Digital Dividends:
Environmental and Economic Benefits
of Information Technology
in Chemical Management Services

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Introduction

E-Commerce is a rapidly growing phenomenon that has the potential to substantially alter consumption and distribution patterns. Despite the well-publicized failures of numerous "dot coms" in recent times, market analysts predict that the e-commerce market will continue increasing in the US, as well as Asia and Europe. New technologies – including Web-TV and advanced mobile applications – will help fuel this growth.

What are the environmental ramifications of this rapid growth? Business to consumer (B2C) e-commerce, which replaces "brick and mortar" stores with "click and ship" shopping, could significantly reduce energy consumption required for facility heating and cooling and personal transportation. Some preliminary studies suggest that the logistics of e-commerce are cleaner and greener than the logistics of traditional commerce.

However, not all indicators point to positive outcomes. Predictions that computers would lead to a paperless office may portend a similar fate for e-commerce – an unprecedented increase in consumption of packaging and consequentially solid waste. Unless shipping logistics are carefully planned, fuel consumed by vehicles making home deliveries could exceed the fuel savings from reduced trips to the mall. For example, the 250,000 copies of <u>Harry Potter and the Goblet of Fire</u> shipped to Amazon.com customers in July 2000 required much more energy to transport overnight via air than a trip to the bookstore via car. However, if in the future more products are delivered digitally via the Internet (e.g., music, software, books), energy and emissions from product distribution will be virtually eliminated.

Similarly, business-to-business (B2B) e-commerce, which facilitates improved communication between manufacturers and their suppliers, may also yield environmental dividends. Improved inventory management, including just-in-time manufacturing, is one such application. Better inventory tracking reduces excess inventories (that may ultimately be disposed when they become obsolete) and reduces the space and energy needs for warehousing. However, just-in-time manufacturing may increase the environmental impacts of shipping, or simply shift the warehouse location to distribution facilities operated by FedEx, UPS or other delivery services.

All these examples suggest likely land use impacts resulting from growth of the Internet. While B2C e-commerce could reduce the need for strip malls, it also enables someone living in a remote state to work for an employer located in an urban or suburban center. Thus, telecommuting may actually encourage suburban and rural sprawl.

Although government, industry experts, non-government organizations, and a broad set of stakeholders are beginning to speculate about the potential positive and negative effects of e-commerce on the environment, research on this topic is in its infancy. The rapid development of information and communications technologies in recent years has sparked much discussion about

the costs and benefits of the "information economy" and whether the information, communications, computing, and electronic (ICCE) technologies, as well as the evolution in business strategies made possible by those technologies, will result in net gains or losses for the environment.[1] A recent book on the environmental impacts of the information economy provides insight on the current understanding:

> "The advance of ICCE has been so rapid that we do not yet know, for instance, under what circumstances tangible gains or losses will arise for sustainable development from these technologies, or the degree to which ICCE technologies serve as substitutes or complements to existing technologies and socio-technical systems…. [Some] argue that, because ICCE technologies speed up transactions, provide more perfect information and are less materially intensive than other forms of communication and information, they are likely to yield more concrete environmental benefits. Others argue that these technologies are not so light as is claimed and that the quantity of data and the problem of distinguishing between information and disinformation undermine the potential for accessing better information." (Park and Roome, 2002)

Fichter (2002) distinguishes three types of environmental effects that can be attributed to information technology (IT):[2]

- First order effects resulting from use of computing infrastructure. These first order effects include pollution resulting from the energy required to power the internet and manufacture computer systems. First order effects also include solid and hazardous waste resulting from manufacture and disposal of computer hardware.

- Second-order effects resulting from the use of the information embedded in ICCE. These effects include, for example, changes in material and energy use resulting from information-enabled product design and life-cycle management, manufacturing and supply chain management, logistics/distribution, electronic markets, and product stewardship.

- Third order effects including broad, systemic changes due to subsequent effects of information technology, such as changes in economic structure, lifestyles, and consumption patterns.

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[1] ICEE, as used in this document, is a broad term encompassing all information technology such as internet and intranet applications, databases, and other software products.

[2] Fichter specifically refers to e-commerce, however his insights seem equally relevant for information technology as a whole. E-commerce is the subset of ICEE that deals with online transactions. E-commerce is defined by the US Census Bureau as "the value of goods and services sold online. The term "online" includes the use of the internet, intranet, extranet, as well as proprietary networks that run systems such as Electronic Data Interchange (EDI)."

It is these second-order effects that have enabled fundamental changes in business strategy. One such change is the shift towards selling a service or function in place of a product. In this new business strategy, the product becomes a means of delivering a "function," rather than an end in itself. One such example of this shift is on-line "business finder" services that replace or supplement telephone books and maps for identifying and mapping the location of a business. Environmental benefits include reduced use and disposal of paper-based directories that are quickly outdated.

ICCE technologies have also facilitated more complex product to service transitions, including the transition of chemical manufacturers from their traditional role as a chemical supplier to a service-based function of providing chemical management services. This type of change in business strategy has been called "servicizing." Servicizing transforms what were once relatively simple transactions of buying and selling a "product in a box" into "a spectrum of property rights arrangements, including leasing, pooling, sharing, and takeback." (White et. al., 1999) While servicizing does not necessarily rely on information technology, in cases like CMS, the ability to integrate, track, and analyze information from within and between manufacturing facilities appears to be critical to the success of the service model.

Although the servicizing trend has been driven by business, not environmental concerns, servicizing has the potential to foster environmental improvements by internalizing environmental costs and optimizing product use.[3] The contributions of IT to servicizing, and ultimately to reduced environmental impacts, have not been well characterized to date. This report presents a case study of one example of the servicizing trend – chemical management services (CMS) – and considers the role that information technology plays in making the product-to-service shift possible and assesses the resulting environmental impacts. This report uses the term Chemical Management Information Systems (CMIS) to encompass the information technologies associated with CMS.

This report is divided into five sections. Following this Introduction, the Background section discusses the literature on CMS and related trends in IT and e-commerce. The Methodology describes the process for gathering information included in this report. The Findings section summarizes the results of interviews with CMS providers and customers. The Conclusion offers reflections on the relationship between information technology, servicizing, and reduced environmental impacts in the case of CMS.

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[3] In general, servicizing creates opportunities and incentives for extended producer responsibility (EPR). EPR is "the principle that actors along the product chain cycle share responsibility for the lifecycle environmental impacts of the whole product system." For a discussion of the relationship between servicizing and EPR, see White et. al., 1999.

