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TSAS : 미국석유회사의 자동 Process 통제시스템

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TSAS : A COMPUTERIZED PROCESS CONTROL SYSTEM AT A U.S. PETROLEUM COMPANY

Today's firms exist and run business in an uncertain and rapidly changing environment in terms of industry, market, technology, economic conditions, and culture. To be competitive, at least to survive, firms must cope with and manage uncertainty effectively. In other words, firms should be equipped with powerful weapons to capture competitive advantage over their competitors.

There are several ways for a firm to capture competitive edge over its competitors such as cost leadership, quality of the products and services, manpower, higher productivity, and technology. Among these, technology, especially infomation technology, could be the most effective weapon for competitive advantages since it is possible to monitor competitors' movement as well as to provide appropriate information with both planning and control phases through an information system.

In this paper, a competitive weapon in action, a Process Control System which is developed by and installed at a U.S petroleum company would the described.

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I. INTRODUCTION

More and more executives are referring to what effects their 'bottom line.' Virtually every activity that takes place within a company is evaluated in terms of the 'bottom line.' Of all the tools developed within the last 20 or so years, none have been more influential to a company's bottom line than that of the computer. From the advent of the Unix system on up to the IBM 3090 series, the computer has advanced in its technological capabilities faster than companies have been able to apply those capabilities to the business environment. Slowly but surely the tremendous capacities of this new tool have been harnessed. Today no business can do without them. While attention has always been given to the computers ability to assist with functions such as accounts payable, payroll, accounts receivable, etc., in recent years more attention has been given to less traditional application areas such as automation and the ability to gather and process information instantaneously. This paper will focus on these two areas of advancement as they have played a key role in affecting the 'bottom line' of a business. Specifically, the application of a process control system in terms of its ability to provide a company with a competitive edge would the investigated.

II. PROCESS CONTROL SYSTEM

'Automation' in the world of Information Systems, can represent a myriad of different applications. From office automation to factory automation, computer technology has provided a faster, more economical way of performing what have typically been considered mundane tasks. For the purpose of this paper the term 'automation' will refer to the following process :

> The use of information technology to perform a task that requires little or no human intervention. The primary purpose of such a system is to reduce the risk of error and to provide better performance of the task that is automated.

The area of process control technology is a specific way of providing automation. Process control systems are systems that are developed specifically to control some process. Process control systems have existed for quite some time, but it has only

been in recent years that advanced MIS technology has contributed significantly to these systems. It has introduced a greater degree of flexibility by allowing these systems to be programmed. This flexibility gives the system an ability to react to various conditions based on some conditional criteria. What follows is an actual example of a process control system that was designed and installed by a U.S. petroleum company for the purpose of providing better security to an existing operation while at the same time automating functions that were very labor intensive.

III. Terminal Security Automation System(TSAS)

During the mid 1970's, management in the marketing division of the company, decided that there was a need to provide a better means of security to the 40 plus marketing terminals which it operated in the Midwest and Southeast portions of the United States. The price of oil was on a fast upward trend which meant the value of the gasoline inventory stored at these marketing terminals was increasing in value almost daily. Management of retail marketing made a commitment to provide better security by installing a micro based process control system at each marketing terminal. This system would perform the following tasks :

(1) Control entrance to the marketing terminal property by means of an electronically operated entrance and exit gate.

(2) Control the dispensing of gasoline product to each transport that was responsible for delivering the product to its retail destination, the gasoline station.

(3) Provide a full bill of lading for each load drawn from the terminal. This bill would include all load information such as the number of gallons loaded, the temperature of the product at the time of loading, the customer drawing the product, etc.

(4) Track and account for all product that is dispensed from the terminal by commodity(unleaded, regular, super unleaded, etc.) on a daily basis.

(5) Provide a remote data entry system and a means of transmission for all data pertinent to the operation of the terminal including payroll information on terminal employees, product inventories, pipeline receipts, etc.

(6) Provide a direct communication link from each marketing terminal to the office.

The task was quite a formidable one. At the time no such system existed among the company's competitors. So it was to their advantage to be the first to develop such a system in order to place them at the forefront of technology that automated the process of dispensing product from marketing terminals. Such a system would provide a competitive edge against the competition.

