~5番を見る
		10	Do not understand the objective of this step	Read the objective written in the workflow and material
		11	NewHull が Create できない	Create をクリックした後に、デフォルト名を変更して名前を入力して下さい。(例: MyHull)
		12	Do not know where the Lines View window is	It is the first window after launching the tanker file.
	Compartment	13	Can't find "Shaded Button"	マニュアルに赤丸がついている、表面が描画された立方体と球が書かれているアイコンです。
		14	Can't import hull form	Click "Use" instead of "Import"
		15	透明にする対象は？	エンベロープのトップ項に表示されている、船体外形を半透明にします。
		16	エンベロープとは？	マニュアルを見る
		17	Regenerate でエラーが出る	UPDK1 という作った記憶のない DECK が出来ていて、それが regenerate 出来なかった。ツリービューから UPDK1 を選択し、右クリックして Delete を行い、それから regenerate を改めて行う

		18	How to change the icon from orange to white	Click at the small orange icon.
		19	Bulkhead って何ですか？	Bulkhead とは、隔壁のこと。 CBHD = Collision Bulkhead: 船首隔壁 衝突時の安全性などのために、位置などが規定されている。
		20	ポインタの形状が変わって、操作が出来なくなった	どこかのボタンを押してしまった等で、何らかの操作が進行中になっています。 Esc ボタンでその操作を終了させてください。
		21	ScreenCapture 画像の間違い	一番下のスクリーンキャプチャ図では、CBHD より船首側にもタンクトップデッキが作られてしまっているが、Constraints タブの Forward(前川の起点)を CBHD に指定しておけば、CBHD より後ろにしか作成されない
		22	Can't create tank	Forgot to perform 表示色の設定
2	Project Creation	1	What is "BP"?	Click "Diagram" button and see the explanation.
		2	Forgot to click "Diagram" button	No problem. Just continue to the next step.
		3	Cannot perform "Select" the project	If your project name is Red, it means you have already selected it.
	Patch & Curve	4	Add to Hull Form Definition ができない	Invalid name~ と出ていたら、Hull の命名に問題がある。 Hull を Rename してください
		5	How to open "Patch Option" window?	See page two in the manual.
	Compartment	6	タイトルが適切でない	表示色の設定だけでなく、タンク内容の定義も行うため、タスク名の変更を検討すべし
3	Patch & Curve	1	Window メニューに New Oblique Window がない	おそらく、Lines View のウィンドウの Window メニューを見えています。 Patch and Curve Editor のウィンドウをアクティブにして、そちらの Window メニューを見てください

	Compartment	2	ファイル名を入力する欄がない	「ファイル名は SC.(自分の名前)としてください。」とありますが、ファイル名を入力する欄がないじゃないかという質問がありました。 ウィンドウ左下の New Design の右側で、Cancel ボタンの左側にテキストボックスがあります。そこの欄に入力して下さい。
		3	このタスクは、上手く Patch が作れなかった人の救済用です	このタスクは、必須のタスクではありません。 上手く Patch が作成できなかった人は、TA の指示に従って、このタスクに登録してある Patch ファイルをダウンロードし、自分のファイルと置換します。 Patch に失敗した人は TA に指示を仰いでください。
		4	Camber の値が入力できない	いったん Apply して、その後もう一度 UPDK を EDIT してみてください。

The results from the questionnaire is summarized and displayed in Table 5-8, Table 5-9 and Table 5-10.

Table 5-8 Section 1 result (2007): Knowledge of Tribon M3 Initial Design

	Before the Class	After the Class
- Overall knowledge of Tribon M3 Initial Design	0	5.67
- Ability to perform 'Project Creation' module	0	5.75
- Ability to perform 'Patch and Curve' module	0	6.33
- Ability to perform 'Compartment' module	0	5.14

(0 – 10; 0 = Not at all; 5 = Understand some; 10 = Understand very well)

Table 5-9 Section 2 result (2007): Questions about ShareFast software application

	Agree	Partly agree	Neither nor	Do not agree
- The software is easy to use.	58.33%	41.67%	0%	0%
- Learning ship design by workflow helps understand design process more easily.	50%	41.67%	8.33%	0%
- This software helps shorten the time to study ship design.	58.33%	25%	0%	0%
- Discussion function is useful for communicating with other students and instructor	25%	33.33%	41.67%	0%

Table 5-10 Section 3 result (2007): Class evaluation

	Agree	Partly agree	Neither nor	Do not agree
- This class has an appropriate content.	58.33%	33.33%	8.33%	0%
- Time duration of this class is appropriate.	58.33%	41.67%	0%	0%
- Student's interest for ship design using Tribon M3 raised during the class.	58.33%	33.33%	8.33%	0%
- The class as whole fulfilled the expectations.	41.67%	41.67%	16.67%	0%
- Students prefer to study Tribon M3 using ShareFast rather than normal way.	58.33%	33.33%	8.33%	0%

Chapter 6. Discussion

The results of the experimental classes in both years proved that the idea of using workflow to support CAD software learning is well received. Workflow plays a vital role in instructing learners through more well-structured design process. Log file was able to help the instructor analyze class quality in many points of view. As it can be used to make an analytical graph in the end of group one class of 2006 experiment, log file paved the way to the class content improvement, consequently resulting in shortened class duration and trouble reduction.

The real time monitoring system was verified to be a crucial function in the 2007 experiment. With this function, the instructor could see the learning progress of the students in real time and notice if any students are performing behind schedule. As a result, the instructor could help those students not to be so late in the operation. The result of the class 2007 showed that the learning duration could become more well-managed when using the monitoring system than class 2006's result, i.e. all of the students in class 2007 could complete every task of every module, and 11 out of 12 students could finish the class within the expected time. It satisfied one of the framework objectives, which is to establish a more efficient education for CAD operation, as it helped control the class to finish on time with correct design output, according to the design reports generated at the end of the classes.

