A custom-made miniature shaking table fabricate for Dept. of Civil Engineering of National Taiwan University, with computer controller (MTS Flex test)to simulate ground motions from the shaking table to verify seismic performance The testing initially start from low frequency to high frequency.

Mounted MTS Servo Hydraulic Cylinder and use HSM (Hydraulic Service Manifolds) for testing ,which conducted by senior engineer of ours . who can observe shaking status at different level of shaking scale from the screen. Video is available, please refer to section of media center for further understanding.

Many successful service intergration projects have been put into effect like we collaborated with National Center for Research on Earthquake Engineering ,National Chiao Tung University and National Kaohsiung University of Science & Technology, etc

The e-Impact on the Metals Industry

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Abstract

The Internet age became mature about five years ago. It provides a cyber space for the buyers and the sellers to trade their products, services, and even knowledge. Buying steel coils from the Internet was unthinkable before; becomes a popular alternative in the Metals Industry. Many major steel producers contract with on-line trading e-companies to promote their market position. Most companies establish their own web site for better customer services, product promotion, technology demonstration, and internal communication. The e-commerce business brings in multiple e-advantages from external business transactions to internal process improvement.

1. Introduction

Recent advances in e-business technologies have led to the development of electronic marketplaces. These marketplaces are an aggregation of buyer-supplier connections, which promises to drive down the cost of doing business and to increase the return on investment. Each business entity plays three roles simultaneously – supplier, producer, and customer. The procurement process in the e-market facilitates obtaining the best deal from the suppliers and promoting the products to the customers. The e-commerce does not only bring the convenience of buy-and-sell transaction, but also, maybe more importantly, introduce new control and information concept to the operation. Information exchange between each unit can tremendously improve product quality and operating productivity. For instance, if the hot band gauge information can pass to the cold mill, the control system of the cold mill can "foresee" the gauge variation and provide better control result. All collected mill information can be used to generate a variety of coil reports, which facilitates the management team to monitor the floor operation and exercises the best resources planning.

The e-business age is here. It is real and permanent. It may change the way of doing business and every business process has to be re-examined to take advantages of its potential. This paper is to discuss the e-impact on the metals industry. It will first introduce the basic structure of the new e-business, and the connection between industries. The e-impact to the metals industry is discussed in Section 3. The advantages of the procurement process are discussed in Section 4. Section 5 focuses on the traditional Purdue control model and new unified enterprise model. A typical enterprise control and information system is discussed in Section 5 as well. Section 6 discusses e-impact on level-2 and level-3 system design. The concluding remarks are in Section 7. The paper has no intention to describe every aspect in a great detail. There are lots of rooms for e-business to develop, to innovate, to grow, and to affect our life continuously. Adopting the e-business concept and applying browser technology is a key challenge to the metals industry.

2. New Era of E-business

E-business is about cost saving, customer service, and process improvement. It is to take advantages of teamwork of the entire cooperation, or even across the boundary of industries. It is about connection, either vertical relationship of suppliers and purchasers, or horizontal relationship of competitive entities. For instance, the auto industry has