Chemical Management Services Background

Over the last several years, an increasing number of chemical suppliers have changed the nature of their business from providing a product (chemicals) to providing a service (chemical management). Traditionally, companies purchasing chemicals for indirect use (versus direct use where chemicals are a constituent of the final product) view these chemicals as having limited intrinsic value. Rather, the real value of the chemical is in the function it performs such as cleaning, coating, or lubricating. Under the traditional relationship between the chemical user and its supplier, wherein the supplier is compensated based upon the volume of material sold, the two parties have conflicting incentives – while the customer has the incentive to reduce chemical use, the supplier wants to increase the volume of chemical sold (see diagram below).
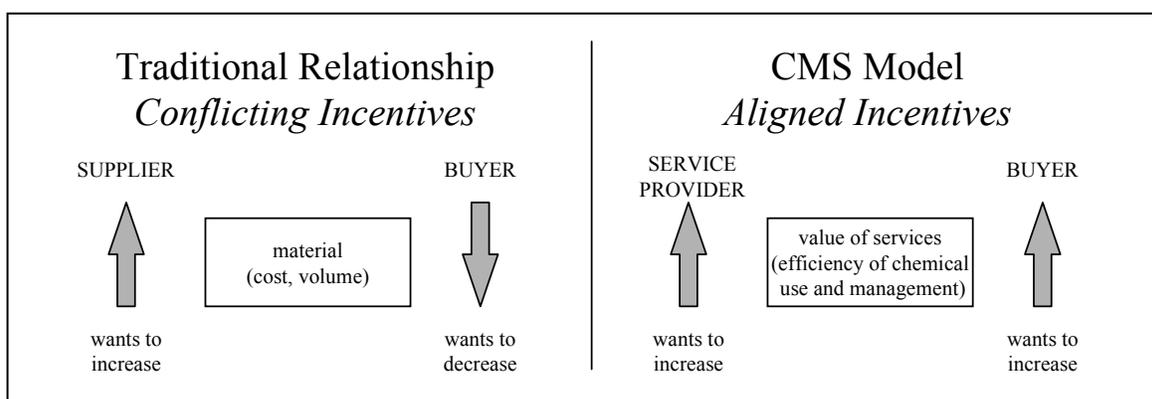
The Chemical Strategies Partnership (CSP), a joint partnership between Tellus Institute and California Environmental Associates, has developed a new supplier-customer model known as chemical management services (CMS). As shown in the diagram, CMS restructures the financial incentives in supplier-customer contracts and transforms the role of the chemical supplier to that of a chemical *service provider*. The chemical management service provider (CMS provider) assumes responsibility for managing chemicals and its compensation is tied to this service. As a result, both the customer and the service provider have aligned incentives – reducing chemical use.

Chemical management begins with chemical procurement and spans the activities associated with the use and disposal of the chemical. These stages of chemical management (which are often called the "chemical lifecycle") include procurement, inspection, inventory, delivery, use, collection and disposal, environmental health and safety, emergency preparedness, and liability. When a chemical supplier agrees to take on some of the responsibility for chemical management in any or all of these stages in the chemical lifecycle, it represents a shift to chemical

management services (CMS).[4] CMS providers may purchase and deliver chemicals, maintain the inventory, and track Material Safety Data Sheets (MSDSs). They also may provide a broader range of services including process efficiency improvement, data collection for environmental monitoring and reporting, and waste collection and disposal. (Chemical Strategies Partnership, 2002)

CMS customers are primarily large, multi-national Fortune 500 companies in four industry sectors: automotive, metalworking, aerospace manufacturing/air transport maintenance, and electronics (e.g., semi-conductors and disk drives). CMS market penetration varies by industry, from a low of 5-15% of the value of chemical purchases in aerospace manufacturing, to a high of 50-80% of the value of chemical purchases in automotive manufacturing. (Chemical Strategies Partnership/CMS Forum, 2000) Newer areas of CMS growth include, for example, food and kindred products and paper and allied products.

IT is a key component of most CMS arrangements. While the type and scope of information technology used varies widely, the value of information is a clear driver for CMS. The Chemical Management Services Industry Report for 2000 states that the most common benefits of CMS claimed by both providers and customers are improved data management, improved inventory management, and reduced chemical purchase costs. The second most common environmental benefit as reported by consumers, after chemical use reduction, is environmental information management (reported by about 70% of respondents), followed by improved MSDS management (reported by about 50% of respondents). Perhaps because of the high value of information as a part of CMS, the top area for planned capital investment among CMS providers was information management (cited by about 90% of CMS providers interviewed). (Chemical Strategies Partnership /CMS Forum, 2000)

Methodology

The findings in this report are based on a total of nine telephone interviews with CMS providers and customers conducted between June 7 and September 24, 2002. Tellus selected CMS providers and customers based on the recommendations of the Chemical Strategies Partnership (CSP), for which Tellus Institute is a program manager. CSP initially contacted potential interviewees by email to request volunteers to participate in the study. Tellus then conducted follow up phone calls and emails to request participation of some companies that did not initially volunteer, in order to get a sufficient pool of interviewees. Interviewees are listed in Tables 1 and 2 below.

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[4] CMS providers may also include waste haulers, environmental engineering firms, or other services firms that are not using chemicals themselves but that take on responsibility for chemical management. This paper focuses on CMS provides that have their roots in the chemical supply business (either as chemical manufacturers or distributors).

Table 1. CMS Providers Interviewed for this Report	
Company	**Business Focus**
Air Liquide	Air Liquide's core business is supplying industrial and medical gases to industry. Of the 3,800 people working in the company's US subsidiary, approximately 230 people are working on CMS.
Ashland Inc./ Ashland Specialty Chemicals	Chemical services located within Ashland's specialty chemicals business; focus is on the semi-conductor industry. Ashland Inc, which includes the specialty chemical business and the distribution business, has 7,100 employees worldwide, 250 of whom work in the chemical management group.
Haas Corporation	Originally a specialty chemical manufacturer, now 98% of Haas' revenues derive from CMS. Haas specializes in chemical usage and waste reduction, particularly in the automotive and aerospace industry, but increasingly in the electronics sector. On October 1, 2002, Haas that it had acquired the Total Chemical Management business of Radian International LLC, forming Haas TCM. The acquisition doubles the size of Haas, creating a company with annual revenues of $100 million and 250 employees.
Shell Services	An independent subsidiary of Shell Oil. Shell Services as been in operation for between five and six years, and the US division of Shell Services has been in operation for two years. The company provides CMS primarily to the automotive manufacturing industry, and is beginning to supply services to the pulp and paper and food industries.
URS/Radian	URS Corporation is a professional services company with a focus in planning, engineering, architecture, environmental and applied sciences. URS/Radian's Total Chemical Management (TCM) services specialized in procurement, logistics and environmental, health and safety compliance, particularly in the aerospace and defense sectors. As noted above, URS/Radian's TCM business merged with Haas in October 2002.

Table 2. CMS Customers Interviewed for this Report	
Company	**Primary Industry or Products Produced**
Daimler Chrysler	Automotive industry; using CMS in 10 of 12 assembly plants
General Motors	Automotive industry
Seagate	Computer disk, tape, and software products
United Technologies Corporation	Aircraft engines, heating and air conditioning systems, elevators and escalators, aerospace systems, helicopters, and fuel cells

Tellus sent interviewees a list of questions that served as an interview guide in advance of the telephone interview (see Appendix A). The telephone interviews generally lasted between 30 minutes and one hour. Tellus prepared summary notes from each interview and sent a copy of these notes to the interviewee to check for accuracy and to identify any confidential information. Tellus then made any needed revisions to the notes. The notes that resulted from this process are included in Appendix B.

The interviews which form the foundation for this report do not represent a statistically valid sample of CSP providers or customers. Consequently, no definitive conclusions can be reached about overall characteristics of CMIS based on this report. However, this report does provide illustrative examples of the use of CMIS.

Findings

There is no single definition for CMIS. For the most part the companies interviewed do not conceive of CMIS as a stand-alone tool distinct from CMS. For several companies, CMIS is an umbrella term to describe databases that have been evolving for some time. The foundation of CMIS is chemical tracking, which is central to a successful CMS system. CMS providers we interviewed incorporate information technology to different degrees and with different emphases within the scope of their services. Despite the diversity in CMIS, all respondents perceived CMIS as an important element of CMS. It is interesting that while most companies are using CMIS capabilities provided by CMS suppliers, some customers (e.g., General Motors) have created their own, company-specific CMIS programs. Most CMIS programs are at least partially customized based on customer requirements. Also, several of the CMS customers interviewed are in the early stages of adopting a CMIS, or have not yet fully rolled out use of such a program. Therefore, these findings reflect anticipated CMIS capabilities, benefits, and costs to the extent that CMIS programs have not been fully implemented.