The answers received from the students via the questionnaire were also useful for the framework analysis. For the 2006 experiment, in section 1, it showed that all students, selected based on a voluntary basis, had no background knowledge and experience of the CAD software at all before the classes. However, they confirmed that, after taking the class, their understanding of the software had been improved to some extent. Questions about ShareFast software were asked in section 2. The answers were satisfying as 83% of

the students agreed that the software was easy to use and learning ship design by workflow helped them understand design process more easily. Conversely, 67% of the students did not think that the discussion thread function was very practical for the classes. The answers of the questions in section 3 explained to us about their feelings toward the whole class. The outcome revealed that 83% of the students felt that this class had an appropriate content, but time duration was not so appropriate, according to 50% of the students. Finally, the students wrote down comments and suggestions in section 4. Some messages from them were that it was good to have an opportunity to learn CAD from this class because it would be difficult to learn by themselves. Additionally, the learning instructions in the Compartment module were quite difficult to understand, so it would be good to simplify them and add more instructive details.

In the 2007 experiment, all the students had no background knowledge and experience of Tribon M3 software package at all before the classes, according to the answers in section 1 of the questionnaire. However, their understanding of the software had been improved to some extent. In section 2, the answers revealed that all of the students agreed that the ShareFast software was easy to use and it helped shorten their time to study. 91.67% of the students said that learning by workflow helped them understand design process more easily. 67% of the students felt that the discussion thread function was very practical for the classes. The answers in section 3 told us about their feelings toward the whole class. The results showed that 91.67% of the students felt that this class had an appropriate content, their interests for ship design raised during the class, and they preferred to study Tribon M3 using ShareFast rather than the normal way. All of the students said the time duration of the class was appropriate.

The results from the questionnaire in both years indicated that the students from class 2007 were more satisfied by the class and the framework than the class 2006's students. This mainly resulted from the class duration adjustment and learning material improvement based on analysis from discussion messages and students' opinions. The decrease in the numbers of the learning modules of CAD software from class 2006 to class 2007 also accounted for the better satisfaction.

According to the result from the questionnaire, however, the discussion thread function performed not very well in the experiment. From the instructor's observation during the classes, it seemed that the reason was that the experimental classes were conducted on small groups of students, where everyone, including the instructor, was in the same room. Hence, the students found it more convenient to ask questions directly to other students or the instructor. Nevertheless, it is convincing that the discussion thread function would be a significant feature when class communication can not take place on a face-to-face basis.

From the experiment, it is proved that this educational framework is in line with many principles of Newcastle Protocol, including ease of use, short familiarization time to obtain key results, minimal naval architecture knowledge and experience assumed, student focused help and tutorials, and ease of installation to standard networked university hardware. However, due to the experiment limitations, other principles of the Protocol have not been verified in this experiment. Those are transparent calculations, short time to gain initial design parameters, and ease of integration with other software packages. The framework was also proved from the experiment that it can support standardized software outputs of lines plan and body plan suggested by the Protocol when using basic data sheet and sample CAD data as input information. In order to ensure that the framework can cover the rest of the principles and concepts of the Protocol, it is needed to carry out further experimental classes that would be able to confirm them.

Although the experimental classes in 2006 and 2007 used the same CAD software to teach, it is believed that this educational framework using ShareFast can also support other CAD software, as the framework was designed to be independent from the type of CAD software.

The experimental case studies in this paper, however, were conducted with merely small groups of students. It might not be enough to prove every area of this ShareFast-based educational framework functions. Moreover, the experimental classes were conducted on the topic matter only consisting of self-learned items. There was no

group collaboration required, so we cannot evaluate how well the framework can cope with lag times in collaborative feedback among students and instructors. Hence, the authors need to work more on further case studies of bigger number of students and more complicated study scenario.

Chapter 7. Conclusion

In this thesis, a CAD educational support framework using ShareFast, a client/server document management system based on workflow, was proposed and examined. The system offered several functions targeting two main objectives- 1) making it easy to maintain and improve learning materials, and 2) establishing faster and efficient education for CAD operation. The experimental classes were conducted to verify the framework in year 2006 and 2007. Through the experiments, the framework was proved to be satisfying for its objectives. Using class analysis and improvement method, the learning material was able to improve as it could shorten learning duration and reduce number of students' questions asked. Moreover, the framework was able to establish a faster and more efficient CAD education as it could control the classes to be finished within the expected duration by means of the monitoring system.

Acknowledgements

This thesis would not have been possible without the support of many people. First and foremost I offer my sincerest gratitude to my advisory professor, Prof. Hiroyuki Yamato, who has supported me throughout my thesis with his patience. Also thanks to my supervisor, Mr. Kazuo Hiekata, who read my numerous revisions of this thesis and every of my publications, and helped make some sense of the confusion. Without these two persons, this thesis would not have been completed or written.

In the various experiments and technical problems I have been aided by Mr. Masakazu Enomoto. Ms Junko Mizuno always helped me handle all the administrative matters. Wataru Oishi, my tutor and friend, helped me go through my hard time during the first year as a foreigner in Japan, the country I had never been to, and a new comer of the laboratory. I would like to thank them here for their best help and support.

In my daily research I have been blessed with a friendly and cheerful group of fellow students. Dinariyana Anak Agung Bagus, Ryo Kakuta and Kouichi Inoue have provided good suggestions about my work and daily life as the seniors of the laboratory. Yohei Minatoya helped me a lot in computer programming and often taught me new Japanese words. Kohta Tsubouchi, Sho Tsujimoto and Maytouch Udommahuntisuk kept us entertained with their good sense of humor. Tetsuya Kakinuma and Yuji Yamanaka were really good companions, giving me a hand every time I was in trouble.

Also, I would like to thank Matsushita Electric Industrial Company Limited for awarding me a Panasonic Scholarship to pursue my master's degree in Japan, and always taking care of me in every aspect. Last but not least, thanks to my parents, and numerous friends who endured this long process with me, always offering support and love.