The first version of the project was undertaken and completed in 1979. Since the installation of the system in 1979, there have been several upgrades of the system and the accompanied equipments. There are now over 40 marketing terminals that can be operated 24 hours a day with absolutely no repuired human intervention. What follows is a brief description of how this system operates and the benefits that are being enjoyed as a result of this state of the art operation.

Ⅳ. The Satellite System

Each marketing terminal is equipped with what was termed a satellite computer system. This system is the nerve center of the marketing terminal and controls its entire operation. It is a micro based system which utilizes the Motorola 68000 chip. The system was designed from a board level by employees of the company and was to control all the functions of the rack.(The term "rack" refers the structure that houses and controls the dispensing of the product stored in the large storage tanks located on the property of the terminal. It is a large covered area with one or more 'lanes' that a transport truck can pull into and attach dispensing hoses in order to dispense product into the truck.)

The satellite computer is electronically interfaced to the rack which allows it to continually poll several sensors. This design allows the computer to monitor the number of gallons that flows from each dispensing hose. Also, each dispensing unit is equipped wiht a temperature probe which allows the computer to know the temperature of the product at the time of loading. In addition to the rack, the computer controls the opening and closing of a large entrance gate, while the exit gate is activated by a pressure pad.

Ⅴ. Simulating A Load

To fully appreciate the total function of

the satellite computer, it is necessary to go through the steps of acquiring a load of product from the terminal.(See figure I for a flow chart rendition of this activity.) In order to understand this process better, it is first necessary to understand that the company operates in both the retail and wholesale gasoline markets. The company provides gasoline product to all the gas stations which carrying their brand as well as their wholly owned subsidiarys' brand. All of these gas station make up what is known as retail Marketing Division.

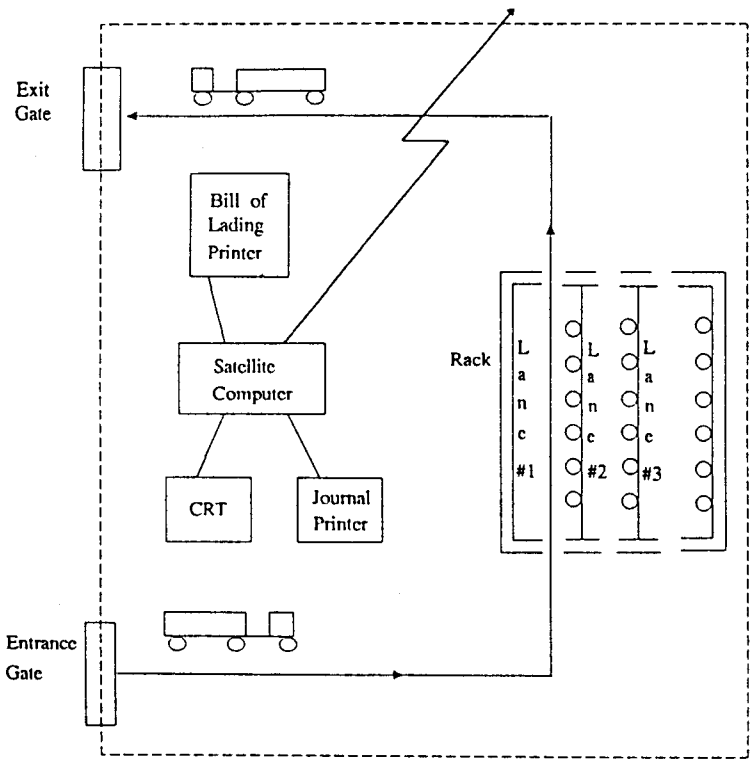

Figure 1. TSAS Satellite Operation To Host

On the flip side is the company's Wholesale Marketing Division. This division sells gasoline products to independent customers that have no direct affiliation with the company branded gasoline. This class of customer purchases a large amount of gasoline product from the company. In fact, several of the company's marketing terminals located in the Southeast portion of the United States are located where there are no company's retail stations and very few of the its subsidiary's marketing stations.

These terminals exist primarily for the purpose of selling product to the company's Wholesale customers.