The following four sections summarize the results of the interviews. The first section discusses the motivation of companies to adopt CMS, and the role that information needs played in that motivation. The second section describes capabilities of the various CMIS systems in use among the companies interviewed. The third section discusses perceived benefits and costs of CMIS. The fourth section reports goals for future CMIS development.

Motivation to Adopt CMS

CMS customers interviewed described numerous motivations for adopting CMS. As might be expected, customers' overarching goals were to save time and money. Customers anticipated that CMS would help them:

- Save on chemical costs;
- Gain supplier expertise in chemical management;
- Create an incentive for suppliers to reduce amount of chemicals used;
- Reduce number of different types of chemicals used (to simplify chemical management); and
- Provide a safe workplace.

In addition to the general motivations above, the specific need for chemical use and purchasing information has motivated customers to adopt CMIS as a part of CMS.   Customers interviewed said they wanted to have CMIS capabilities in order to:

- **Streamline data collection**. Without CMIS, customers end up sending frequent data requests directed to chemical suppliers, and these data requests quickly become a burden to customers and suppliers. Moreover, different requests for chemical data produce inconsistent responses from suppliers. The customer then has to spend a considerable amount of time manipulating the data to make sense of it. CMIS promises to make the data collection process more efficient and to provide more accurate, consistent data.

- **Automate or facilitate regulatory reporting**. Preparing reports required by regulatory agencies can take an enormous amount of staff time for customers. CMIS has the potential to significantly reduce the amount of labor needed to compile reporting data.

- **Provide information in a more useful form**, including standardized reports and user-defined reports. CMIS allows customers to specify which data points they want reported, and different reports can be generated for different users within the company (e.g., operations, purchasing, environmental, etc.).

- **Understand cost centers**, by tracking chemical use and costs for various plant activities. CMIS allows customers to analyze where and how chemicals are being used in order to improve efficiency.

- **Standardize purchasing** and make procurement procedures more user friendly. Customers want to make sure they pay the same price for chemicals at all sites and that all facilities follow standard purchasing procedures.

- **Increase oversight** for purchasing chemicals not on authorized procurement lists. Customers want to enable managers to block or review purchase of chemicals that the company is trying to tightly control or phase out altogether.

- **Avoid liability** for improper worker chemical exposure (both by avoiding employee overexposure and also by documenting exposure, in the event that workers make unreasonable claims).

Thus it becomes clear that customers need for increased access to information and improved ability to analyze data are contributing to the demand for CMS.

CMIS Capabilities

The CMIS in use by the companies interviewed are quite diverse in their structures and capabilities. CMIS can replace disparate information tracking systems usually housed in various departments. Table 3 lists the types of information that may be tracked by CMIS for each stage in the chemical life cycle. Note that not all CMIS programs have all of these capabilities.

The key function of the CMIS is to **integrate** and **automate** data collection and reporting. Key CMIS capabilities reported by CMS providers and customers include:

- **Transaction automation**, including notification of orders, e-mail notification of threshold levels.

- **Automated inventory systems** using bar coding technology and near real-time location by product, quantity/lot, and expiration dates.

- **On-line documentation,** including EH&S materials, procedures, training materials, searchable MSDS, contracts, specifications, audit processes, and calibration for instruments.

- **Tracking chemical use** by location, shift, machine, department, and facility.

- **Monitoring** chemical characteristics and performance.

- **Unified data requests and reports**. CMIS can ensure that consistent data are being provided from various suppliers to all departments within the customer company.

Table 3: Data Tracked for Each Chemical Life Cycle Stage	
Chemical Life Cycle Stage	**Types of CMIS Data that May be Tracked**
Procurement	Chemical quantity, unit of measure, quantity used each month, cost, purchase price variance, part number, description, shelf life, purchase size, manufacturer, distributor
Inspection	Quality control (either inspection spot checks or certificates of analysis or performance), lot number, time and temperature sensitive material, chemical specifications
Inventory	Quantity and location of inventory by product and containers, storage requirements, lot numbers, expiration dates, working capital investment
Delivery	Points of use (either process area or piece of equipment) for each chemical, quantity, delivery date, lot number, user, procurement, on-time delivery schedule
Use	Quantity of chemical used by location, shift, machine, department, and facility, inventory, ordering, and accounts payable, equipment trends analysis, maintenance records and time spent on preventative maintenance, emissions/waste output, throughput
Waste Collection and Disposal	Cost of disposal, quantity and constituents of waste, water content, recycling information, cost of lab packs, waste manifests, waste profiles and characterization, waste labels, hazardous waste per unit product, and aggregate solid waste
Liability	Worker exposure, risk assessments (stored in a separate, secure location)
Emergency Preparedness	Emergency procedures and response plans
Environmental Health and Safety	Environmental reporting of chemicals and constituents, MSDSs, product placards, safety standard operating procedures, staff training materials

- **Access to integrated data**. Integrated information across departments and facilities that incorporates regulatory data, data on purchase transactions, and chemical and materials usage data. Information on total costs of chemical management, as well as procurement costs.

- **Intelligent procurement and inspection**. On-line catalog with links from procurement to other types of information such as MSDS, quality data, and inventory. Procurement systems can also include on-line "one-click" ordering and electronic invoicing.

- **Supervisory/advisory control in procurement** to prevent unauthorized ordering of chemicals not on an authorized list of chemicals. The authorized chemical list may be process-specific, i.e., a chemical may be allowed for one process but not another.

- **Troubleshooting** to understand problems, for example, to help a customer understand why a process has start up problems Monday morning, or why there are differences between different shifts.

- **Chemical use trending and forecasting** that helps managers predict impending maintenance problems based on variations in chemical use in order to fix problems before they occur. For example, in the automotive industry, there are a lot of bearing failures in equipment. A CMIS can detect leakage of lubricants, thus enabling the manufacturer to repair equipment before the bearings fail. CMIS programs can monitor trends in chemical use, changes in components, and contaminants in chemicals.

- **Waste tracking** from generation point to disposition, including waste profiling and characterization. Some CMIS programs can automatically generate waste labels and waste manifests.

- **Quality monitoring,** including tracking of quality incidents/non-conformities and corrective actions taken, as well as safety and environmental audits.

- **Maintenance tracking** to monitor equipment, preventative maintenance, and repairs.

- **Worker exposure monitoring**, for example, by identifying what chemicals are used in which work areas, and linking those chemicals to exposure of specific workers.

- **Project tracking.** CMIS can allow customers to track information for new practices that are being tested (e.g., piloting a new stripper in a paint booth). Project tracking can include project number, priority, chemicals involved, cost, water use, materials use, quality of project, staff information, status, and project chronology.

- **Benchmarking** enables a CMS provider to show the customer how it is doing on chemical use efficiency or other key characteristics compared to other customers.

Benefits and Costs of CMIS

While it is difficult to distinguish the benefits of CMIS from CMS, companies that adopt CMIS report many types of benefits, as follows:

- **Reduced costs.** Again, it is difficult to separate the contribution CMIS from CMS in cost reduction, but clearly the system as a whole is helping customers reduce chemical costs. For example, one respondent saw fixed cost of products fall 60% after CMIS/CMS introduction. Another company is expecting to save over 15% on its annual chemical costs. Note that the value of CMS varies widely by site. CMS savings could be on the order of a few thousand dollars a year for a smaller site or up to millions of dollars for a large site.

- **Access to a single-point of contact for centralized data**, from various departments and facilities, which reduces response time needed to pinpoint problems and facilitates information delivery based on the user's data needs.