References

- [1] Eder, W.E., Engineering Design Education: Situation Report, *Design Studies*, 12, 4, October 1991, pp. 261-267
- [2] Cynthia, J.A., Monica, E.C., Jennifer, T., and Robin, A., Comparing freshman and senior engineering design processes: an in-depth follow-up study, *Design Studies*, 26, 4, July 2005, pp. 325-357
- [3] Boris, A., and Viktor, P., Intelligent tutoring system for training in design and manufacturing, *Advances in Engineering Software*, 35, 7, July 2004, pp. 461-471.
- [4] Field, D.A., "Education and Training for CAD in the Auto Industry", *Computer-Aided Design*, 36, 14, December 2004, pp. 1431-1437
- [5] Ye, X., Peng, W., Chen, Z., Cai, Y. 2004 Today's Student, Tomorrow's Engineers: an Industrial Perspective on CAD Education, *Computer-Aided Design*, 36, 14, pp. 1451-1460
- [6] Kuo, C., MacCallum, K.J. 1984 Computer Aided Applications in Ship Technology, *Computers in Industry*, 5, 3, pp. 211-219
- [7] Wright, P.N.H., Hutchison, K.W., White, G.D.J. 2006 The Use of Tribon Initial Design for Teaching Ship Design, *Proceedings*, 9th International Marine Design Conference, May, Ann Arbor, MI, pp. 699-722
- [8] Storch, R.L., Singh, H., Lim, S.G. 2005 Education and Training Software for Functional Volume Design: "AccomDesign", *Proceedings*, 12th International Conference on Computer Application in Shipbuilding, Busan, Korea, pp. 461-474
- [9] Wright, P.N.H., Birmingham, R.W. 2006 Towards Student Friend Ship Design Software, *Proceedings*, 9th International Marine Design Conference, May, Ann Arbor, MI, pp. 723-733
- [10] Liaw, S.S., Huang H.M., and Chen, G.D., An Activity-Theoretical Approach to Investigate Learners' Factors toward E-learning Systems, *Computers in Human Behavior*, March 2006

- [11] Hiekata, K., Yamato, H., Rojanakamolpan, P., Oishi, W., 2007 Design Engineering Educational Framework Using ShareFast: A Semantic Web-Based E-Learning System, *Proceedings*, 4th International Conference on Information Technology: New Generations ITNG 2007, Las Vegas, USA, pp. 317-322
- [12] School of Continuing and Professional Studies, the Chinese University of Hong Kong, <http://www.scs.cuhk.edu.hk/scs/course/it/ab/doc/072-214400-01>
- [13] Department of Electrical and Computer Engineering, NC State University, <http://www.ece.ncsu.edu/research/subareas/cdm>
- [14] AutoDesk, Inc., <http://www.autodesk.com>
- [15] Tom Zurflieh, 2005 AutoCAD 2004: 2D Drawing and Dimensioning, Pearson Education, New Jersey
- [16] IBM CATIS V5, International Business Machines Corporation, <http://www-306.ibm.com/software/applications/plm/catiav5/>
- [17] Tribon M3 User's Guides, AVEVA Group plc.
- [18] E. A. Warman and F. J. Reader, 1977 Education and Training for CAD – An Industrial Viewpoint, *Computer & Graphics*, vol.4, pp. 1-4
- [19] X. Ye, W. Peng, Z. Chen, Y. Y. Cai, 2003 Today's students, tomorrow's engineers: an industrial perspective on CAD education, *Computer-Aided Design*, 36, pp. 1451-1460
- [20] Leckenby, H. On the Systematic Geometrical Variation of Ship Forms, *Transactions of the Institution of Naval Architects*, 92 (1950) pp. 289-316
- [21] Formation Design Systems, <http://www.formsys.com/academic/maxsurf/>
- [22] agelesslearner.com, E-learning Introduction, <http://agelesslearner.com/intros/elearning.html>, 2006
- [23] Atsutoshi Oshima, Basic of "e-Learning", Japan, 2000
- [24] Liaw, S. S., & Huang, H.M., 2000 Enhancing interactivity in Web-based instruction: A review of the literature, *Educational Technology*, 40(3), pp. 41-45
- [25] Rosenberg, M.J., 2001 E-learning, strategies for delivering knowledge in the digital age. New York: McGraw-Hill
- [26] WfMC, <http://www.wfmc.org/>
- [27] Rob Allen, Workflow: An Introduction, UK

- [28] Tim Berners-Lee, James Hendler and Ora Lassila: The Semantic Web, Scientific American, Vol. 284, No. 5, pp. 34-43, 2001
- [29] Ivan Herman, What is the Semantic Web?, <http://www.w3.org/2001/sw/SW-FAQ#What1>, 2007
- [30] Ivan Herman, Semantic Web Activity Statement, <http://www.w3.org/2001/sw/Activity>, 2007
- [31] World Wide Web Consortium, Design Issues, Architectural and philosophical points, <http://www.w3.org/DesignIssues/>
- [32] Ivan Herman, How do I participate in the Semantic Web?, <http://www.w3.org/2001/sw/SW-FAQ#What3>, 2007
- [33] World Wide Web Consortium, Semantic Web, <http://www.w3.org/2001/sw>, 2004
- [34] Jupitermedia Corporation, Explorer's Guide to the Semantic Web, <http://www.webreference.com/internet/semantic/4.html>, 2007
- [35] URI Planning Interest Group, URIs, URLs, and URNs: Clarifications and Recommendations 1.0, <http://www.w3.org/TR/uri-clarification/>, 2001
- [36] Graham Klyne, Jeremy J. Carroll, Resource Description Framework (RDF): Concepts and Abstract Syntax, <http://www.w3.org/TR/2004/REC-rdf-concepts-20040210/>, 2004
- [37] Dan Brickley, R.V. Guha (eds.): RDF Vocabulary Description Language 1.0: RDF Schema, <http://www.w3.org/TR/rdf-schema/>, 2004
- [38] Deborah L. McGuinness, Frank van Harmelen, OWL Web Ontology Language Overview, <http://www.w3.org/TR/owl-features/>, 2004
- [39] Institute of Industrial Engineers, Northeastern University, <http://www.coe.neu.edu/Groups/nuiie/Pages/whatisie.html>
- [40] Department of Industrial and Systems Engineering at Texas A&M University, <http://ise.tamu.edu/>
- [41] Kwaliteg Management Services, Industrial Engineering Services and Engineering Consulting, <http://www.kwaliteg.co.za/industrial/industrial%20engineering.htm>
- [42] Hiekata, K., Yamato, H., Rojanakamolsan, P., 2006 CAD Educational Support Framework Using ShareFast: A Semantic Web-Based Knowledge Management System, *Proceedings*, 3rd Workshop on Groupware and Network Services, Shizuoka, Japan, pp. 13-18