Because of the exitstence of the wholesale structure, it becomes necessary for the company to accurately account for all product dispensed through its terminals, in order to bill the independent wholesale customers. The company delivers product with its own transports to all the company branded dealers and its subsidiary's marketing locations(There are some exceptions where common carriers are used). Wholesale customers are responsible for picking up and delivering the product to their respective retail outlets. Since the company is not the recipient of the gasoline in these instances, it is necessary for the company to know who the customer is that is picking up a load of product from its terminal. This information is provided by means of a magnetic stripe card which the company provides to each wholesale customer. With there magnetic stripe cards in hand, the driver of a transport truck performs the following activities in order to obtain a load from the terminal.

(1) The transport driver pulls up to the gate of the terminal and swipes one of his magnetic stripe cards in the card reader. This particular card is known as the driver card. It is one of three cards necessary to pull a load of product from the terminal (the other two cards will be explained later.) The card reader which reads the card is one of several card readers strategically placed at various points in and around the terminal. These card readers are the means of communication between the driver and the Satellite. Every few seconds, the satellite polls each card reader defined to the system. If a magnetic stripe card has been swiped, the data is communicated to the satellite. Each card reader is defined to the system as having a specific function, i.e. the gate reader (the reader residing by the entrance gate), or a lane reader (a reader residing by the product loading lanes).

(2) Once the Satellite has received the data from the driver card via the card reader by the entrance gate, it immediately performs a verification process to determine if the driver is allowed to enter the terminal. This task is accomplished by matching the 3 digit terminal ID and the 3 digit driver number as read from

the driver card with a positive file of driver numbers located in the driver file. If verification is positive, the satellite opens the gate. The gate is equipped with a device similar to the pressure pads used at some traffic lights. When a truck pulls through the gate, the pressure pad is activated which keeps the gate open. When the pressure pad becomes deactivated as a result of the truck's complete entrance, the gate closes. This mechanism prevents two trucks from entering the terminal under one driver card.

(3) Once inside, the transport pulls under the rack in one of the designated lanes and prepares to load product. Each Satellite computer can monitor up to 8 lanes at one time. Therefore up to 8 trucks could pull into a terminal at one time and be served simultaneously assuming that 8 lanes exist at the terminal.

(4) Once the truck has pulled into a lane, the driver proceeds to a small closed in area under the rack. Inside is another card reader that he must use to communicate to the satellite that he is ready to load. As mentioned earlier, the driver has three magnetic stripe cards. The driver must now swipe all three cards.

- Driver Card : This is a white colored card that was used at the entrance gate.
  It has information encoded on the magnetic stripe that tells the satellite who the driver is.
- Trailer Card : This blue colored card has information about the trailer being used to hall the product.
- Customer Card : This red colored card has information about the customer that is about to pull the load of product.

As each card is swiped, a validity check is performed on either the driver, trailer or customer depending on which card was swiped. If the card is valid, i.e. the driver/trailer/customer is not to be locked out of pulling product, the appropriate light lights on the card reader, indicating to the driver that the card was valid or invalid. If all three cards are valid, the driver is given a green light to proceed with the load. Otherwise, the satellite does not authorize the lane for loading.

(5) Once the lane is authorized for load-

ing, the driver proceeds to connect the loading hoses to the truck. Each lane may have up to eight hoses that may be used to load a particular product. Each hose is dedicated to a particular product(regular leaded, regular unleaded, premium unleaded, fuel oil, etc.) The driver must select the hose(s) that he wishes to use to obtain aload and fasten them to the loading port(s) on his truck.(Each truck usually has multiple compartments in order to segregate the different grade of gasoline. The truck therefore has multiple entry points which he may use to load. This allows the dirver to have as many as three of four hoses loading product at one time.)

(6) When the hoses are connected, the driver inserts a loading ticket into the ticket printer located at the base of the loading hose. By turning the crank handle on the side of the ticket printer, the meter reading is stamped onto the loading ticket. The truck is now ready for loading. The driver preenters the number of gallons he wishes to load and pulls the start lever.

(7) At this point the satellite takes over. It monitors the loading process by monitoring the temperature of the product and by counting the number of gallons loaded. When the load is completed, the satellite automatically shuts off the dispensing unit.

(8) At the completion of the load, all hoses are deactivated and the load information is immediately transmitted to the Host computer located in the main office(Host processing is discussed in a later section.)

(9) Once the Host has received the load information, it returns to the satellite the address of the customer and the destination of the load.(Due to space limitations of the satellite, customer addresses and destinations reside on the Host rather than the satellite.)