- **Regulatory and "decision-making" reporting**, including standard regulatory reports and ad-hoc reports requested by regulators or customers down the supply chain. For example, one respondent noted that it used to take several staff people weeks to compile regulatory reports from disparate sources. With a CMIS in place, regulatory reporting took very little time. Moreover, CMS customers were able to respond within minutes to spot inspections and inquiries by instantly calling up data on company-wide chemical use. For example, one CMS customer was able to respond to an inquiry by one of its customers regarding company-wide use of a particular chemical based on CAS number. The CMIS enabled a response within hours, while staff working without the CMIS needed at least several weeks to respond.

- **Reduced regulatory obligations**. One company found that improved data on chemical use allowed the company to limit some of its Title V air permits.

- **More relevant information** due to better context for data. Several respondents emphasized that different data users have different information needs. For example, EH&S staff may be primarily interested in regulatory reports, while process managers may be more interested in forecasting chemical use or troubleshooting problems. In response to these varying needs, CMIS can facilitate both standardized reports and user-defined reports.

- **Streamlined purchasing** by reducing the number of purchases, consolidating the types of chemicals purchased, standardizing chemical names and reporting units (e.g., kilograms or pounds) used across facilities, enabling control over listed chemicals defined by CMIS customer.

- **Allowing staff to shift focus to high-value activities and/or reduce staffing needs.** One respondent noted a 50% reduction in staff time spent tracking chemicals through use of bar-coding and automated data capture. Another respondent said that the CMIS allowed EH&S staff to spend more time tracking and managing waste, rather than pulling together data for reports. Some CMIS customers have been able to reduce staffing requirements or re-assign employees.

- **Better understanding of the total costs of chemical use**, including management costs, which helps companies drive down chemical costs.

One respondent pointed out that the value of CMIS varies by industry. Specifically, CMIS is most valuable in industries that use a diversity of chemicals, and/or where chemicals comprise a relatively high proportion of manufacturing costs.

CMIS results that directly benefit the environment as well as CMIS customers include:

- **Reduced chemical use and waste**, as a result of chemical use analysis and troubleshooting. Also, since chemicals are tracked more closely they do not become lost or expired. CMIS analytic services can be used to extend product bath life, which prevents waste by making additions or replacing one component of a chemical bath, rather than replacing the whole chemical bath. Most interviewees were not able to provide quantitative data on reduced chemical use, but most respondents cited this as a benefit of CMIS. One CMIS provider said that as a result of CMS and CMIS services, its customers usually see a 20-30% reduction in chemical use over three years. Chemical use information can be also be used to drive pollution prevention projects.

- **Product substitution**. In most cases, businesses say they do not have much flexibility to substitute chemicals due to given customer or product specifications. However, CMIS has enabled some substitutions of less toxic chemicals, and it has also allowed some companies to streamline the number of different types of chemicals they use, thus facilitating chemical management. CMIS can help customers phase out of chemicals using alternate chemistry, if certain chemicals can no longer be used due to environmental impact or if a supplier is going out of business. One CMS provider noted that most of its recommendations for chemical substitution are performance-based (e.g., related to viscosity). This company has made some substitution recommendations based on environmental concerns, but these recommendations cannot be attributed to the CMIS.

- **Ability to better control procurement of banned or listed chemicals** through advisory or supervisory control over chemical orders.

Based on responses in this survey, it seems that business benefits from CMIS are more predominant than environmental benefits. This should not be a surprise, given that the motivations for adopting CMIS and CMS are centered primarily on business concerns. However, CMIS does also enable environmental benefits as described above.

Since CMIS is generally adopted as part of the CMS package, customers do not generally report costs of CMIS adoption. Where customers are creating their own CMIS, costs include buying software and managing information technology. Even in the cases where customers have

directly invested in information technology associated with CMIS, they report that the benefits far outweigh the costs.

Goals for future CMIS development

As noted above, CMIS capabilities vary based on the system. Capabilities that are standard in one system may not be included in another. Therefore, goals for some CMIS development include some capabilities that are already encompassed in other existing systems. The goals for future CMIS development reported by CMS customers and suppliers include:

- More user-friendly interfaces;

- Enabling document sharing in a secure location;

- Providing links to statistical analysis packages to analyze quality and process control;

- Using live data that provide real-time, continuous monitoring of processes;

- Global inventories;

- Complete tracking of chemicals through the project life-cycle stages. While the various CMIS systems in aggregate have information on tracking chemicals throughout the chemical life cycle, not all CMIS programs have all life-cycle stages represented;

- Ability to quantify the total costs of adding a new chemical to the manufacturing process. For some respondents total costs are not routinely calculated, but are conducted on a special case-by-case basis; and

- Life cycle data for chemicals, e.g., environmental impacts in raw materials extracting, production, use, and disposal.

Conclusions

Based on the results of this survey, it seems clear that CMIS programs are providing significant value to CMS customers among the companies interviewed. Information technologies enable companies to access data that were previously unavailable and integrate many sources of information into reports tailored to users needs. CMIS enables chemical use trending and analysis that can help pinpoint inefficiencies and identify opportunities for better performance. The direct contributions of CMIS to reduced environmental impact are difficult to quantify or isolate from CMS systems. Overall, CMS and CMIS together help companies reduce chemical use and waste, control the use of targeted hazardous substances, and in some cases substitute less toxic products in the manufacturing process. Thus, information technology is enabling a shift to a service-based business strategy, which is associated with positive environmental impacts.

As an example of information technology overall, the case of CMIS suggests that the contribution of information technology to second-order environmental impacts may be positive.

Since CMIS enables CMS, which has positive environmental impacts, the role of information technology appears, at least in this case, to facilitate the transition to a more sustainable industry by allowing more complete material and cost accounting, facilitating more detailed analysis, and improving management control over business operations.

Appendix A :   References

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Appendix B :   Interview Protocol

Note: The Interview Protocol for CMS customers was slightly revised after the first few interviews, when it became clear that not all customers were in the same stage of implementing a CMIS. Revised versions of the questions are included in brackets below.

Chemical Management Information Systems Survey:

Tellus Institute, a non-profit environmental research and consulting organization, is currently conducting a project evaluating the economic and environmental benefits associated with chemical management information systems. Tellus joined with California Environmental Associates to create the Chemical Strategies Partnership (CSP), which is working with several electronics firms to advance chemical management services (CMS) to reduce chemical use while achieving cost, efficiency, and environmental improvements. This survey grows out of the work of the CSP and its CMS Forum, and is funded by an Environmental Leadership Grant from the Robert and Patricia Switzer Foundation.

The goal of this survey is to determine the environmental and economic ramifications of CMS and chemical management information systems (CMIS) as compared to traditional chemical procurement, use, and disposal handled internally by chemical users. As you know, CMIS is an e-commerce application that uses the Internet to collect and track real-time data on chemical purchases, inventories, use, and waste. An integrated CMIS can replace disparate information tracking systems usually housed in various departments of a firm including procurement, finance, EH&S, inventory tracking and scheduling. Tellus Institute is seeking to assess the environmental and cost implications of implementing CMIS. The survey includes two sections, one for CMIS providers and one for their customers, as follows. Tellus intends to conduct this survey by phone interview. The questions below are provided as a guide to the questions Tellus would like to cover in that interview.

Questions for CMIS Providers:

1. Can you briefly describe your CMIS product's capabilities and features?

2. What chemical life cycle stages are included in your CMIS product? For example, are procurement, inspection, inventory, delivery, use, collection, management/disposal, liability, emergency preparedness, and environmental health and safety covered?