- [43] Hiekata, K., Naito, N., Ando, H., Yamato, H., Nakazawa, T., Takumi, K. 2005 A Case Study of Design Knowledge Acquisition Using Workflow System, *Proceedings*, 12th International Conference on Computer Application in Shipbuilding, Busan, Korea, pp. 849-861
- [44] Newcastle Protocol, School of Marine Science and Technology, Newcastle University, September 2002, www.marinedesign.gcrmtc.org/NUprotocol.pdf
- [45] Bruner, J. 1960 *The Process of Education*, Harvard University Press, Cambridge, MA
- [46] AVEVA Group plc., <http://www.aveva.com>
- [47] AVEVA Solutions, Tribon M3 Training Guide, February 2005
- [48] Peter Wright, Graeme White, Keith Hutchinson, Session 1: Hullform Definition and Hydrostatics, Undergraduate Student User Notes, Marine Design: MAR 302, Ship Design Coursework – Tribon M3 Initial Design, University of Newcastle, November 2005
- [49] Peter Wright, Graeme White, Keith Hutchinson, Session 2: Hullform Refinement and Compartmentation, Undergraduate Student User Notes, Marine Design: MAR 302, Ship Design Coursework – Tribon M3 Initial Design, University of Newcastle, November 2005

Appendix A. Newcastle Protocol

The Newcastle Protocol: Student Friendly Software in Marine Design Applications

September 2002
School of Marine Science and Technology
University of Newcastle Upon Tyne

Endorsing Institutions

The Newcastle Protocol for Student Friendly Software in Marine Design Applications has been developed at two workshops held at Newcastle University in 2001 and 2002. The following institutions of Higher Education and software developers who attended the Workshops endorse this document as a statement of the aspirations of higher education institutions for the provision of marine design software.

- Newcastle University, School of Marine Science and Technology
- Friendship-systems.
- National Technical University of Athens, School on Naval Architecture and Marine Engineering.
- Technical university of Denmark, Department of Mechanical Engineering.
- Tribon Solutions (UK) Ltd.
- Formation Design Systems.
- Massachusetts Institute of Technology, Engineering Systems division.
- Delft University of Technology, Department of Marine Technology.
- Institute of Land and Sea Transport Systems, Faculty of Mechanical Engineering and Transport Systems.
- University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture.
- Design Systems and Technologies.
- Helsinki University of Technology, Mechanical Engineering, Ship Laboratory.
- Herbert Software Solutions, Inc.
- Michigan University
- Napa Oy Ltd.
- The University of Tokyo.

THE PROTOCOL

1. Introduction

Throughout the World higher education institutions offering courses in Naval Architecture have been concerned at the high learning overhead associated with the use of discipline specific

software. While the software developers' success in creating 'user friendly' software is helpful, it does not account for the specific needs of students and educators. This issue has been discussed at two workshops held at the University of Newcastle upon Tyne in 2001 and 2002, and from these workshops recommendations have been developed for the provision of 'Student Friendly Software'.

2. Principles of Student Friendly Software

At the workshop in 2001 the principles that underlie the concept of Student Friendly Software were established. These are:

- o Ease of use
- o Short familiarisation time to obtain key results
- o Minimal Naval Architecture knowledge and experience assumed
- o Student focused help and tutorials
- o Transparent calculations
- o Short time to gain initial design parameters
- o Ease of integration with other software packages
- o Ease of installation to standard networked university hardware

3. Structure of Student Friendly Software

The scope and structure of the Protocol for student friendly software is indicated in the Student Friendly Software schematic. This shows both the preparatory concept design work necessary to generate initial coefficients and dimensions prior to using software, and the additional functions that advanced students may require (such as damage stability calculations) that are not included in the Protocol. The Protocol itself defines necessary databases or libraries of standard information, the essential functions of the software, tutorial and help requirements, and the standardised outputs.

4. Concept Design

Concept design procedures are required to provide essential data for input to any marine design software package.

5. Student Friendly Software Databases

The Protocol intends to identify databases of information for students to use in ship design coursework. The Protocol identifies that students will require hard ship data to initiate design calculations. This data should be available in any Student Friendly Software package from a range of databases covering different ship types. Through discussion between educators and software developers, it has been recognised that it is not appropriate for vendors to create student orientated databases, but it is anticipated that collaboration between vendors and other institutions will produce them. The Protocol recognises that the newly created databases will need to be updated and requests that users, and/or institutions or developers add to the databases should data become available. For the benefit for future students and research, it is suggested that a selection of previous student design projects are stored. Finally, databases should reflect the fact that the way ship design is being taught is migrating from 2D based to 3D based methods. It is recommended that all databases have the following characteristics:

- They must be as simple to use as possible
- Universal or easily readable file systems should be used
- They should be Implemented on a web site or disk with open access
- Databases and the files within them should be compatible with standard networked hardware and software used in higher educational establishments

6. Required Functionality

The Protocol identifies key functions necessary for ship design coursework. It proposes that the menu structure of Student Friendly Software should emphasise these functions (by highlighting them in some way) in order to direct the students to focus on these key functions. Other advanced functions need not be disabled, but effectively filtered out of the students' immediate options while learning.

Recommended key functions are provided for 6 design areas listed below.

