Gintic
Institute of Manufacturing Technology

CUTTING EDGE

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Gintic Is Poised For The New Era

Dr Frans Carpay, Managing Director of Gintic Institute of Manufacturing Technology

Having emerged from the regional economic recession, Singapore enters the new millennium with renewed optimism and strength. The strong growth achieved last year by the manufacturing sector will continue unabated in the Year 2000.

As a national applied R&D institute, Gintic Institute of Manufacturing Technology (Gintic), has significantly boosted the technological edge of local industries. Through the continuous generation and application of advanced manufacturing technology, the institute has contributed considerably to the competitiveness of Singapore industries. Small and medium-sized enterprises, promising local enterprises and multinational corporations have benefited from the National Technology Upgrading Programmes, industry-wide initiatives, consortia and company-specific projects.

However, the manufacturing landscape and business environment have changed significantly in Singapore as well as globally. "Industries today have to grapple with lower profit margins, faster time-to-market and an intensely competitive business environment. In Singapore, the new generation of industries such as chemicals, pharmaceuticals and semiconductors, which have taken root, are more sophisticated and capital intensive. At the same time, the chain of manufacturing activities, located in multiple sites worldwide, is increasingly globalised and complex," said Dr Frans Carpay, Managing Director of Gintic.

Gintic is poised to take up the challenges in the new generation industries which demand technologies encompassing IT, multimedia, communication, logistics, supply chain management, semiconductor and high-end production equipment. Over the years, the institute has developed emerging technologies and core competencies in anticipation of industry needs. Some of these are e-engineering communities, Internet-based Corba, Micro-Electro Mechanical Systems (MEMS), Intelligent Process Optimisation toolkit and VEDIO methodologies for virtual equipment design. Where applicable, strategic alliances will be forged with relevant world-class partners to develop other emerging areas of technology.

The institute has grown in the number, size and complexity of R&D projects, the types of industries served as well as manpower strength. "In anticipating the needs of future industries, we expect further growth to develop new technological requirements and to go into sufficient depth to be able to provide the necessary high level support to the new era industries," said Dr Carpay.

Having taken the lead to develop emerging technologies and core competencies in anticipation of industry needs, the institute is poised to take up the challenges in the new generation industries

Highlights

Boosting Performance
With Dynamic Tester Optimisation And Scheduling System

Gintic has successfully translated R&D work in a project for a semiconductor test manufacturing environment to implement an integrated, discrete event simulation based tester optimisation system which offers online and near real-time features.

Implemented in May 1999, the system arising from this joint project with Infineon Technologies (Asia Pacific) Pte Ltd is expected to allow the company to optimise its delivery performance.

The system is on the leading edge of technology and will pave the way for high delivery accuracy and a shorter time in drawing up plant schedules, with capability for "what if" analysis

The expected impact of the system includes highly accurate response to customer on order completion and low cycle time, while reducing the time invested in drawing up plant schedules. It will also allow for more predictable and repeatable manufacturing performance and capability to carry out "what if" analysis to plan for the future.

The system dynamically generates schedules and reports at required frequency at anytime based on the latest online operational status. It takes about 10 minutes to generate an optimisation run. In each run, there are over 3,000 decisions made, with each decision considering in excess of 2000 alternatives for an optimum choice to be made.

The pioneering system determines the optimum dispatch schedule for each IC tester, taking into account relevant constraints, and optimising the conflicting needs of delivery accuracy, utilisation and cycle time. The system is on the leading edge of technology particularly in the following aspects:

- Customised dispatching and optimisation algorithms integrated with discrete event simulation that considers a variety of factors
- Real-time integration of manufacturing IT systems, including shop-floor interfaces, manufacturing databases, engineering databases and the dispatching engine
- Dynamic creation of the simulation model, eliminating the need for highly trained specialists

For details, please contact Dr A I Sivakumar on 793 8258 or e-mail: siva@gintic.gov.sg

IC testing.. A technical challenge to schedule and optimise

GrindStar:
A High Precision, Cost Effective CNC Profile Grinding System

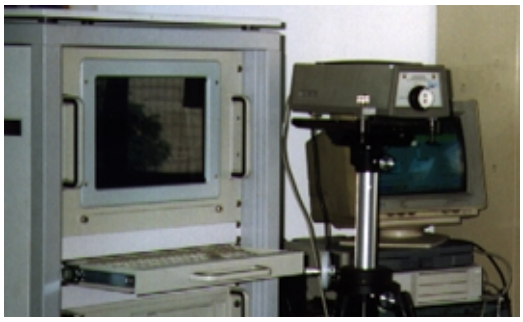
A joint project with Gintic has led to a local precision tool-and-die company, Sin Star Hou Engineering, enhancing its competitiveness, thanks to the development of a PC-based CNC profile grinding system, GrindStar.