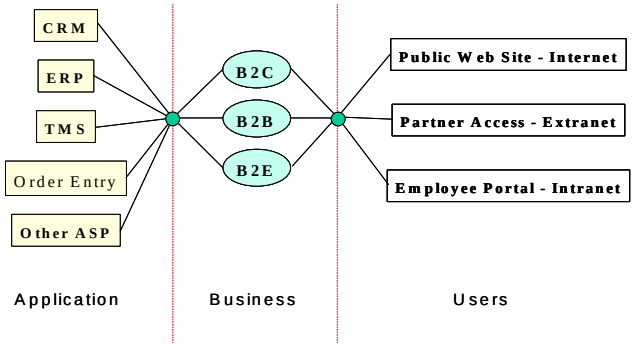

Figure 1: Three components of e-Business

adopted the e-business to improve operating processes, the customer relationship, and the marketplace. E-business has been changing the automotive industry in traumatic ways since inception. However, the auto industry cannot reach the target e-advantages without cooperation with other industries. It is because the e-business cannot go alone. It must leverage the power of the networks and integrate all other available e-efforts into its own enterprise. As for the customer relationship, GM for instance, the largest auto producer has no needs to replicate the efforts of other net players, such as AOL, and Kelley Blue Book. All the contents are already there in the network for GM to embrace, to extend, and to leverage. As for the procurement process, the Metals industry is one of the largest supply industries to the auto industry. The leading on-line efforts from the auto industry drive the metals industry to follow their standard, and perhaps, to exceed their expectation. The answer from the metals industry to the auto industry is the growing metal-related dot-coms and the contents-enhanced web sites of Steel companies.

As shown in Figure 1, the e-business is composed of three major components. The central portion is the e-business, which is further divided into B2C, B2B, and B2E. B2C means "Business to Consumers". It is the first wave of the e-business enthusiasm. The e-vendor sells the goods to the customers directly in the Internet. Since the e-vendor is mainly a middle agent to take the orders and ship the goods, it does not produce the product with factories and warehouses. Amazon.com is one of the largest B2C portals. The B2B, "Business to Business", operates based on the business model of selling the services and goods to other business organizations, not individual consumers. Most of web sites for the metals industry like e-Steel and MetalSite belong to this group. The newest group is B2E, which does the "Business to Electronic Markets", provides trading communities (private or public) where buyers can negotiate directly with preferred strategic suppliers.

The Application is provided by various ASP (Application Service Providers) ranging from accounting service to transportation management. Since all application software are centralized in ASP's server computers, the users can access to their data at anytime in any place through the Internet connection. It is very convenient for the top management, however, many companies feel "threat" to have a possibility leaking their trade secret or accounting information to their rivals.

The other end of the chart is the user group who accesses the information through the Internet, Extranet, and Intranet. Internet is open to the public so that potential customers can surf the company web site searching for their needs within their budget. Extranet is for invited business partners only. The customers can trace their order status, obtain quality reports, modify the order, or even link their warehouse with the supplier's production lines. Intranet is for authorized employees within the organization. It can be used to monitor the activities of floor-level operation, to achieve paper-free office automation, and to provide better communication between each individual unit within the cooperation.

3. E-Impact on the Metals Industry

The e-impact to the metals industry can be analyzed from two viewpoints – (1) what the e-commerce can do for the industry and (2) what the industry needs from the e-commerce. For the first part, the e-business is not only about the web site and the mouse click. It is about the new concept of buyer-supplier connections. The new concept will ultimately reshape industry value networks and business processes. It is about what on-line ASP can offer including the procurement process, the accounting services (order, payment, payroll), the inventory control, the manpower services, web site design and monitoring, the on-line training classes, the web-based mill simulations, technology trades, and other activities in the cyber space. It is about the new Internet technology that drives the e-business behind the scene. The new technology cannot only support the e-business, but perhaps more importantly, it introduces the enterprise information system into the day-to-day operation of the entire cooperation. It provides new ways of cost-cutting and process improvement. A typical example is that the control and information system for plant-wide cold mills can provide better strip quality through the control system, and also promote the productivity through the information system powered by the browser technology .

The second one touches the sensitive parts of the metals industry as a whole. Many metals companies are unable to find and retain qualified and capable employees with sufficient technical knowledge to operate their sophisticated facilities. The steel industry has been painted as a sunset or dying industry, or if not, it has a long-term reputation for being conservative, slow, dirty, unprofitable, overworked, and less rewarding. As estimated, many departments of the steel companies face a loss of 30-50% of their workforces in the next five years. With an average age of 47, the steel industry needs to be more imaginative and constructive, and look at how business processes can be improved so as to re-gain their ground. The e-business offers one solution. The high-tech e-business can attract the young digital generation (d-generation) better than ever. The e-procurement can facilitate selling excessive and/or secondary coils on-line. Yet it brings the power of strategic negotiations right to the desktop, allowing the buyers to streamline supply chain linking to the best deal in the market. The modified Purdue's control model brings control and information system to the network age. The web-like connection within cooperate enterprise improves the procurement process, product quality, and operating productivity.