- Generic software functions
- Hull form generation/manipulation
- Hydrostatic analysis
- Resistance and propulsion
- General arrangement
- Longitudinal strength
- Stability assessment

7. Outputs

The objective of the Protocol is to ensure that the students present their design proposals in a form that will concisely provide the fundamental data necessary for scrutiny. Every Student friendly software package should provide the output in a standard form consistent with this objective.

The standardised outputs recommended by the Protocol are a guideline for software developers as to what is required by higher education establishments teaching marine design. The typical forms for such outputs suggested by the Protocol covers the following elements:

- Principal design particulars
- Hullform definition
- Hydrostatics
- Resistance and propulsion
- General arrangement
- Capacities and centroids
- Longitudinal strength
- Weight estimates
- Trim and stability

8. Tutorial and Help functions

The Protocol identifies two main types of instruction required in Student Friendly Software: that related to domain knowledge (marine technology), and that related to tool knowledge (the software). It recognizes that both academic institutions and software developers have responsibilities for the provision of tutorials and help functions, and emphasises the importance of collaboration in this area.

Tutorials

Tutorials are required to cover both domain and tool knowledge. They should be succinct and rapidly lead students through the fundamental elements of the relevant area. Developers should provide short tutorials covering core tool knowledge, and academics provide demonstration of the use of the software with relevant case studies.

Familiarisation

Student Friendly Software should provide functions that enable the novice user to rapidly identify routes to achieving specific goals. These should include:

- A dictionary and thesaurus of synonyms to assist students unfamiliar with the terminology of the specific software package,
- A printable visualisation of the entire menu hierarchy and dialogue boxes, to enable students to navigate to specific tasks,
- And comprehensive prompts for input errors and omissions.

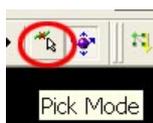
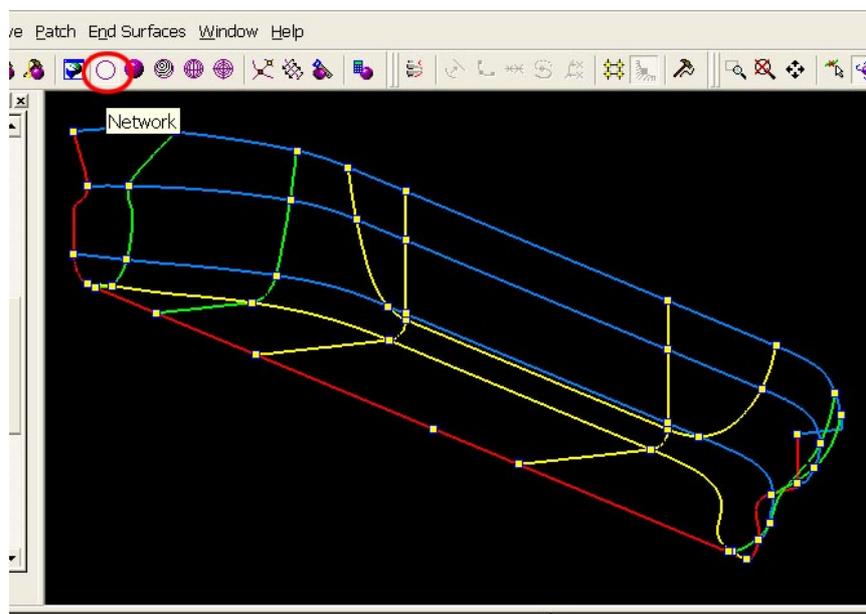
Help Pages

Help documentation is considered as reference material for students undertaking coursework exercises. It is required for both domain and tool knowledge. In Student Friendly Software the developers should provide cut down versions of their standard help pages, highlighting the key issues in the areas defined in Section 6, above. They should also provide a simple and visible link to text or web style documents that could be used to enlarge on context relevant domain knowledge. These documents should be authored and updated by the academic institutions using the software, and this should be facilitated by straightforward procedures provided by the developers as part of the Student Friendly Software package.

Appendix B. Learning Material (Original)

Complete the Surface

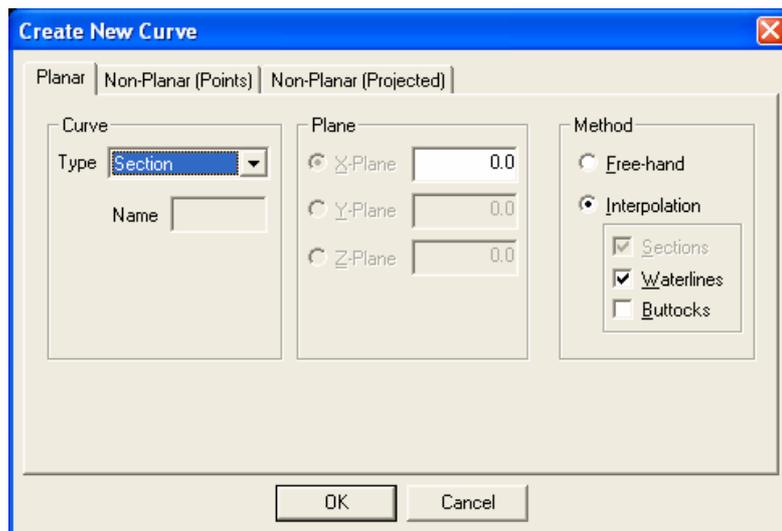
1. Add more curves (section and/or waterline) to complete the surface.
2. Click at Network icon to change view



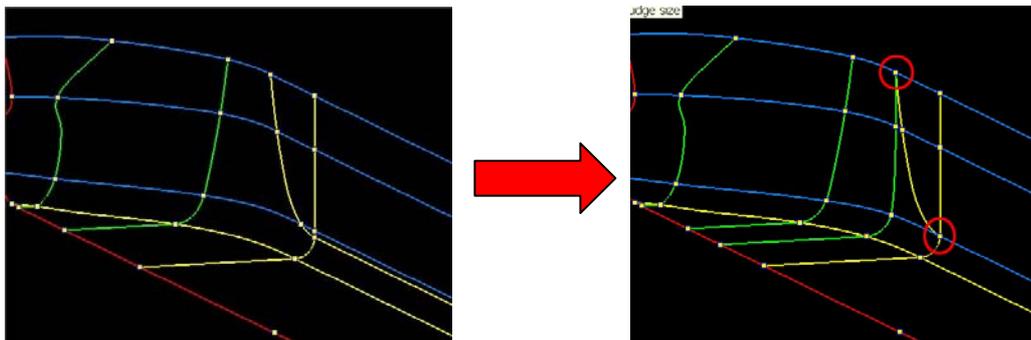
3. To make new curve, click at  and click at the point that we want to add curve.