The development of the system testifies to the institute's capability to offer affordable, yet high-tech and high value-added solutions for local industries. The system hardware costs less than a tenth of the cost of a conventional optical profile grinder. The high precision, cost effective profile grinding system is affordable for most small enterprises.

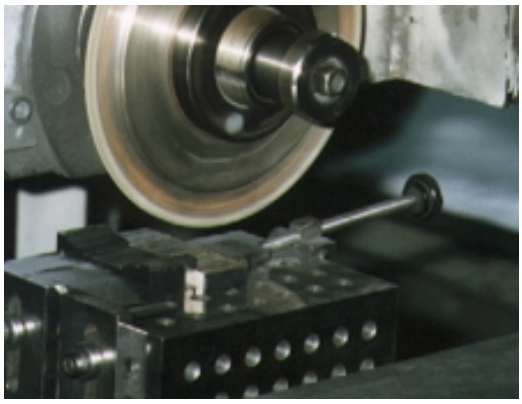
GrindStar is a 2+1 axis CNC profile grinding system developed for precision punch and die finishing. It consists of a 3-axis CNC sliding table, a PC-based controller and profile grinding software. Brushless DC servomotors drive the compactly designed CNC table, which can be mounted onto a manually operated surface grinder. The PC-based CNC controller is housed in a 19-inch cabinet containing an industrial PC, the motion control card and amplifiers.

Aside from being Windows-based, the CNC profile grinding software has a user-friendly man-machine interface and accepts standard G codes from a CAD/CAM system. The software divides three stages of the CNC table into two groups. The X and Y stages are controlled by the G codes, while the Z stage is controlled by a set of pre-set parameters including starting point, stroke and feed rate.

There are three operation modes, namely, system set up, file management and operation. The machine mode includes functions to initialise the system, set up limit switches and control the stages manually. The file management mode provides functions, such as browse directories, CNC programme and parameter files, check error messages and loading and unloading programmes. The operation mode controls the machining process, featuring a user-defined coordinate that can be set up at a selected position and a compiler to check the structure, syntax and commands of the CNC programme to be run. In addition, the tool path can be previewed from different angles and zoomed in or out with the machining simulation function. When a programme is run, the tool path and machining status are dynamically updated in the display window.



Calibration of the CNC profile grinding table with a laser interferometer



Profile grinding of a sample with GrindStar

To compensate lead screw error, an error-mapping algorithm was developed. A three dimensional error-mapping matrix was generated, based on the position error measured with a HP laser interferometer. The CNC profile grinding software can extract data from the error-mapping matrix and calculate the amount of compensation required to a resolution of 0.001mm. With this function, the position error of the CNC table is reduced from 0.014mm to 0.0015 mm. As the feed rate is selected in a range of 0-10 metres/minutes, the system can produce fine grinding of 0.001-0.003 mm or rough grinding of 0.003-0.005 mm in a workshop environment.

For details, please contact Dr Lu Li on 793 8340 or e-mail: luli@gintic.gov.sg

The development of the system testifies to the institute's capability to offer affordable, yet high-tech and high value-added solutions for local industries

Strategic Alliance For New Precision Jet Cutting Technology

The partnership facilitates the development of a 'complete' solution to customer's needs, providing a one-stop location for part handling, vision, inspection, positioning and part processing as well as a comprehensive support network

The Waterjet Technology Centre (WJTC) is working with Hongguan Technologies to develop the next generation of precision abrasive waterjet cutting systems.

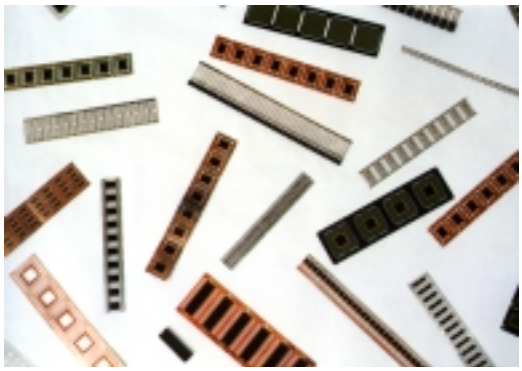
By introducing the latest cutting edge abrasive waterjet technology directly into the market through Hongguan's equipment building and marketing arm, end users can now take full and immediate advantage of the benefits offered by this new technology for a whole range of hitherto untapped applications from electronics to surgery.