3. What types of data are tracked at each life cycle stage, e.g., chemical quantities, labor, costs?

4. To what extent have you been able to document the benefits for companies using your CMIS product?

    a. For example, compared to the costs of traditional chemical use (without CMIS systems), have your customers found measurable reductions in chemical cost, volume of chemical use, cost of waste management, production downtime, chemical obsolescence, chemical management costs, or liability?

    b. Have your customers found qualitative improvements in the extent of information available about the chemicals they are using, knowledge of regulations affecting those chemicals, or less hazardous/more efficient substitutes?

5. Based on your market research, what benefits of the CMIS do you believe are most valuable to your customers? Do companies in different industry sectors value CMIS benefits differently? If so, how?

6. Are there features of CMIS that are not currently incorporated into your product, but that you believe would be valuable to your customers?

Questions for CMIS Customers:

1. [To what extent has your company adopted CMS and/or CMIS?]

2. What information tracking system(s) did your company use to manage chemicals prior to adopting CMIS? For example, did you use procurement, finance, environmental health and safety management systems, inventory, or scheduling systems? What data did these information systems track?

    [What information tracking system(s) does your company use to manage chemicals? What data do these information systems track?]

3. What motivated your company to invest in a CMIS?

    [What motivated your company to invest in CMS and/or CMIS?]

4. What are the primary differences between your former tracking system(s) and the CMIS?

5. What chemical life cycle stages are included in the CMIS you use? For example, are procurement, inspection, inventory, delivery, use, collection, management/disposal, liability, emergency preparedness, and environmental health and safety covered?

6. What types of data does the CMIS track at each life cycle stage, e.g., chemical quantities, labor, costs?

7. Now that you are using a CMIS, do you track new kinds of data or more detailed data about your chemical use/management compared to your previous tracking system(s)?

[Does your CMIS track new kinds of data or more detailed data about your chemical use/management compared to other methods you have used in the past to manage chemicals?]

8. What benefits has your company derived from implementing a CMIS?

    a. For example, have your found measurable reductions in chemical cost, volume of chemical use, cost of waste management, production downtime, chemical obsolescence, chemical management costs, or liability?

    b. Have you found qualitative improvements in the extent of information available about the chemicals they are using, knowledge of regulations affecting those chemicals, or less hazardous/more efficient substitutes?

    c. Can you describe specific examples of where implementing the CMIS has provided environmental and/or economic benefits to your company?

    d. What do you think are the most valuable benefits of adopting a CMIS?

9. Have you found any disadvantages of having a CMIS? For example, has adopting the CMIS resulted in any added costs of chemical management (either time or monetary costs), other than the cost of the system itself?

10. How has adopting a CMIS affected your company's labor and staffing needs?

11. Are there additional features that you would like to see incorporated into your CMIS product?

Appendix A :   Interview Notes

INTERVIEWS WITH CMIS PROVIDERS

Notes from June 28 Interview with Joe Hill, Product Manager, Services for Total Gas and Chemical Management, Air Liquide

Background

- Air Liquide is a 100-year old French company that has operated in the United States for the last 30 years. Air Liquide started working in the electronics industry in the late 1980's. The main organization is in Dallas. There are 230 people working on CMS in the US, and 600 people working on CMS worldwide.

- Approximately half of Air Liquide's CMS business is for chemicals and gases; half is just gases. There is only one operation where Air Liquide provides CMS for just chemicals.

- Part of Air Liquide's services include making arrangements for waste disposal, preparing hazardous waste manifests, and regulatory reporting.

- Air Liquide provides analytical services for gas, liquid chemicals, and ultra pure water management.

- Air Liquide's CMS contracts are service based and depend upon services desired. For example, a contract could include warehouse management and point of use validation. Air Liquide generally operates, maintains and repairs its customers' equipment. In some cases a customer may ask Air Liquide to maintain a spare parts inventory, so that Air Liquide can make minor repairs and simply charge the customer for needed spare parts. However, customers usually retain control over making major repairs. Contracts include a labor cost.

CMIS – How it Works

- Air Liquide's internet- and Oracle-based CMIS is called Fab Net. It has five primary components: quality information management, computer maintenance management, environmental management, laboratory inventory management system (LIMS), and purchasing.

- The quality information management component provides document control, procedures, chemical specifications, calibration for instruments, and training information for employees. All of these features are available to Air Liquide's customers except for document control and training information.

- The quality management system tracks quality incidents (non-conformities) and corrective actions taken. This information is available to customers if it is related to their facility. The system also tracks safety and environmental audits. When non-conformities are found, the system automatically emails the person responsible for following up.

- The computer maintenance management system tracks all of the customer's equipment, preventative maintenance, and repair. The system generates work orders for work to be done.

- The environmental management system tracks waste streams for profiling and characterization. It also contains MSDSs that are available to customers and employers. The system can generate labels for waste as well as waste manifests.

- LIMS is linked to the quality information management system. When chemical are received, they are verified against a certificate of analysis and then entered into the inventory. LIMS can report how much of a chemical is on site, the expiration date, a summary of how much of the chemical was used over time, and where the chemical was used (point of use validation). Once chemicals are used, the chemicals are checked out when containers are collected and taken for disposal. LIMS can generate trend information, such as changes in components, contaminants in chemicals (even if chemicals are within specification they may have some contaminants). Sometimes this trend information is used for process optimization.

- The purchasing system, which is tied to the other 4 systems, allows customers to place orders for chemicals through the internet if they purchase their chemical from Air Liquide. The system allows forecasting by enabling customers to summarize how much they are buying, the cost of chemicals over time, and past chemical usage.

- Air Liquide offers to monitor its customers' systems – this "rounds and readings" service provides information on chemical use that is entered into an electronic notepad once a shift by an Air Liquide staff person.

Life Cycle Stage	CMIS Data Tracked
Procurement	Quantity, cost
Inspection	Chemical specifications
Inventory	Quantity, expiration dates
Delivery	Where chemical is delivered
Use	Quantity
Waste Collection	Containers are scanned when the leave the factory; the system does not track where containers go
Waste Management/Disposal	Manifests, waste profiles and characterization, labels
Liability	The system tracks where the chemicals are, but otherwise this isn't covered
Emergency Preparedness	Procedures, MSDSs
EH&S	Procedures and staff training (including classes completed and needed for individual Air Liquide staff members)

- The CMIS data on chemical usage could help with regulatory reporting, as would information on wastes and hazardous materials, but Air Liquide does not provide information directly on emissions, nor does it prepare regulatory reports for its customers.

- The CMIS tracks chemical quantities for all chemicals. Cost data are only tracked for chemicals purchased from Air Liquide. Cost data include high level numbers as well as detailed spreadsheets.

- The majority of Air Liquide's customers don't want to relinquish their strategic purchasing (i.e., price negotiation), however Air Liquide can generate purchase orders for release of materials against contracts with other vendors.

CMIS – Benefits

- Air Liquide's customers usually won't or can't share specific information on the benefits of the CMIS. However, there are several general types of benefits. First, the CMIS allows Air Liquide to identify alternate suppliers (with lower cost) for chemicals that are not critical to the customers processes. (Air Liquide's customers are generally reluctant to switch suppliers for process-critical chemicals).

- The CMIS allows Air Liquide help customers phase out chemicals. For example, if a chemical needs to be replaced because of its environmental impact or because a supplier is going out of business, Air Liquide can help customers develop alternative chemistry to replace the chemical of concern.

- Using the CMIS, Air Liquide can determine the efficiency of usage for customers' chemicals, e.g., how much residual product is left in the container.

- Air Liquide can arrange joint training programs for its staff and the staff of its customers on hazardous materials and emergency response, thus generating cost savings through efficiencies of scale.

- Air Liquide can help customers save money by increasing packaging sizes, installing bulk systems, or changing equipment.