4. Click at  icon.
5. At Create New Curve dialog, choose Curve Type (Section, Waterline, etc.) and click OK



6. New curves will be added.

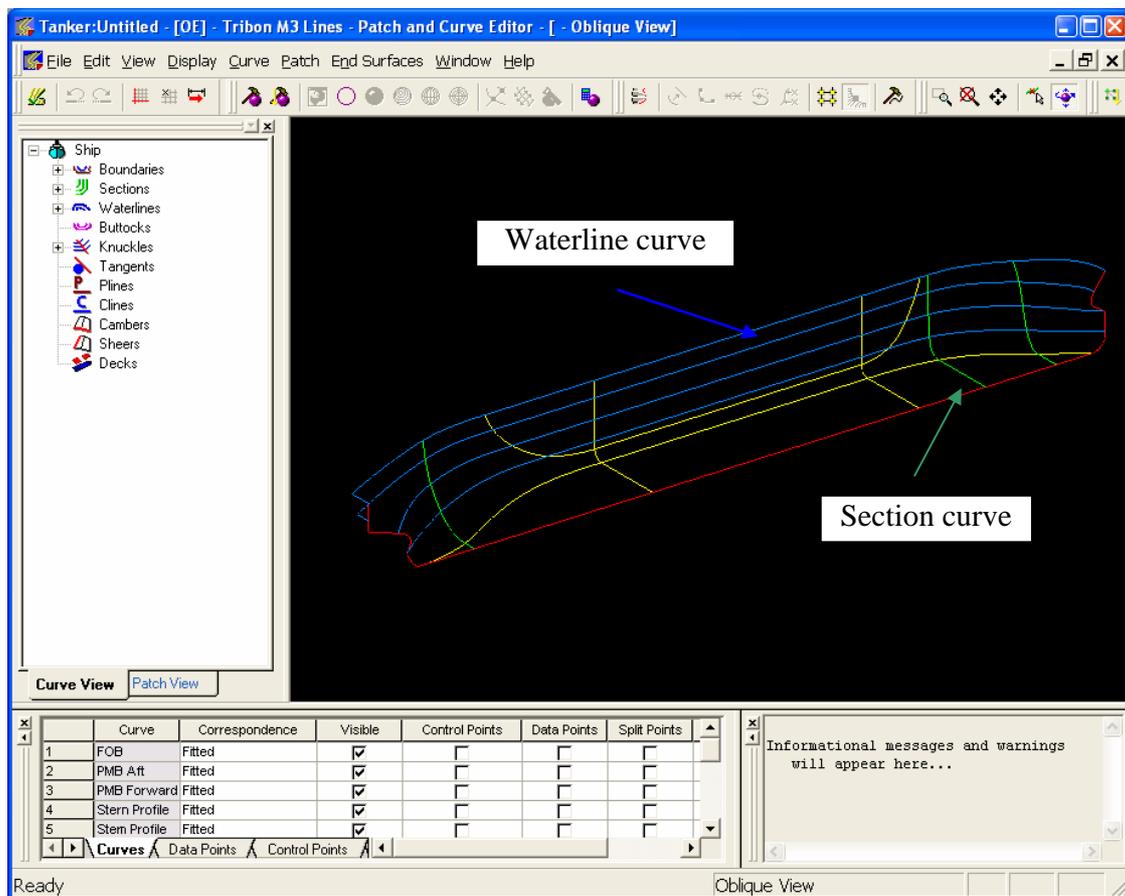


7. Click at  to make new surface.

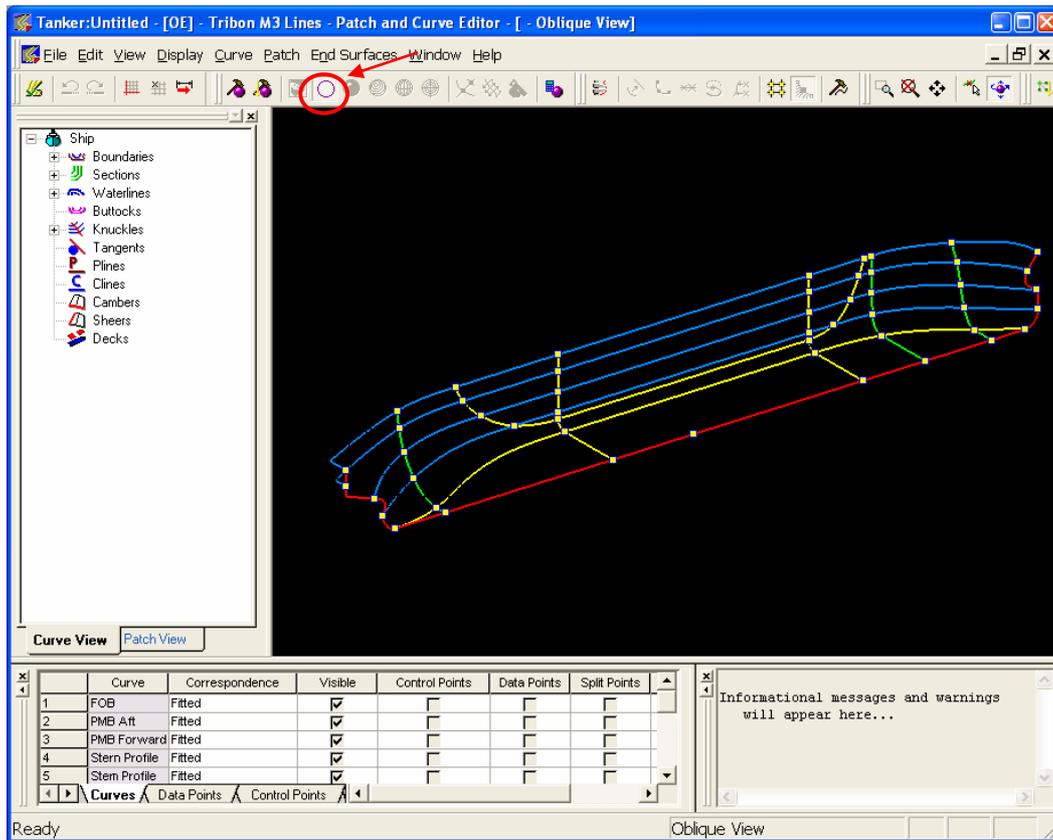
Appendix C. Learning Material (Revised)