The abrasive waterjet technology is inherently three to five times more efficient than conventional abrasive waterjets. It facilitates faster cutting to a higher quality at reduced costs. The unique jet generation technique enables finer precision cut widths as small as 0.1mm whilst providing higher cutting speeds at a superior quality and precision. Indeed, studies have shown that for the same input power, the new abrasive waterjet cutting technology can cut up to five times faster than conventional systems.

Without the slow cutting speeds of Electro-discharge maching, the clogging and high consumable cost of Diamond saws or the heat effected zone of Lasers, the ability to generate such fine cut widths, with high precision, opens the door to a wide range of new applications that traditional abrasive waterjet cutting systems have not been able to explore. The unique ability of the system to recycle the abrasive used, further reduces the running costs to a fraction of that experienced with other precision cutting technologies.

The strategic alliance between the WJTC and Hongguan Technologies brings together the

Precision abrasive water-jet cutting system



An example of electronics sub-strates

WJTC's waterjet experience and knowledge and Hongguan's equipment building capbilites and network to develop a wide range of new abrasive waterjet cutting systems from both specialist one off systems to conventional or multiple applications. The partnership facilitates the development of a 'complete' solution to customer's needs, providing a one-stop location for part handling, vision inspection, positioning and part processing as well as a comprehensive support network.

For details, please contact Dr Michael Gadd on 793 8491 or e-mail: mgadd@gintic.gov.sg

Gintic Works With Local Company
On Product Data Management

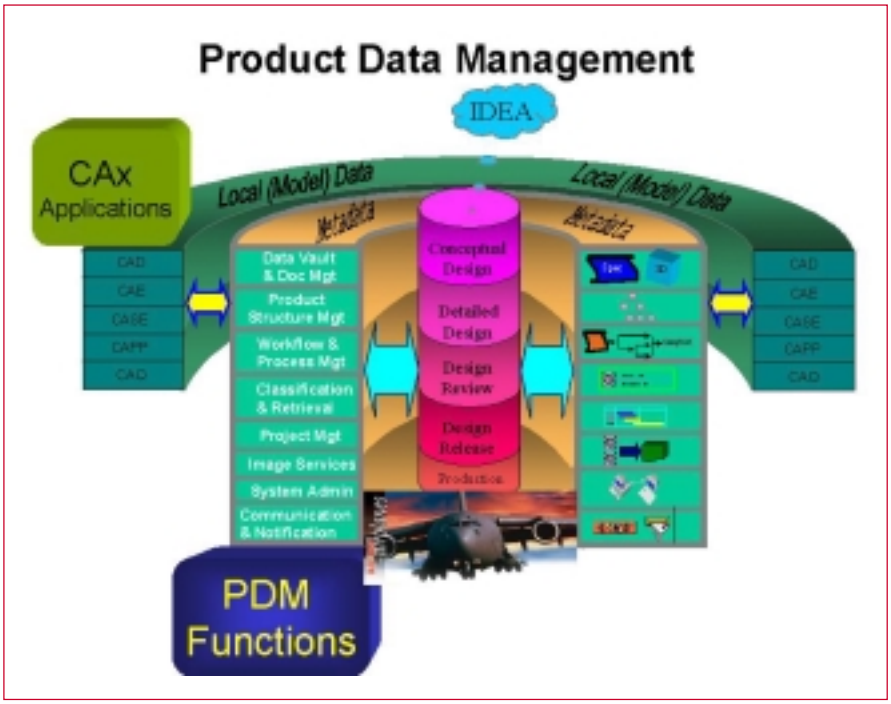
Cost reduction and shorter development time are major benefits from using a Product Data Management (PDM) system, an integration tool that can also improve the quality of products and services.

Early adopters like Boeing and Ford Motor turned to PDM to help control spiralling design costs, manufacturing foul-ups caused by tardy engineering change orders and lengthy product development cycles. In recent years, more companies are implementing PDM systems as part of their enterprise-wide information management system.