(10) Upon receipt of the customer information, the satellite routes a bill of lading to a printer located in an enclosed shed near the exit gate.

(11) In the mean time the driver disconnects all hoses from the transport and pulls around to the exit gate. By the time he arrives, the satellite has transmitted the load information to the host, received the customer

information and routed the information to the printer where a bill of lading has already been printed and is waiting to be picked up.

(12) The exit gate is equipped with the same pressure pad device as the entrance gate. When the bill of lading is picked up by the driver, he pulls on to the pressure pad which activates the microswitch at the base of the gate to open the gate for the truck to leave.

The entire process of pulling a load of product from the terminal has been performed and controlled by a micro process control system. This system provides the following benefits to the marketing terminal in terms of the load processing.

(1) Lower Labor Costs—Due to the fact that no assistance is required from terminal personnel with product loading, lower labor costs are incurred.

(2) Increased Security Over Product Dispensing—No product could be dispensed "on the sly" since the computer "sees" every gallon that goes through every hose. Therefore, a terminal employee can't slip a few gallons out without being detected. Additionally it is very difficult if not impossible for a thief to steal product from the terminal. This degree of security was the original justification for installing these process control systems and remains a major function of the system today.

(3) Easier Accounting Tasks—The terminal personnel have always been required to account for the inventory and dispensing of the product. With the satellite system the number of man hours for performing this task has greatly been reduced and the task itself, simplified.

(4) Reduced Vulnerability To Error—Prior to the TSAS project, terminal personnel were required to monitor every load. By eliminating manual intervention, the exposure to error has been greatly reduced(almost to zero risk.).

(5) Improved Customer Service—The terminal is now open 24 hours a day allowing customers to pick up loads at their convenience.

(6) The Immediate Availability of Information—Within minutes of the completion of a load, the information is available to personnel in the main office.

(7) Same Day Billing—As a result of

billing information transmitted at the time of loading, same day billing is made possible. The company saves thousands of dollars daily because of our ability to bill the customer the same day the product is pulled.

The satellite not only controls a very complex process but also provides an electronic link between the main office and the terminal. This affords the following benefits.

(1) Access To Host and Mainframe Processing—Since the satellite is a microprocessor based system, it is limited in the amount of computer processing and storage it can perform. However with a link to the Host and the Mainframe in the main office, the satellite can receive reports that are a result of processing performed by the large systems. A prime example is the inventory report produced by the Host. This is a report generated by the Host system that compile the number of gallons dispensed by each hose at a particular termianl. It reconciles and balances the product dispensed from the terminal on a daily basis and sends the report back to the terminal, which in turn is printed on a local printer located next to the satellite.(This is the second printer, different from the one that prints the bills of lading.)

(2) Payroll Data Entry—By entering the payroll data via a CRT connected to the satellite, payroll data can be transmitted to the Host and eventually fed into the payroll system on the Mainframe. This eliminates the manual handling of payroll information. It also eliminates the possibility that the information is lost in the mail or mishandled in the main office.

(3) Communication Abilities—The communication network allows messages to be sent from one terminal to another or from the terminal to the main office. This allows hard copy communication among the participants of the network instantaneously.

The satellite computer system is truly the nerve center of the marketing terminal. It provides a highly sophisticated means of security and automation to the terminal and its employees. It provides an electronic link to information and processing power that assists the terminal in its

daily operation. The satellite is one of the two necessary elements of the TSAS project. The other key essential to this system is the Host computer system.

Ⅵ. The Host System

Just as the satellite system is the nerve center fo the marketing terminal, so is the Host system the nerve center of the entire marketing terminal network of satellites. (For a flow chart rendition of this component, see figure II.) The primary purpose of the Host is to provide a 'receiving center' for all the information gathered by the satellites. Thus the term 'Host' system is used. The Host is located in the main office and is operational 24 hours a day, with the exception of when preventive maintenance and scheduled back ups, are performed.(Back ups are done daily and only take 20 minutes to perform. They are generally performed in the early hours of the morning when satellite communication activity is significantly lower.)