Complete the Surface

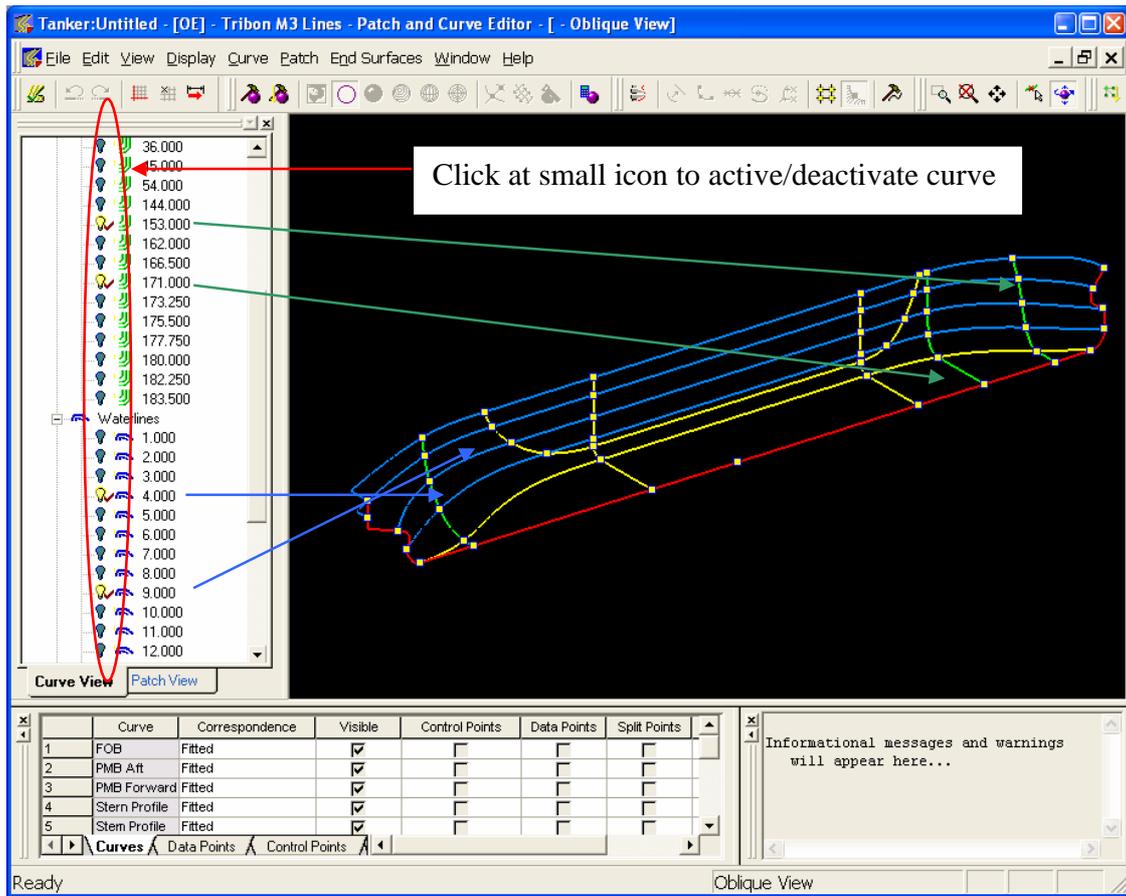
1. Adjust curves by adding/deactivating curves (section and/or waterline) to complete the surface.