From planning through to implementation, Gintic has the capability to assist companies to adopt PDM solutions. Apart from being costly, implementing PDM means a significant culture shift and is a long-term decision, which requires top management commitment. To succeed, careful planning is crucial for any company taking this route, as a PDM solution has cross-functional implications. PDM works best in a re-engineered environment and external consultants like Gintic, with one-stop in-house expertise, can fulfil a vital role.

Gintic recently worked with the research and development arm of Singapore Technologies Aerospace, Engineering Development Centre (EDC) on a three-month feasibility study for implementation of PDM systems. The positive findings have led to the PDM vendor working on implementation of this technology at EDC.

As an integration tool, PDM manages product data throughout the enterprise, ensuring that the right information is available for the right person at the right time and in the right form. In this way, PDM improves communication and cooperation between diverse groups and forms the basis for organisations to restructure their product development processes and institute initiatives such as concurrent engineering and collaborative product development.



Short product development cycle time through PDM

Among others, PDM systems control product-related information including design geometry, engineering drawing, project plans, part files, assembly diagrams, product specifications, numerical control (NC) machine tool programmes, analysis results, correspondence and bills of materials.

For details, please contact Mr Neo Aik Chian on 793 8374 or e-mail: acneo@gintic.gov.sg

Cost reduction, shorter development time as well as improved quality of product and services are benefits from using PDM systems

Gintic Sharpens Comp Singapore's

These successful R&D collaborations demonstrate Gintic's strong capabilities to propel the Singapore aerospace industry to new heights of global competitiveness

Recognising the importance of the aerospace industry, Gintic has been actively spearheading R&D projects to enhance the global competitiveness of this cluster.

In addition to company specific projects, the R&D collaborations are in the form of the national Aerospace Technology Upgrading Programme (ATP). Four of the nine R&D projects under the ATP were awarded to the institute which were undertaken with key aerospace maintenance and repair companies, as well as the Nanyang Technological University and the National University of Singapore.

The projects that were successfully completed under the ATP are:

• SMART 3D grinding/polishing system

This first-ever automated 3D polishing system for turbine airfoils exemplifies the cutting edge applications arising from the programme. For its innovativeness and contribution to the aerospace industry, the project team from Gintic, the National University of Singapore and Turbine Overhaul Services was awarded the coveted National Technology Award in 1999 by the National Science and Technology Board. Its significance lies in the synergistic blending of hardware, software and process solutions to meet the stringent quality needs of the aerospace cluster. The system incorporates self-compliance, multi-tasking, adaptive planning, reconfigurable and teaching-free characteristics.

• Automated honeycomb repair system

This involved three projects carried out to achieve quick turnaround time in the repair of honeycomb segments.

– *Automated honeycomb removal and polishing system*
A robotic system was developed for the grinding and polishing process for honeycomb and residual removal. A vision system is used to inspect the surface texture and to ensure final output quality.

– *Automated spot welding and braze powder system*
This intelligent material handling control system transfers the honeycomb segment to the spot welding machine and braze powder application where powder is accurately dispersed over the entire spot welded segment.

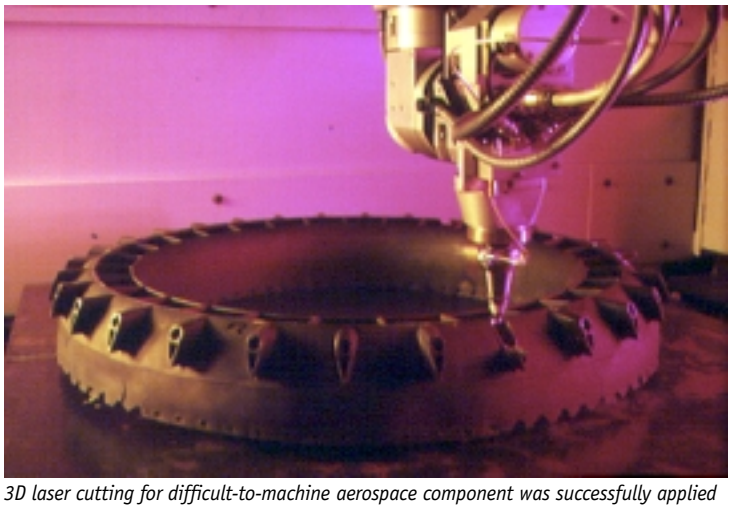
– *High speed grinding of honeycomb segments*
To double overall repair volume, a high speed grinding machine and fixture were developed to provide finish grinding of honeycomb segments.