4. The Procurement Process

The life cycle of the traditional procurement includes the functions of requisitioning, ordering, receiving, and paying. The e-procurement is to reduce the life cycle by doing the entire process electronically. The components include

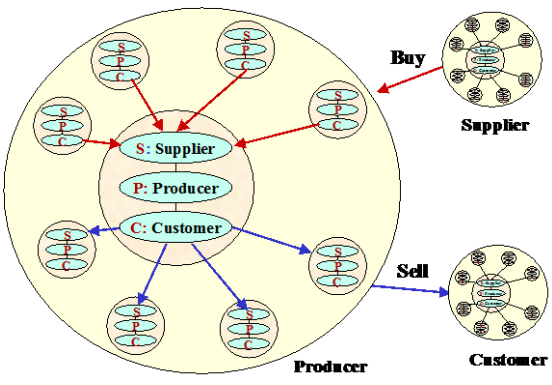

Figure 2: Each entity plays supplier, producer, and customer roles at the same time

locating and communicating buyers and sellers, creating and distributing Requests for Quote (RFQ), negotiating and executing purchase contracts, and even developing a sourcing strategy. Nowadays, many metal producers are well along in e-procurement efforts – selecting and sourcing raw materials and other supplies, and linking into one or more e-business sites to sell their finished products. As shown in Figure 2, any business transaction includes three major entities – the supplier, the producer, and the customer. A producer has multiple suppliers and customers. The producer is a customer of its supplier and is a supplier of its customer. Each entity plays three roles simultaneously – supplier, producer, and customer. The procurement process involves the external business transactions – buy from suppliers and sell to customers.

Figure 3 displays detailed operation within one organization. As a supplier, the producer needs to develop a business strategy to sell products and/or services; the procurement site can be a business storefront to showcase product quality, availability, reliability, technical support, and even the price. Customer relationship management (CRM) and transportation management system (TMS) are key issues. CRM conducts customer relationship such as measure of customer value, monitor the customer experience, and educating customers about new/existing products. TMS is used to find the best path to transport products and/or raw materials, from which the company can reduce costs and maximize profits. As a customer, the producer can employee the procurement site as a business locator to categorize goods and service, a place to strike the best deal, and a resources to access more product information. Supply chain management (SCM) is a key issue. Balancing the warehouse inventory and the bulk purchase program provides an extra cost saving. There are three types of the procurement exchanges, public exchange, private exchange, and exchange-to-exchange connection. The private exchange being an invitation-only B2B e-commerce is normally designed by the producer to form tighter ties with existing customers. The public exchange managed by the third party can be used to find new customers or suppliers. It facilitates suppliers to reduce inventory and warehousing and to enhance the distribution chain, yet helps customers to find the best value and to accelerate the procurement life cycle. The exchange-to-exchange connection is doing the connection between public exchanges. It helps the user to compile a variety of offers from various public exchanges. Typical public exchanges in the metals industry are e-Steel, MetalSite, MetalSpectrum, MetalMaker, MetalAutions, MaterialNet, IronSide, SteelBroker, and so on.