2. Click at Network icon to change view

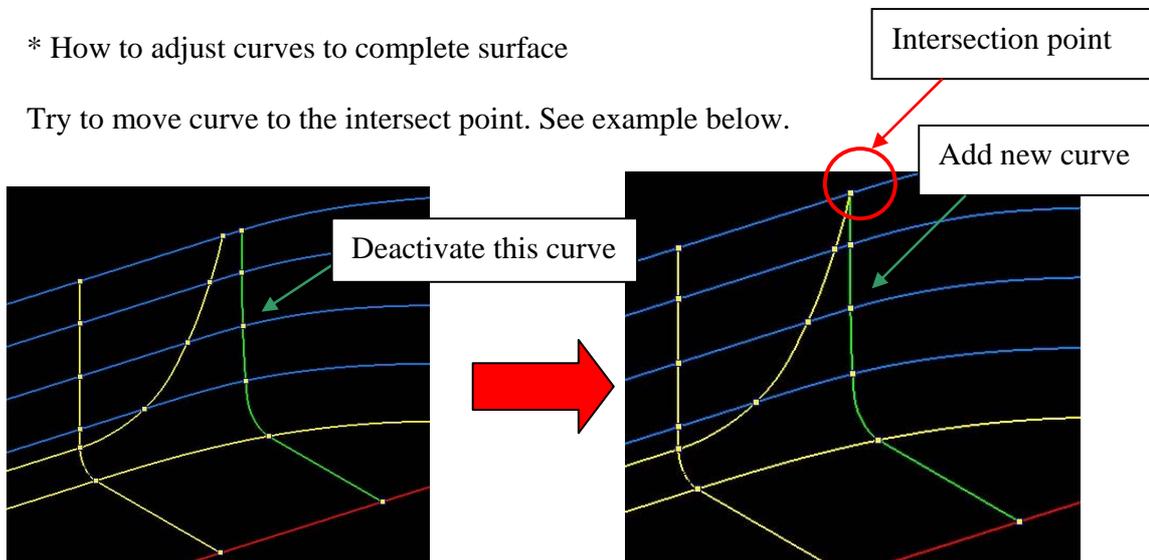


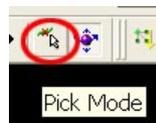
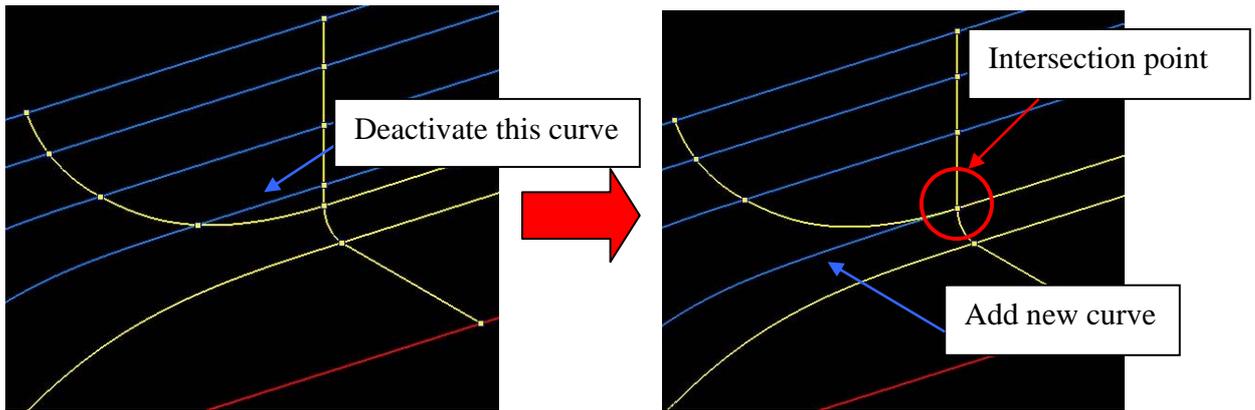
Curves at the screen are related to the tree view at the left hand side. We can activate/deactivate curves by clicking the element in the tree view.



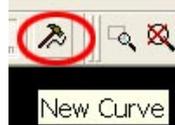
* How to adjust curves to complete surface

Try to move curve to the intersect point. See example below.

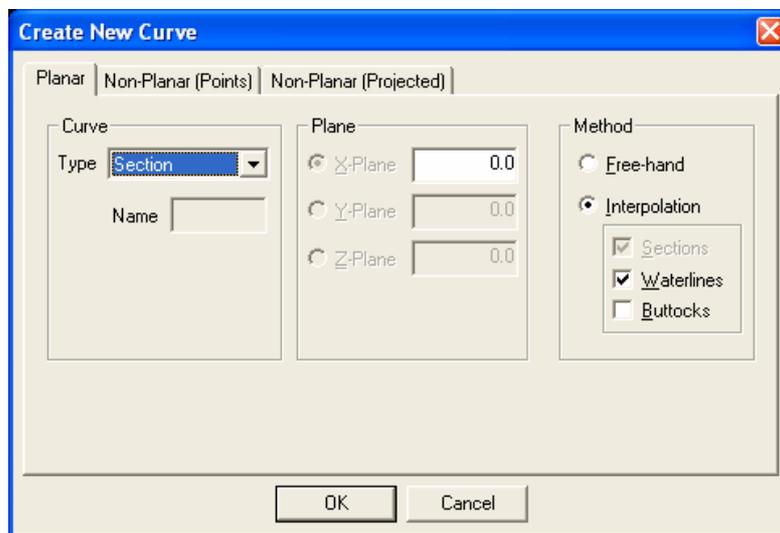




3. To make new curve, click at **Pick Mode** and click at the intersection point that we want to add curve.



4. Click at **New Curve** icon.
5. At Create New Curve dialog, choose Curve Type (Section, Waterline, etc.) and click OK



6. Click at **Rebuild surface using current options** to make new surface.

Appendix D. Experiment Questionnaire

Learning Tribon M3 Initial Design via ShareFast – Questionnaire

This questionnaire consists of 4 sections. Please read each section's instruction and answer all the questions.

Section 1. Your knowledge of Tribon M3 Initial Design

Please write down your level of knowledge towards the topic below. (0 – 10; 0 = Not at all; 5 = Understand some; 10 = Understand very well)

	Before the Class	After the Class
- Overall knowledge of Tribon M3 Initial Design		
- Ability to perform 'Lines Design' module		
- Ability to perform 'Patch and Curve' module		
- Ability to perform 'Compartment' module		
- Ability to perform 'Calc/Hydro' module		

Section 2. Questions about ShareFast software application

Please mark *X* in the right-hand-side boxes below.

	Agree	Partly agree	Neither nor	Do not agree
- The software is easy to use.				
- Learning ship design by workflow helps you understand design process more easily.				
- This software helps shorten your time to study ship design.				
- Discussion function is useful for you to communicate with other students and instructor.				

Section 3. Class evaluation

Please mark *X* in the right-hand-side boxes below.

	Agree	Partly agree	Neither nor	Do not agree
- You feel that this class has an appropriate content.				
- Time duration of this class is appropriate.				
- Your interest for ship design using Tribon M3 raised during the class.				
- The class as whole fulfilled your expectations.				
- You prefer to study Tribon M3 ship design using ShareFast rather than normal way.				

Section 4. Comment/Suggestion

Please write your comment and suggestion for this class.