• Automated aircraft wing surface inspection system

A robotic system was designed and built to automate the inspection of hairline cracks on aircraft wings. This system dramatically reduces the inspection time by automating what was previously a time-consuming process. It is guided by multiple robotic sensors, vision, ultrasonic and touch, linked to a computer-controlled system.

• Complex profile waterjet trimming system

This entailed the development of a complex profile abrasive waterjet trimming system to cut composite aircraft components of different shapes and sizes. Compared with the conventional routing method, this system improves productivity between 3 to 6 times and cuts component cost by 50%. It is achieved through the waterjet system's ability to perform highly accurate single-pass cutting of complex contours.



3D laser cutting for difficult-to-machine aerospace component was successfully applied

etitive Edge Of Aerospace Industry

In addition to these national projects, other successful company-specific partnerships were also completed, including:

– ***An intelligent computer-based scheduling system*** automating the planning of heat treatment operations. This system gives the multinational aerospace company the strategic advantage of having a computer-based tool able to take into account essential variables connected with the heat treatment process. The client-server configuration allows the company to quickly plan the furnace loading and maintenance schedules.

– ***An intelligent fuzzy controller*** to speed up heat treatment for the aircraft engine overhaul sector. It has the capability to take into account the load within a furnace, automating the heat treatment process. The fuzzy controller, which saves time by 20% to 25%, compared with existing manual control, is designed for easy integration into existing furnaces without any changes.

– ***A product data management system*** for a local aerospace company. With this integration tool, the company is in a better position to manage the engineering data and engineering activities to enhance its competitive edge. The availability of accurate and up-to-date engineering information will contribute to reducing product development costs and cycle times.

– ***A plant layout and resource capacity study*** for a multinational aerospace company. The use of computer graphic 3D visualisation and walk-through technology provided the company with the opportunity to preview its proposed new facility. The findings helped the company to decide on an efficient plant layout, taking into account its proprietary processes and fixtures, and placed it in better stead to provide more accurate estimates of its production capacities.

– ***Development of high speed grinding technology*** for thin aerospace components. The process, using super abrasives, reduces cell deformation to as low as 2%-5%. The metal removal rate is 2.5 to 3 times more effective than the conventional process, such as electro-chemical machining, grinding using aluminium-oxide wheels and milling using special cutters, without affecting the surface finish, dimensional accuracy or generating material stress to the component.

– ***3D laser cutting*** for difficult-to-machine aerospace components was successfully applied. This reduces the time to implement performance-enhancing modifications by 75%, extending the component life and creating less microstructural damage.

– ***A compliance-controlled robotic polishing system,*** integrating an automatic inspection system for aircraft canopy, was successfully developed.

These successful R&D partnerships demonstrate Gintic's strong capabilities in harnessing automation, process and manufacturing information technologies to propel the Singapore aerospace industry to new heights of global competitiveness.

For details, please contact Mr Gan Chong Cher on 793 8365 or e-mail: ccgan@gintic.gov.sg

The compliance-controlled robotic system enhances aircraft canopy polishing

Sharing Expertise On The Use Of High Speed Milling For Very Hard Materials

Positive results show the benefits arising from using HSM technology on materials of very high hardness

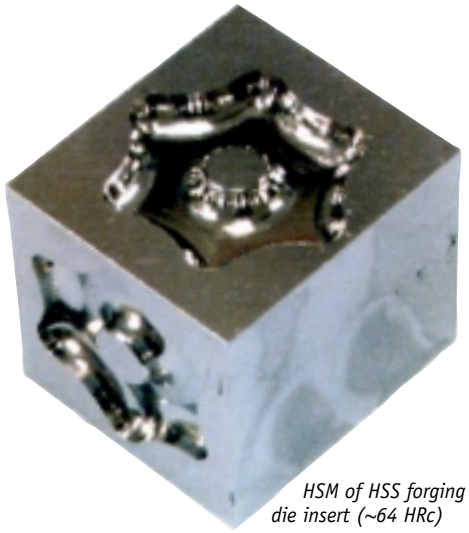
The many benefits of High Speed Milling (HSM) are widely recognised by the precision engineering industry. Through in-house research and industrial alliances, Gintic's researchers have built competency and expertise in HSM technology for various work materials. These include Aluminium 6061, Copper, Stavax (~52 HRc) and SKD11 (~62 HRc).