- The CMIS does help reduce obsolescence of chemicals, although the issue doesn't come up much since Air Liquide uses a first expired, first out system. The CMIS can help customers adjust purchasing so they don't over-buy. Also, Air Liquide's analytical services can determine whether there actually has been any degradation in a product that has technically expired.

- Analytic services are also used to extend bath life, which prevents waste by making additions or replacing one component of a chemical bath, rather than replacing the whole chemical bath.

- Air Liquide offers on-side blending/diluting to help customers reduce packaging and save on shipping costs.

- The most valuable benefit of the CMIS to Air Liquide's customers is having a single point of contact for the data which can be accessed by the internet. This greatly reduces the response time needed to pinpoint a problem, and it also helps customers determine what is not a problem, so they can bring the system back on-line faster.

- The CMIS system also means that customers don't need to buy or maintain a stand-alone MSDS or lab inventory management system.

- The semi-conductor industry uses such a diversity of chemicals that the breadth of information provided by the CMIS is probably more valuable in this industry than it would be in others. Also, chemicals comprise a relatively high portion of the semi-conductor industry costs. Most other industries don't need CMS or CMIS.

- Air Liquide is currently working on adding two new features to its CMIS. The first provides a place for customers to deposit shared files in a secured location, so they can share them with Air Liquide. This feature is currently being tested. Secondly, Air Liquide is developing a link between LIMS data and statistical analysis packages to enable statistical quality and process control.

Notes from June 7 Interview with Mark Kappes, Ashland Chemical

Background

- Ashland is a Fortune 110 company. Within Ashland, the chemical services/CMIS is located within Ashland Specialty Chemicals, Electronic Chemicals Division, Fab Services Business Unit, Total Chemical Management (TCM) services. The focus is on the semi-conductor industry.

- The Chemical Management group has 250 employees, and offers cradle-to-grave chemical services, such as procurement, on-site handling, hazardous waste handling, equipment maintenance, waste treatment, ultra-pure water, and analytical work. The Chemical Management group tries to offer its customers a complete line of services that covers everything except the manufacturing itself.

- The Chemical Management group has 10 sites in the U.S. and a few overseas.

- Ashland's services are usually provided on a cost plus basis, however, there is no single standard since each customer requests different invoicing methods.

- Most tier II and tier III semi-conductor businesses do chemical management in house; tier I semi-conductor business outsource, and the remainder have a combination of in-house and outsourced chemical management.

CMIS – How it Works

- Ashland's CMIS program is home-grown. Ashland has an Access program that helps with procurement and EH&S. The system is not web-based, nor is it off-the-shelf software. The Access program is tied into the overall corporate system. Ashland is looking for a new, off-the-shelf CMIS system that would support Ashland's other information systems. The CMIS Ashland is hoping to acquire will track essentially the same data as Ashland's current system, but it should allow customers to access that data directly.

- Ashland's current CMIS does not provide information on liability, emergency preparedness, or EH&S. It does provide data on MSDSs, quantity, cost, users, and lot number for chemicals. Cost data are for procurement only, not handling or overhead. Cost data are tracked by cost centered, so the CMIS can report which area of the fab is responsible for the cost, and how it relates to customer output.

Life Cycle Stage	CMIS Data Tracked
Procurement	Quantity, cost
Inspection	Chemical lot number, spot checking quality of chemicals
Inventory	Quantity, lot number, usage, trends, storage requirements, working capital investment
Delivery	Quantity, date, lot number, user, procurement, process area, piece of equipment
Use	Quantity, lot number, user, equipment, emissions/waste output (can indirectly determine throughput)
Waste Collection	Number of pounds/gallons from pickup points (does not track emissions/effluent – customer tracks those separately)
Waste Management/Disposal	Quantity of drums/containers, cost of disposal (per gallon or drum)

CMIS – Benefits

- There are three main uses of CMIS data:

  o First, to report to the customer data per unit of production, e.g., chemical usage per wafer start, disposal cost per wafer start, or chemical usage per tool

  o Second, to conduct benchmarking – how is the customer doing compared to other customers

  o Third, for research and development, how to reduce costs from a life-cycle standpoint

- Ashland has not been able to document the value of the CMIS for customers separately from the value of its chemical management services. The value of chemical management services varies widely by site – it could be on the order of a few thousand dollars per year at a smaller site. At larger sites, Ashland has documented millions of dollars in savings.

- Ashland does not negotiate chemical price with vendors (that's the responsibility of the customer). Ashland offers savings on logistics, bulk systems to reduce costs of disposing of bottles, and hazardous waste recycling or reuse (on-site or off-site). The Chemical Management group works with the Environmental Services Division within

Ashland to sell wastes between Ashland customers. For example, waste sulfuric acid from some of Ashland's fab customers is purer than the standard sulfuric acid other customers would buy elsewhere. Ashland also helps customers reuse plastic bottles and drums.

- Ashland reports to its customers chemical usage data and cost per wafer moves for areas of the fab plant.

- Ashland has worked on some joint improvement programs with its customers, such as batch studies to reduce chemical usage. Sometimes just changing the grade of a chemical can extend the batch life, thus reducing costs.

- Ashland does sometimes suggest chemical substitution based on the EH&S characteristics of chemicals, but it's very hard to get customers to switch chemicals. Generally companies are reluctant to make a change unless another customer has already proven it can work. So, Ashland can serve to share information on innovations that have been proven.

- The semiconductor industry is very finicky about tweaking its production processes, since the industry has such a small margin for error. A fab must pay for itself within 18 months or it won't be commercially viable.

- Ashland's customers rely on outsourcing chemical management primarily because of expertise – they want to focus on their core business, not peripheral operations. They also want to transfer liability to Ashland as much as possible.

- The semi-conductor industry is probably an industry leader in using CMIS.

- Ashland helps support environmental reporting, but they don't fully take on the responsibility of environmental reporting because they don't believe that's a function that should be outsourced (i.e., a company needs to be aware of its environmental performance). However, Ashland can help a company reduce the amount of time it needs to spend on environmental reporting.

Notes from July 2 Interview with Thad Fortin, CEO, Haas Corporation

Background

- The Haas corporation started out in the 1920s as a specialty chemical manufacturer, but in the late 1980s transformed into a chemical management company. Haas does still have a small chemical manufacturing facility, but 98% of the company's revenues derive from chemical management.

- Haas' main customers for CMS are in the automotive and aerospace industry, although Haas is now also moving into the electronics industry.

- Haas' fee structure varies depending on the customer (e.g., dollar per unit production, cost per pound or per gallon of chemical, service fees for staffing, gain sharing, management fees). Haas often uses a cost per unit of chemical fee structure. Haas does not use a cost-plus system (i.e., does not integrate management fees into cost of chemicals). The company does not sell its CMIS system separately from its CMS services.

CMIS – How it Works

- Haas has two proprietary CMIS products, Haastrac and Haastec. Haas also has purchased an environmental reporting CMIS system.

- Haastrac is a purchasing and business information management system. It tracks orders through the system and reports on chemical usage. Haastrac can track a chemical in up to six different locations or users within a plant. Haastrac ties directly to the Haas accounting and billing model.

- Haastec is a statistical process control (SPC) model that addresses chemical processes. The system looks at how products are being used in a plant, chemical characteristics (e.g., pH, conductivity, dissolved solids), and performance (e.g., usage analysis, problem tracking). The system can analyze unlimited parameters and is used for problem solving analysis.