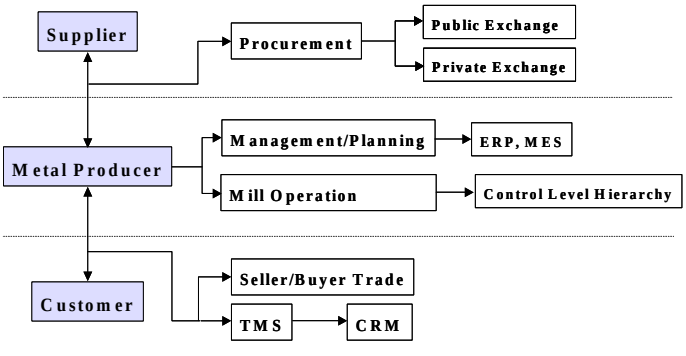

Figure 3: e-Impact on Suppliers, Producers, and Customers

The above discussion is to employ the e-procurement for accounting-based cost cutting and profit maximizing in the transactions with customers and suppliers. As a producer, streamlining the internal operation is even a more challenging task to reduce product cycle time, to maximize equipment utilization ratio, to monitor quality and productivity, to improve material and data flow, to increase overall yield, and to reduce internal inventory and warehousing. The control system and the information system hold the key to success. Within an enterprise, most of metal producers adopt the traditional Purdue model (discussed in the next section) to separate each control layer based on functionality and expertise. The model extensively includes the top layer of managing and planning as well as the low layer of floor operation. Advances on e-technology calls for modification of the model to better fit into the current e-structure.

5. Control Levels of Operation

5.1 Traditional Control Level Hierarchy

The control level hierarchy was introduced by Purdue University in the 70's. It has been used in the Steel Industry since then. The control system is divided into various control levels, from level-0 to level-5. Each level focuses on one specific aspect, such as sensors for level-0, real-time controller for level-1, process set up models for level-2, and so on. As shown in Figure 4, Purdue model clearly define functions of control levels. The scope of the lower level is limited to a very specific task, such as a pressure sensor, and the higher level involves the enterprise system, such as enterprise resource planning.

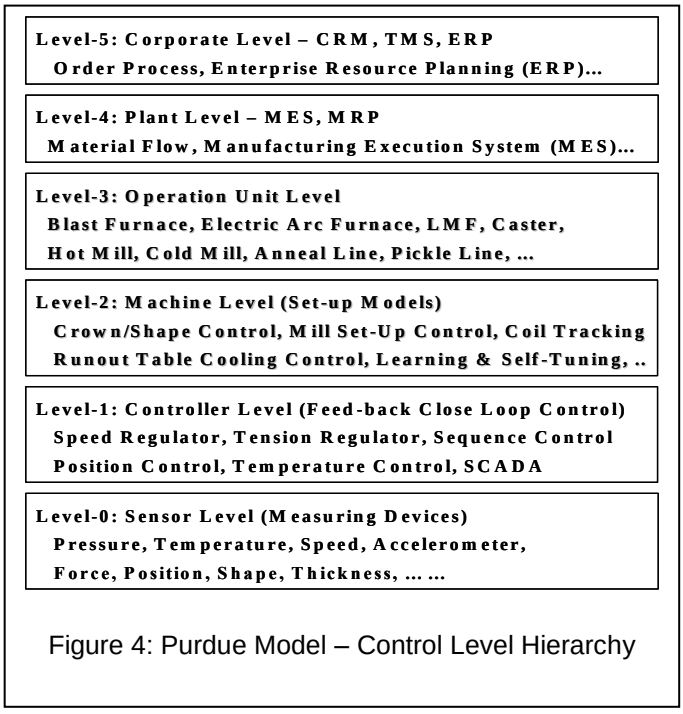

Figure 4: Purdue Model – Control Level Hierarchy

The higher levels focus on overall planning than detailed operation. The higher levels make decisions and command the low levels to execute. Hence the lower levels operate in much higher a frequency than the higher levelers. For instance, the level-2 system performs set-up calculation once for each coil. During the course of rolling, the level-1 system needs to deliver the set points specified by the level-2 system regardless of any kind of mill disturbances. The level-0 system records mill data, transfers to the level-1 system, and further passes to the level-2 system, which summarizes the coil information and continuously reports summary results to upper control levels. Thank to separated functions of each level, different skilled personnel can be assigned to different

control level. For instance, the level-1 system is conducted by electrical and/or mechanical engineers. Computing machines for each level is different as well. Microprocessors are used in the level-0 sensors, distributed controllers for the level-1 system, process computers for the level-2 system, "mid-frame" computers for the level-3 system, and "main frame" computers for upper levels.