The understanding of cutting tool materials and geometries, parametric optimisation and CAM knowledge provide the foundation for the institute to advance in HSM research.

Gintic has successfully studied the machining of High Speed Steel (HSS). Positive results show that the benefits of using HSM technology on materials of very high hardness, for example, M2 high speed steel with hardness of approximately 64 HRc.

With the use of a two micro-grain end ball carbide cutters, the researchers were able to machine high hardness HSS to achieve good surface finish of Ra 0.06 µm.

An alternative process like Electro-Discharge Machining (EDM) results in subsurface defects such as heat affected zone, while the HSM method produces compressive stress which helps to prolong the fatigue life of the die insert. This achievement minimises the need for skilled workers and the time required to polish the component in the final stage. The study results, shown in the table, demonstrate the cost savings offered by using HSM technology.



HSM of HSS forging die insert (~64 HRc)

The institute is offering training in high speed milling to industry as part of its Technical Infusion Programme (TIP). The course covers HSM technology, including fundamental principles, selection of cutters, coatings and CAM.

For details, please contact Dr Alex Thoe Teck Beng on 793 8571 or e-mail: tbthoe@gintic.gov.sg

TIME AND COST TO PRODUCE THE HSS FORGING DIE INSERT

Traditional Machining Methods	Time (Hrs)	High Speed Milling	Time (Hrs)
Generating the EDM programme	1	Generating the NC programme	2
Making Roughing & Finishing EDM electrodes	6	Direct HSM on HSS component	1.5
EDM the component	5	Polishing	2
Polishing	3.5		
TOTAL	15.5	TOTAL	5.5
		HSM Total Time Saved vs. Traditional Machining Methods	10
	Cost (S$)		**Cost (S$)**
EDM & machining cost (S$35/hr)	385	HSM machining cost (S$40/hr)	60
Polishing (S$30/hr)	105	Polishing (S$30/hr)	60
Cost of copper electrodes (S$70/pc)	140	Tooling cost	160
TOTAL	630	TOTAL	280
		Total Cost Savings	350

Building A Component-Based Framework To Facilitate Factory Integration And Control

From simple client-server models, distributed manufacturing systems have evolved to operate across diverse platforms, and interact over intranets and the Internet. As industry demands are dynamic, the underlying manufacturing framework must have the capability to be changed and scaled easily with minimal disruption. The main trend today is to use object oriented and event driven middleware in distributed manufacturing systems.

One middleware technology being used, known as Object Request Broker (ORB), manages communication and data exchange between objects, regardless of hardware platforms, programming languages and communication protocols.

ORBs provide the mechanism for objects – from different vendors - to communicate with each other to facilitate the software developers' task in building distributed systems. ORB technology serves three functions - interface definition, location and activation of remote objects, and communication between clients and objects.

Gintic is building a framework for factory integration and machine control, based on SEMATECH CIM Framework Specifications. Using object oriented and event driven middleware technology, this component-based standard is widely adopted. The framework will be implemented using a de facto industry middleware standard, Common Object Request Brokers Architecture (CORBA). It will provide a gateway allowing DCOM components - another ORB technology - to be deployed.

The framework being developed is designed for manufacturers as well as machine tool and equipment builders, and provides three levels of interface - factory, cell and equipment.

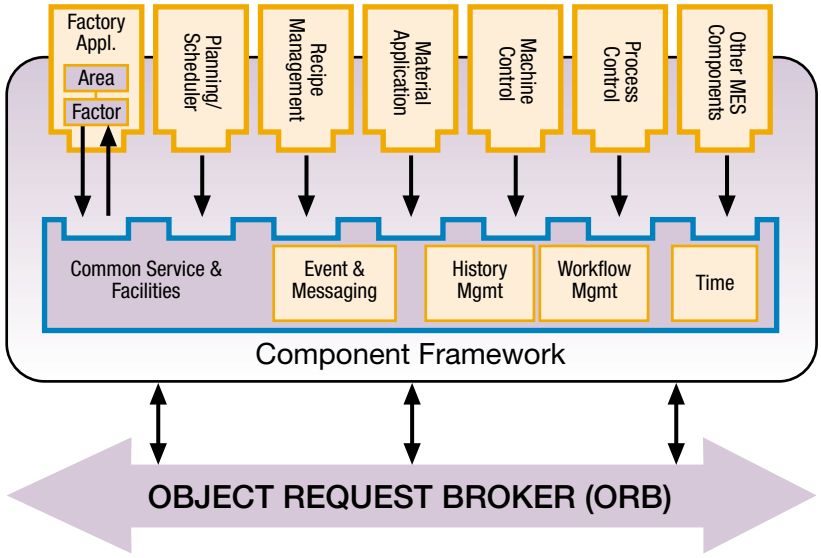
Technically, the framework consists of three parts:

- A CORBA-based CIM platform/environment
- A set of pluggable fundamental components such as Recipe Management, Alarm Management, Equipment Management, etc.
- Methodology and tools that facilitate the component development and deployment

The components can be extended to meet unique requirements, other developers can build completely new components by simply incorporating Gintic's framework into specific designs. By providing a clear template and guide for these extensions and components, the product will minimise future software development efforts. When a required component does not exist, it can be created using a similar component as a template.

For details, please contact Dr Huang Guanbin on 793 8408 or e-mail: gbhuang@gintic.gov.sg

Gintic is building a framework for factory integration and machine control, based on SEMATECH CIM Framework Specifications



CORBA-based framework for factory integration and control

Producing Small Precision Components Using Vertical Semi-Solid Forming Process

This novel process is suitable for a wide range of small components - as light as a few grammes - including electronic and computer parts, leisure and recreational goods

Semi-solid metal processing is rapidly developing as an attractive near-net or net-shaped component fabrication process because it offers many advantages over conventional casting.

Currently, the technique entails the induction heating of metal slugs to a semi-solid state and subsequent casting using an advanced horizontal cold chamber die-casting machine. This process is normally applied to relatively large parts, such as automotive components, as it is uneconomical for the production of small components which offer 20% to 40% part yield. To overcome this problem, Gintic has developed a new vertical semi-solid forming process for the production of small, geometrically complex, precision and high performance components. After heating the metal slugs to a semi-solid state, small components are easily formed with the vertical hydraulic press.

This novel process is suitable for a wide range of small components - as light as a few grammes - including electronic and computer parts, leisure and recreational goods. The process offers a high material to part yield of up to 70% and is easily adaptable to different materials - from aluminium, zinc, magnesium and brass to metal composites. These benefits are just two of the many advantages of this vertical forming process. This process produces small and complex net and near-net shaped components with high integrity and precision. It is also low in manufacturing costs, uses simple process control and press operation.

An actuator arm produced using the vertical semi-solid forming process was found to have high integrity and stiffness, overcoming the porosity and low stiffness problems often present in conventional high pressure diecasting.

Semi-solid forming of small and precision components in Gintic

Gintic will extend this advanced technology to magnesium alloys and will develop a compact and integrated semi-solid forming system for the local industry.

For details, please contact Dr Hu Banghong on 793 8581 or e-mail: bhu@gintic.gov.sg

Tap Technology And Change Mindset In Response To New Order: Dr Ma

Joining Gintic four years ago, Dr Ma YongSheng is encouraged that the institute's drive to facilitate technology transfer in computer-based product design and manufacturing is well supported by the Precision Engineering (PE) sector.

As Group Manager, Dr Ma spearheads a research team dedicated to developing computer-aided tools to improve the competitiveness of the precision engineering sector. The Computer-Aided Product Technology (CAPT) group, he heads, is charged with the mission to study, develop and transfer design knowledge, design processes and methodology to the sector.

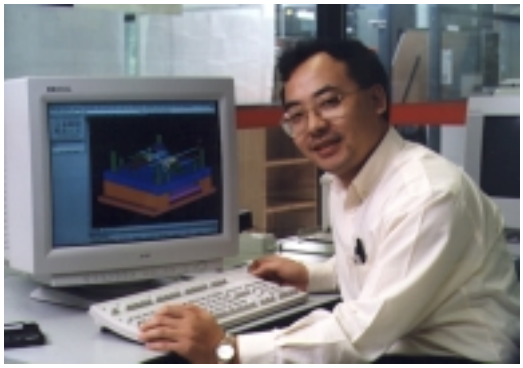
Said Dr Ma: "The industry responded readily to migrate from 2D to 3D technology which is a strategic initiative by the institute to move the sector up the technology ladder."

"The institute is also well-placed to offer specialised computer-based solutions for mould making and sheet metal stamping, through software products like Quickmould and SMCAD. Quickmould is a 3D CAD software for companies producing plastic moulds, and SMCAD, is a feature-based software for sheet metal dies.