- Haas purchased an environmental reporting system. The company purchased this system off the shelf, rather than developing a proprietary system, because this way it receives quarterly updates on regulations, reportable quantities, and similar information by state. MSDSs are included in the environmental reporting system. Haastrac and Haastec both tie into the environmental reporting system. The environmental reporting system generates reports for SARA Tier II, CERCLA spill

reports, HAPs/VOCs reporting, and spill reporting. The system enables analysis of product constituents, customized reporting, and secondary labeling. The environmental reporting system can also conduct MSDS search by location, ingredient, CAS number, supplier, or issue date.

▪ The CMIS systems at Haas cover all of the life cycle stages, depending on customer requirements.

▪ Customers get monthly reports and can get customized reports (they cannot access data directly).

Life Cycle Stage	CMIS Data Tracked
Procurement	Quantity, cost
Inspection	Quality control, lot number, time and temperature sensitive material
Inventory	Location, by product, quantity, containers, what can and can't be stored near each other
Delivery	Point of use -- what cabinets or areas have which chemicals
Use	Quantity by location, shift, machine, department, facility
Waste Collection and Disposal	Cost, quantity, constituents, water content, recycling, cost of lab packs
Liability	Not tracked
Emergency Preparedness	Not tracked
EH&S	Environmental reporting of chemicals and constituents, MSDSs (including archived obsolete MSDSs), product placards, safety standard operating procedures

CMIS – Benefits

▪ The primary benefit of Haas' CMIS is that it provides much more accurate information for the customer. The system operates off of usage information, not purchasing data, providing a much more precise, in-depth picture of chemical

management at the facility. The CMIS allows the customer to funnel down to detailed levels of data, rather than just providing high-level information.

- On average, the CMIS allows for a 50% cost reduction in manpower spent on tracking chemicals. In addition, customers don't have to continually invest in software.

- Haas' CMS services and its CMIS help customers reduce chemical usage and find alternative products. On average, customers have double-digit cost savings annually.

- Typically, at the end of three years, a company is saving 20% off of chemical costs (net of all fees), and 20-30% off of chemical usage.

- Haastec process reporting is probably the most valuable service for customers. Customers use this service to troubleshoot problems. For example, Haastec can be used to help a customer determine why a process has start up problems on Monday morning, or why there are differences between different shifts.

- The benefits of the CMIS are relatively consistent throughout the industries that Haas serves.

- Haas is currently prototyping having live data on Haastec. This improvement to the system would provide real-time, continuous monitoring of processes (currently data is entered on a daily basis through metering and other analytical devices). Having access to live data would be very valuable for Haas' customers.

Notes from June 7 Interview with William Soliday, Business Development, Shell Services

Background

- Shell Services is a global company. It has been in operation for between five and six years. The company is run under Shell Oil, but it operates as an independent organization in those geographic locales where there is a market. Shell Services is based out of London and operates in 15 countries. US Shell Services is two years old.

- One of the main motivations for Shell to start its services business was to differentiate itself from competitors through its services. Shell Services offers maintenance, energy management, environmental management, and chemical services, for example.

CMIS – How it Works

- Shell Services offers CMMS (Computerized Maintenance Management System), a CMIS tool to deliver its chemical services; they don't sell their software separately, nor do they view it as a separate product.

- The CMIS system uses barcodes, so that all equipment has a barcode that records chemical usage. The barcode system is then tied to Shell Services' SAP system for ordering chemicals and generating accounts payable.

- Shell Services sets up the barcode system, and then trains their customers on how to use it. When a technician services a machine, s/he records the parameters and inputs the information into the barcode reader. Bulk tank inventories are continuously monitored by phone line.

- Shell provides CMS services primarily in the automotive industry, and is beginning such services for the pulp and paper and food industries. Each of these industries uses the CMIS in essentially the same way.

- The CMIS tracks what is in inventory, usage of chemicals by each piece of equipment and what is produced as product. It can also track some materials exiting the process as waste. However, the CMIS does not provide a complete, single picture of materials throughput.

- The CMIS does not record accidents or incidents.

▪ The CMIS does not track labor costs, but it can look at the amount of time that a customer spends on preventative maintenance.

CMIS Data Tracked	Use Of Data
Chemical usage	Inventory, ordering, and accounts payable
Lubricant	Equipment trends analysis
Coolant	Equipment trends analysis
MSDS data and updates	Proper chemical handling procedures
Waste (in some cases)	?
Time spent on preventative maintenance	Equipment trends analysis

CMIS – Benefits

▪ A primary use of the CMIS data is to set up a trend analysis for a machine. For example, using the CMIS, Shell Services could track whether lubricant use dramatically increased for a particular piece of equipment, which could indicate an equipment failure.

▪ Developing trends on chemical usage helps Shell Services be in a predictive or preventive mode, rather than troubleshooting after a problem has occurred. For example, in the automotive industry, there are a lot of bearing failures in equipment. The CMIS has resulted in significant reductions in bearing failures, because it can quickly detect leakage in the system, so that equipment can be repaired before bearings fail.

▪ The CMIS allows Shell Services to quantify reduction in maintenance costs.

▪ Shell Services typically will conduct a baseline survey for customers that benchmarks chemical usage, maintenance costs and time, and production efficiency and downtime. (In some cases it is difficult to quantify reduced downtime – it depends on whether or not the plant is running continuously).

▪ Shell Services' customers do not have a particular interest in how the CMIS functions. Inventory management happens behind the scenes. As long as the customer does not have any outages, they are not concerned about how the CMIS works.

▪ Shell Services' basis for remuneration varies greatly, depending on the customer. It can be cost per unit of product, or fixed fee, or a management fee. While cost per unit provides the best price signal to the customer, there is not always enough

baseline information upon which to base a cost per unit contract, especially given changes in production rate, or changes in what is being produced.

- Shell Services would like its CMIS to be able to interface with the preventative maintenance systems of its customers, but they are often nervous about having an outside company interfacing with their data.

- Shell Services does sometimes make suggestions to customers about chemical substitution. For example, if usage of a certain lubricant is excessive, they might suggest a different viscosity lubricant. In other cases, they have suggested different coolants or cleaners. Most chemical substitution recommendations are performance based. In some cases chemical substitution recommendations are motivated by environmental characteristics, but these can't be attributed to the CMIS.

- An example of Shell Services' products is LubriPlan 2000. LubriPlan is a user-friendly, Microsoft Windows-based total lubrication management tool. The goal of LubriPlan is to make the total management of lubrication and maintenance easier and more cost-effective. LubriPlan is used by large and small businesses across market sectors.

Notes from August 6 Interview with Leigh Hayes, Vice President and General Manager URS/Radian Chemical Management Division

Background

- The Chemical Management Division will be merging with Haas, to form Haas TCM. Haas brings expertise in the metals and automotive industry to the merger while URS provides expertise in the electronics and aerospace industries and its CMIS.

- URS' CMIS system is called Total Chemical Management Information System (*tcm*IS).

- In some cases, clients outsource all of their chemical management to URS (in which case URS employees would primarily use *tcm*IS), while in other cases its customers are The primary users of *tcm*IS. In either case, URS' customers use *tcm*IS for centralized chemical information and reporting needs.

- URS's fee structure is a combination of a flat service fee, a pass through (for commodities costs), and a gain share for savings accrued from improved chemical management.

CMIS – How it Works

- *tcm*IS is not a stand-alone tool. Rather, it is integrated into its customers' and suppliers' business processes. *tcm*IS does not require double-entry of data as the system is designed to capture data from existing sources, compile the data, and analyze them. *tcm*IS functions include e-commerce, transaction automation, EHS compliance automation, and record-keeping and reporting.

- *tcm*IS contains an active catalogue of all chemicals used and their cost and health attributes.