5.2 Migrate to New Unified Enterprise Model

What challenge the Purdue model are recent advances on the networking system, faster computing power, and enterprise programming techniques. An enterprise control and information system can provide as many functions as process computers with lower initial and maintenance costs. Affordable workstations (or personal computers) are used everywhere in the system. The system can be easily implemented on the existing wide area network. The enterprise system can conduct many functions of multiple control levels. For instance, since the SCADA (Supervisory Control And Data Acquisition) system can provide feedback control and supervising control functions, it can be classified as the level-1 and the level-2 system. For legendary control systems, each control level has its own file cabinet and data storage. The data is not open for the entire organization; only the authorized personnel can save and retrieve the data. The production and quality reports are made by a dedicated person manually. This procedure is tedious, laborious, and error-prompted. Also since the data is controlled by certain employees, frequently, the operating problems cannot be solved quickly because of lack of operating data.

Although Purdue model provides a very good measure for the control system, it cannot fit into the current enterprise control system. Re-defining functions of each level is necessary. The impact of e-Business on the control system is pervasive, and it has a direct effect on metals automation. As a result, the current control system of the metals industry could change as following:

Current System	Updated System
VAX/ALPHA	PC, Workstation, Group Server
VMS	Windows NT/CE/Linux
Fortran	C/C^{++}/VB/Java
PLC/DCS	PC-Based Control
Proprietary Networks	Ethernet NIC
Proprietary Protocols	Open Protocols
Proprietary I/O	Network I/O, OPC Compatible
Custom Software	Package Software, Database, HMI
Closed System	Open Enterprise System

Integration of real-time control and transaction-based information into a single Unified Enterprise Model becomes the goal of the entire system that must respond fast to dynamic e-Business requirement. The new model with horizontal connectivity provides the free flow of information across the entire enterprise to support more efficient and responsive manufacturing. Under the new model, although roles and responsibilities of IT (Information Technology) and automation

professionals may change, implementation of the system can be achieved by joint efforts of both personnel. The following section expresses a typical example.

5.3 New Enterprise Control and Information System

Figure 5 shows a general layout of an enterprise control and information system. It is particularly convenient for a plant with many small operating units. This system is designed for multiple reversing mills in one plant. Integration of those units using the enterprise system can eliminate man-made errors, increase productivity, and improve quality.

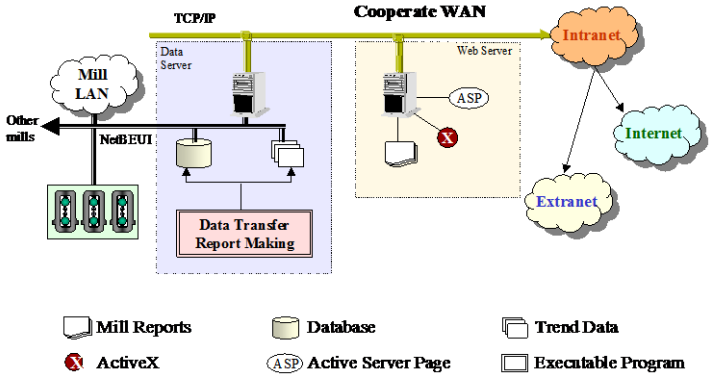

Figure 5: Enterprise Control and Information System

Upon receipt of a customer order, the scheduler enters the coil information into his Level-3 computer. Whilst doing this, he is able to view the actual up-to-the-minute status of coil orders that have already been entered, and modify the processing sequence as necessary. The coil information entered by the scheduler in his Level-3 computer is then automatically transferred and saved to a centralized database computer (the data server). Instantaneously, the data server downloads the coil parameters to the mill's Level-2 process computer. Hence, the data server forms the link between the Level-3 and Level-2 systems. When the mill operator "rolls the next coil", the Level-2 process computer employs a set up model that automatically generates an optimum pass schedule based on the coil properties and adaptive control algorithms. The operator can view and modify the pass schedule when required to adjust for specific unforeseen rolling conditions, such as excessive edge cracks on incoming hot band material. When the operator signals the Level-2 process computer to initiate rolling, the required mill set points are automatically sent to the Level-1 PLC. During rolling, Level-1 mill data is continually collected and fed back to the Level-2 process computer. It is stored in the local Level-2 computer. The mill data is then manipulated by learning algorithms that improve the mill's performance on the next passes and on subsequent coils. It is also "swept" back to the data server upon finishing one coil. Here, the data is accessible by way of the Level-3 Mill Information System to serve the needs of engineers, managers, foremen, schedulers, and operators. The Mill Information System generates standardized reports such as coil reports, productivity reports, customer SPC reports, crew evaluation reports, or other customized reports. In addition, detailed engineering data for the mill and specific coils can be searched for, observed, and plotted to provide in-depth analysis of mill performance. Operation engineers can use the mill simulation capability to experiment with