"The challenge for our researchers is to understand their precise requirements and customise these strategic tools to their needs. The PE sector is only a start, we will be looking at extending our R&D expertise to the construction, electronics and aerospace industries."

He added that the engineering software developed by Gintic is a first step towards creating a new economic sector for Singapore. The institute is also working with Unigraphics Solutions, a leading engineering software company on joint projects.

Whilst computer-based technology is crucial in offering strategic advantages, he feels the new order in the business world calls for more aggressive mindset to be adopted by Singapore companies. "Singapore industries should be more daring to exploit technology, do things never been done elsewhere," he said. "They can count on R&D support from Gintic."



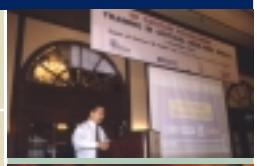
Dr Ma YongSheng, Group Manager of Gintic's Computer-Aided Product Technology Group.

He said that companies should build communities to exploit their combined strengths. Beyond OEM status, they could also aim to achieve ODM and OBM capabilities, that is, to achieve world standard for in-house design and business capabilities.

After obtaining his Bachelor of Engineering degree from TsingHua University, Beijing, he was awarded a Sino-British Friendship scholarship. He continued his studies to obtain his Doctorate and Masters degrees from the University of Manchester Institute of Science and Technology. He was a lecturer at Ngee Ann Polytechnic before joining Gintic in 1996.

Singapore industries should be more daring to exploit technology and they can count on R&D support from Gintic

Date	Event	Venue	Organiser	Contact
Forthcoming Events				
4 Apr - 9 May 2000	Technology Infusion Programme : Advanced Welding Technologies & Applications	Seminar Room, Level 1, Gintic Valley Block	Gintic	Jiun Tel: 793 8346
19 Apr - 24 May 2000	Technology Infusion Programme: Injection Moulding Process Optimisation & Control	Seminar Room, Level 1, Gintic Valley Block	Gintic	Jiun Tel: 793 8346
20 Apr 2000	Joint Seminar on eManufacturing	Auditorium, Level 3, Gintic Tower Block	Gintic, Institute of Engineering Singapore & Society of Mechanical Engineering	By invitation only
19 Apr 2000	Seminar on Compounding and Blending – Trends, Challenges and Opportunities	Auditorium, Level 3, Gintic Tower Block	Gintic	Sam Tel: 793 8423
Past Events				
2 Nov 1999	Launch of Final Phase of 3D CAD/CAM Programme – Training in Critical High-end Skills	Ballroom 3, Level 2, Hotel Inter-continental	Gintic, Hewlett-Packard, Unigraphics Solutions & PSB	
3 Dec 1999	Visit by SEARCC'99 Delegates	Auditorium, Level 3, Gintic Tower Block	Gintic & IDA	
8 Dec 1999	Symposium on Advances in Packaging	The Sheraton Towers	Gintic & NTU	
13 Jan 2000	Visit by EDB Overseas Centres' Directors	Board Room, Level 5, Gintic Tower Block	Gintic	
14 Jan 2000	Launch of e-Engineering Community	Ball Room 4, The Sheraton Towers	Gintic, Oracle, Siemens Advanced Engineering, Sun Microsystems & Temasek Polytechnic Supported by IDA	
20 Jan 2000	Seminar on Developments in Corrosion Testing and Prevention for Industrial Applications	Auditorium, Level 3, Gintic Tower Block	Gintic	
25 Jan 2000	Seminar on Advanced Process Control Technologies for Injection Moulding	Auditorium, Level 3, Gintic Tower Block	Gintic	



About Us

Gintic Institute of Manufacturing Technology (Gintic) formed in 1993 is a national applied R&D institute funded by the National Science & Technology Board. Its major tasks are to :

- Perform and implement applied R&D in strategic processes and technologies to propel Singapore's industrial sector into the future.
- Upgrade local-based industrial companies to be competitive.
- Transfer applied research technologies to the local-based industrial community through training and transfer of staff.

No other R&D institute in Singapore is engaged in improving manufacturing technologies across the whole spectrum of Singapore's industrial sector. It provides industrial companies with R&D services in automation technology, manufacturing information technology and process technology.

Gintic has completed over 500 projects for more than 350 companies, including multinationals, public listed companies and small and medium enterprises.

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