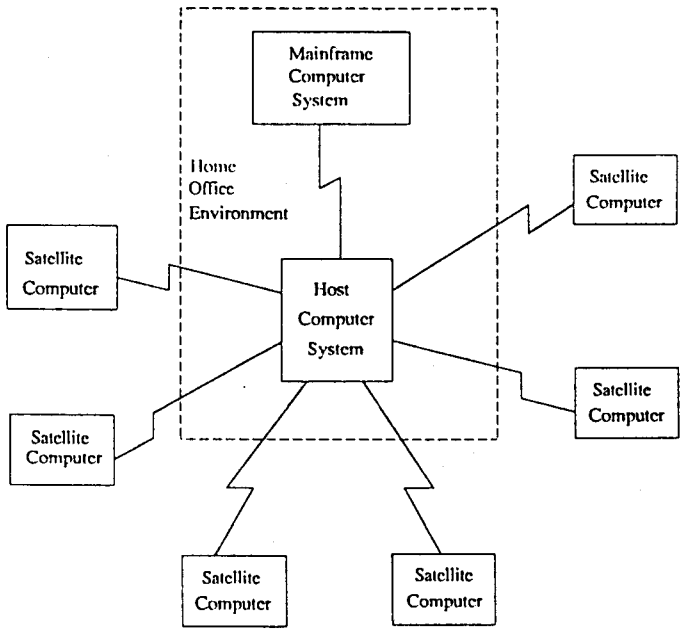

Figure 2. TSAS Host Operation

In order to understand Host processing better, let's step through the tasks the host performs on a daily basis. Since the Host's work day never really ends, there obviously is no specific beginning time in which the Host begins its work on a daily basis.

There are however several functions that the Host performs each day. The following is a discussion of these daily tasks.

(1) Transaction Processing—The primary function of the Host is to act as a receiver of information, to the satellites. Technically speaking this is referred to as transaction processing. The communication between Host and satellite typically occurs in a two step sequence :

(a) The satellite dials the 800 number of the Host and requests permission to communicate. The communication protocol is performed and the satellite begins to transmit the information. Upon completion of transmission, the Host checks the transaction for any errors in the data. If errors are detected, the Host simply returns the appropriate error message(s) to the sending satellite and disregards the erroneous transaction. If the transaction is error free, the Host continues to the next processing step.

(b) Once the transaction is received and is without errors the Host determines what type it is, i.e. load, payroll, general message, etc. Based on the transaction type, the Host processes it accordingly. For a load transaction,(the transaction that occurs as the result of a load of product taking place) the host immediately stores the transactions on its data base. It then looks up the customer information and routes it back to the sending satellite before the communication line is dropped. Likewise, all other transactions are stored on the data base for future processing and historical reference.

(2) Transaction Up Loading—At specific intervals durng the day(usually every hour), all the 'load' information is up loaded to the Mainframe.

(3) Generation of Satellite Reports—Every work day, each marketing terminal is required to balance the number of gallons which the Satellite 'saw' go out of the terminal, against the number of out going gallons each individual meter detects. In addition, they must account for the amount of inventory transferred into the terminal verses the amount of inventory that was dispensed out over the rack. The Host processes these reports for each of the terminals at their request. Each must

transmit the necessary information such as the individual meter readings or inventory levels of each product. Once the appropriate information is transmitted,the Satellite requests a report. At that time, the Host processes and transmits the report to the requesting Satellite.

(4) Sophisticated Supplemental Processing—Since the original installation of the Host system in the late 1970's, several sophisticated systems have been added on to the Host. Including a system of allocating the amount of product each customer is allowed to draw from a specific terminal. This system is quite sophisticated and an extremely flexible tool for the people responsible for product allocation to various customers. The system was originally conceived during the gasoline shortage in 1974. At that time the federal government demanded that all distributors of gasoline must allocate their limited amount of product equally to all customers based on their usage rate prior to the shortage. For example, if a customer's average purchase from the terminal prior to the shortage was 100,000 gallons a week and the terminal sold an average of 1,000,000 gallons per week, that customer was to receive an allocation of 10% of the total amount of product that terminal was to receive on any given week. Each customer was not to receive an amount in excess of their allocation. In addition to this horrendous task, each petroleum company was required to file detailed reports concerning their effort to allocate equally among its customers.