new pass schedules and mill configurations. Furthermore, using the Mill Information System, the real-time operation of the rolling mill – including rolling schedule, speed, crew, and coil parameters – can be viewed live, as depicted by an animated rolling mill. Since the data server is connected directly to an Intranet system, users can access the Mill Information System from corporate network, according to their specific password-protected viewing privileges.

To further enhance the level of automation within the plant, a Roll Shop Enterprise system can be connected directly to the Level-3 Intranet system. Once rolls are ground in the roll shop and their specifications are entered into the roll shop computer, the system allows the rolling mill operator to directly view the detailed roll parameters on his process computer at the mill. In addition, the roll parameters can be specified and checked by roll shop engineers and supervisors using any computer in the plant environment. The real advantage of the Roll Shop Enterprise system, however, is the benefit it provides to the rolling mill setup model; the setup model can produce much better pass schedules by accurately calculating rolling force according to actual roll diameters and the specific roll-stack configuration.

6. E-impact on Level-2 and Level-3 System Designs

6.1 Web-based Design Architecture

As mentioned before, Fortran has been used extensively in the Metals Industry for past decades and the desktop application has been the mainstream program design. The control model is loaded into a single mainframe computer, whose operating system is either Unix or VMS. The communication between computers relies on proprietary networks and protocols. The data format is based on proprietary I/O and the data store/retrieve must go through proprietary software. The entire system is designed with vendor's future business in mind, instead of customer's need. It is difficult to expand and to maintain.

The new web-based architecture provides an open structure for mill information. As shown in Figure 5, the WAN (Wide Area Network) system is used as the backbone of the Intranet system. A LAN (Local Area Network) is built to link all operating units. Data servers are used as the central data store for all operating units within a plant. They also serve as the data gateway between two networks. Through the data server, the level-3 information is distributed to all operating units whose operating data flow back to the data server upon finishing the coil. The coil reports can be generated in the data server also. Thanks to the intranet, all mill information and coil reports can be transferred to all locations within the cooperation or even the entire organization. The entire system is build using the browser technology with common used programming languages like Visual C^{++} for numerical analysis, Visual Basic for user interfaces, and Visual InterDev for web page design. It is designed using the state-of-the-art enterprise DNA (Distributed internet Application) based control and information system. The new system is very efficient, flexible, expandable, and cost-effective.

6.2 Universal Data Format and Communication

Data format and structure have been a problem between computers and operating platforms. A universal data form facilitates integration of data sources within an enterprise even across the business boundary. Extensible Markup Language (XML) - based formats and protocols are designed to be a universal data structure. XML, a metalanguage that defines markup language, is a method for exchanging information across different types of hardware, operating systems, applications, and database formats. It is turning the Internet into a platform for programmable web-based services. Although XML's main use had been in the Web realm, its role has expanded into specific industries' e-business architecture, or even government's organizations. The goal is to make the same information available to users and customers through a variety of channels. XML-based data structure can provide significant benefits to not only the users but also the developers when XML is integrated into software products.

6.3 OPC (OLE for Process Control) Compatibility

The OPC interface is a standard for data transfer across the network. The optimal goal is for the users to obtain the sensor data through the network using the object(s) provided by the vendor. For instance, the operation engineer can access the exit gauge data from a particular mill by

1) Creating an object without knowing the complexity of the embedded object, and the location of the object host,
2) Retrieving the gauge data from the network by using the data collection method of the object.

It becomes a very simple task if the sensor has OPC compatible capability and the sensor is linked with the network. Applications using the OPC interface standards fall into two categories: OPC Servers (the sensor computer) and OPC clients (the engineer computer). OPC servers supply data to OPC clients. A typical example of OPC clients is hardware I/O device that set or query data from OPC servers. Since the data is available in the network, the user can even view the real-time operating data in the intranet.

6.4 Remote Data Access and Mobility

With the mobility of the m-commerce, the user can access the data from anywhere at anytime by any type of communication channel. Here the data is not limited to the real-time trend data. It extensively includes the coil information, the tuning results of the process model, the learning information, and even the simulation results produced by the set up model. Hence a PDA can be used for troubleshooting the mill from a remote location.

7. Using Internet Services to Reduce Cost

There are three major types of Internet services for the Metals Industry. The first kind is to trade metal product in the web site. The second one is application service provider (ASP), which

allows metal companies to exercise accounting-based functions in centralized server computers. And the last one is designed to provide technical assistance for metal engineers and operators. The first type has been discussed in the procurement process. The service of the second type is not limited in the metals industry since it is based on management layer. The first two type provides Internet tools for administrative personnel. However, they have no contribution to the majority of organization who runs the day-to-day operation. The third type does the service for engineers and operators.

Rolling models are very complicated. It takes a long time to develop and to maintain. It is very costly to develop internally or to purchase from external vendors. Because of the complexity of the models, the model engineers (development and/or maintenance) require engineering knowledge such as mechanics, heat transfer, control, mathematics, and programming. Frequently, a company bought a software for a particular project. The software was then never used again after finishing the project because the software may not be easy to use, or it becomes out of date after certain period of time, or the person used it left the company. Training is another issue. It takes a long time to train engineers to understand rolling theories and rolling models.

The industry will benefit from the technology if rolling models can be operated in the Internet and the user can be trained in the Internet,. There is no need to install the software to a particular computer. In the Internet, every computer with NIC (Network Interface Card) can process rolling simulation. There is no need to purchase expensive package just for a particular project. No engineers are required to maintain the software since the software will be maintained and upgraded by the ASP. The user can do self-paced training in the Internet as well. This is the most cost-effective way to access rolling technology.

Steelskills provides a series of hot mill learning classes in the Internet. However, the web site is not completely finished yet, some subjects shown in the menu have no contents. iContRolling provides more than 30 simulation studies in their web site. In CyberMill, iContRolling offers three solutions of mill simulation – quick solution, advanced solution, and expert solution. "Quick Solution" requires a very limited input and is designed for the beginners and new comers. The model supplies default values for the study and generates a report with charts. It normally takes less than 5 seconds to obtain the result in the Internet. Advanced solution calls for more detailed input data, hence it is more flexible and have better capability. Both Advanced and Quick solutions are for a single stand rolling mill. The simulation studies of tandem mills and reversing mills depend on "Expert Solution". There are more than one input screen in the expert solution. The user needs to "build my mill" by specifying strip material, rolls, stands, mills, schedules, crown controls, and so on. Although it is the most complicated for data input, Expert Solution provides a series of crown control results which have been used to solve the real-world rolling mill problems. Besides of simulation studies, iContRolling also provides technology trade,

metal forum, consultant registration, and other community-oriented services. Other web sites by mill builders and control vendors can also provide certain mill information and control simulation.

7. Concluding Remarks

Since the inception of the e-business, the metal industry starts to ask "Will e-Business have an impact in metal producing?" It seems reasonable to purchase a book or a toy from the Internet, but it is hard to believe to purchase a steel coil from the Internet. When the people wondered about the feasibility, the other group was working to make this unbelievable thing to happen. Very quickly, MetalSite and e-Steel was launched to serve the metals industry. The e-business begins to impact metal producing. The question now is "What impact is e-Business having on my organization?" This paper has discussed some key issues of the e-impact on the metals industry. As technology becomes more and more advanced, the usage of the Internet service will continue to grow. Growing recognition of the e-Business in the metal industry will encourage more system connectivity and necessitate system upgrades to compatible platforms.