With an automated means of dispensing and accounting for the products each terminal distributes, the company was in a good position to install an automated means of allocating product to each customer. Thus the birth of the Allocation and Monitoring system was given. The idea behind this system was to have the Host maintain a counter for each customer that counted the number of gallons pulled on a daily basis. Even though the government only required that customers be allocated monthly, from a practical standpoint each customer had to be monitored on a daily basis in order to prevent a customer from making a 'run' on the terminal.('Run' is a term used to describe a situation when a customer would send a large number of

transports to a terminal all at once in hopes of either obtaining more than his entitled allocation or just to attempt to get his entire allocation in one day. If a rather large customer decided to make a run on a terminal, that one customer could pull the terminal dry. To be out of product at a terminal is an extremely undesirable position to be in.)

The system was designed to count the number of gallons pulled by each customer and if the customer exceeded their established daily, weekly or monthly allocation, the Host would send a transaction to the satellite of every terminal which that customer was authorized to draw product from. This system provides the following benefits :

(1) It is totally automated. No manual labor is required to track the number of gallons that each customer pulls. This was a very labor intensive task during the days of government enforced allocation. Every terminal had to hire people to do nothing but log the number of gallons each customer pulled and mail that information to the main office. The main office would compile aggregate figures for all terminals(Many of the company's customers pulled from more than one terminal. Allocation was not done on the basis of terminal but rather on the basis of customer. Therefore, the directives to lock out a customer fell upon the general office once the aggregate figures were determined.)

(2) The new system could automatically generate many of the required reports which the government required. This would also save man hours and enhanced reporting accuracy.

(3) This system also provided a huge measure of flexibility. Customers could be allocated on a customer basis, on a terminal basis, on a state basis(i.e. limiting the number of gallons a customer pulled out of one state. Unfortunately, state governments instituted their own allocation requirements as well.) and so on.

(4) The system also allows for an instant lock out. This means that an individual could sit down at a CRT in the main office and request that a customer be locked out from all company terminals until further notice was given. In less than five minutes the message would be sent and processed by each receiving sat-

ellite. This capability prevented a run by a company that was about to go bankrupt. A common practice is to file chapter 11 late Friday afternoon and make runs on as many terminals as possible over the weekend. This way all of the product pulled over the weekend did not have to be immediately paid for due to chapter 11 procedures.

(5) The main benefit from this system is inventory control. Even during times of plenty, the system provides a strong measure of control over inventory. The information it generates assists in making decisions for everyday operation.

Sophisticated systems such as the Allocation and Monitoring system not only help bring down labor costs, they provide the company with a method of control far superior to its competitors.

Ⅶ. CONCLUSIONS

All companies that want to survive in todays business world must continue to strive for the competitive edge. That means to continue to examine and develop methods of automation and control that not only cut costs and reduce errors, but also provide valuable information in a timely fashion for the purpose of decision making. Process control systems do just that. They provide timely information to a specific destination for the purpose of achieving a highly automated mode of operation.

It takes an aggressive philosophy toward business in order to support the development of new MIS tools. However the companies that gain the edge over their competitors are those that don't wait for the competition to develop and test these new tools. They are in the forefront utilizing the new tool when its competitors are deciding whether or not to invest in this new activity. By the time the competitors decide to act, the aggressive company already has the competitive edge.

The potential for MIS applications, is almost boundless. As hardware becomes smaller, faster and cheaper, the more attractive MIS becomes as a weapon to capture and maintain competitive edge. Those companies that fail to recognize its importance, will ultimately get left behind. Those that do recognize not only its importance but also its potential, will reap the rewards of sharing the competitive edge.

◇ 저자소개 ◇

저자 유 상진은 서강대학교에서 물리학과 경영학을 복수전공하였으며, 미국의 Middle Tennessee State University 에서 MIS 전공으로 이학석사 학위를 받았고, University of Nebraska－Lincoln에서 MIS 전공으로 박사학위를 취득하였다. 현재는 계명대학교 경영정보학과의 교수로 재직중에 있으며, 현직에 오기 전에는 미국 Ohio주의 Bowling Green State University에서 MIS담당 조교수로 1985년 8월부터 1989년 2월까지 근무하였다.

Long Range Planning, California management Review, 경영정보학 연구 등 국내외 학술지에 20여편의 논문을 발표하였으며 관심분야는 정보자원관리, 정보기술의 전략적 활용, 의사결정지원시스템 등이다. 현재 정보화추진협의회 산업분과 위원, 구미지역 종합정보센타 이사 및 태창장학 문화재단 이사로 활동 중이다.