- *tcm*IS tracks chemical quantity, cost, MSDS, and chemical species throughout the chemical life-cycle stages: procurement, inventory, usage, waste pickup, and final disposition. *tcm*IS can display data and customize reports for the user. For example, a staff person from production would look at procurement in terms of 55 gallon drums of chemical X, while an EHS staff person could access reports summarizing the quantity of various chemical species (e.g., methylethyl ketone (MEK), acetone, etc.) in the 55 gallon drum of chemical X. *tcm*IS might report unit price information compared to a baseline for purchasing, exposure and regulatory information for a product safety manager, and chemical use efficiency for a production staff person.

*Tcm*IS supports both standard reports and user-configured reports (created with an on-line drag-and-drop query construction and sent to the user in an excel file format or posted on a website).

▪ *tcm*IS allows advisory and supervisory uses of data. For example, if a client wants to prohibit use of carcinogenic chemicals, the client could use the supervisory function of *tcm*IS to screen procurement requests for carcinogens and route any unapproved chemical orders to EHS staff. Alternatively, in an advisory role, the system can simply generate a report alerting the user to the fact that s/he has ordered a carcinogen.

▪ URS's clients can use *tcm*IS in a tactical or strategic way. Tactically, clients can use *tcm*IS to get the right chemical in the right place at the right time. For example, clients can use *tcm*IS to make an emergency chemical order and see where that chemical is in the URS/Radian system. Clients can use *tcm*IS to track chemicals post delivery, or find where a banned chemical is being used. Strategically, clients can use *tcm*IS as an automated gatekeeper (e.g., by requiring approval for chemicals not on an authorized chemicals list). This list may be process specific, e.g., chemical may be authorized for use in one process, but not another. Other strategic uses of *tcm*IS include analyzing chemical efficiency, environmental regulatory reporting, worker exposure (i.e., identifying what chemicals are used in which work areas, and linking these data to specific workers), and workers compensation claims.

CMIS – Benefits

▪ *tcm*IS generates reports relevant to the client. For example, *tcm*IS reports when chemicals are shipped, received, used, and disposed of. *tcm*IS also can report who purchased the chemical (URS or the client). Report contents are driven by the *tcm*IS user.

▪ *tcm*IS allows a client to replenish chemicals by a point and click system. Stocked chemicals ordered this way are delivered to the point of use the next day.

▪ *tcm*IS allows users to monitor chemical usage and stocking levels.

▪ *tcm*IS can assess chemical use efficiency for each piece of equipment. This is typically the best forecasting tool for chemical use.

▪ Anecdotal evidence of *tcm*IS benefits include rapid response and reduced cost of responding to regulatory inspections. For example, one client once had regulatory inspectors show up at their Phoenix, AZ maintenance base to inspect the VOC content of paints. Using *tcm*IS, the off-site environmental manager was able to report all the paints used in the Phoenix plant in the last year, thus addressing the inspector's

concern within a few minutes. Before *tcm*IS, compiling the same data would have taken two weeks for three staff persons.

- *tcm*IS has also allowed URS clients to reduce the number of chemical purchases, consolidate chemicals, standardize purchasing across the enterprise (e.g., standardizing chemical names and/or ID).

- Future features of *tcm*IS may include combining *tcm*IS data with third party information systems (e.g., for products exported, provide notification of chemicals banned by other countries) and developing improved monitoring of chemicals through a facility.

INTERVIEWS WITH CMIS CUSTOMERS

Notes from August 9 Interview with Gary George, Daimler Chrysler, Paint and Energy Management Team

Background

- Daimler Chrysler has CMS in 10 of its 12 assembly plants.

- Daimler Chrysler uses four CMS suppliers.

- The company's CMS fee structure includes fixed and variable components, which are combined into a single cost per unit of product. The fixed components are measured in 1,000 unit per month increments.

CMIS – How it Works

- Daimler Chrysler used to track chemicals on a requisition basis through a non-production inventory control system. Orders were generated through purchasing, and chemicals were automatically reordered.

- Now the company has a paint and energy management system (its CMIS) which feeds into environmental reporting and tracks chemicals needed and units of measurement for each chemical (e.g., pounds, gallons, ounces). The old system tracked the number of units ordered but not the unit of measurement. Thus the new system provides greater accuracy about chemical quantities.

- The old tracking system included pricing, but with the CMIS, all orders go to one chemical manager, who pays the supplier on a cost per vehicle unit basis.

- Implementing the CMIS did not change the way that Daimler Chrysler uses the system – they still enter purchasing data provided by the chemical supplier. However the CMIS can link the data entered to provide new information on chemical management.

Life Cycle Stage	CMIS Data Tracked
Procurement	Quantity of chemical ordered, unit of measure, quantity used each month
Inspection	This is the responsibility of the CMS provider who certifies incoming chemicals
Inventory	Quantity in inventory (tracked by Daimler Chrysler and CMS provider as provider owns the chemical throughout its lifecycle, except disposal)
Delivery	Tracked by CMS provider
Use	Quantity by user (can be tracked by department and a specific user)
Waste Collection and Disposal	This is tracked in a different system.
Liability	Not tracked
Emergency Preparedness	Not tracked
EH&S	MSDSs and restricted product approval are tracked in a different system

- Waste management is a separate system that Daimler Chrysler is now rolling out among its plants. The company has not yet measured the impact of this new system.

CMIS – Benefits

- Daimler Chrysler was motivated to use CMS to save costs, to rely more on supplier expertise (since Daimler Chrysler has lost some chemical expertise in its assembly facilities), and to create an incentive for suppliers to reduce chemical use.

- The CMIS has resulted in considerable cost savings.

- The CMIS system tracks the same types of information as Daimler Chrysler's earlier tracking system, but the CMIS is more accurate and ensures standardization of units of measurement.

- The CMIS forces all purchases to be ordered through the system. Previously, staff sometimes made side agreements with suppliers to order chemicals outside of the purchasing system.

- Daimler Chrysler has not experienced any changes in production downtime due to the CMIS, but hopes to use the system to better track and predict downtime.

- The CMIS has resulted in quality improvement

- The CMIS has reduced the use of "illegal" chemicals (i.e., chemicals whose use is restricted or prohibited by the company), and the CMIS has made environmental reporting more accurate.

- The CMS as a whole has resulted in a significant savings from the baseline – Daimler Chrysler's fixed cost of products fell 60 % after introduction of the CMIS.

- The CMIS has not affected labor and staffing needs. The system has helped the purchasing group staff by making their workload more manageable.

- Daimler Chrysler has not found any disadvantages of implementing the CMIS. The company has not identified any other CMIS features that are needed.

Notes from June 27 Interview with Mike Knoblock and Vicki Maxie, General Motors

Background

- The Chemical Management and Oil Management Group, which is the global operation which uses chemical management services, is housed within the Environmental Services Group, within the Worldwide Facilities Group, which is part of Manufacturing and Engineering.

- The Chemical Management and Oil Management Group deals with chemicals that are indirect materials, i.e., those that are not shipped out with the vehicle, but rather are used as part of the manufacturing process.

- GM outsources its chemical management, regulatory reporting, and resource management.

- GM currently has 5 CMS providers, down from an earlier level of 13 CMS providers. GM has sought to reduce the number of suppliers, in part because it's difficult to get similar data from each supplier.

- GM's contracts with CMS providers are broken down into four major cost drivers: 1) the management fee (profit); 2) a staffing fee (for onsite management of chemicals); 3) equipment and overhead (e.g., lab supplies); and 4) materials/product. The first three cost drivers are part of a fixed contract. The last, materials/product, accounts for the greatest percentage of cost, and is a transactional cost that is billed to specific groups within GM.

- A major concern for the Chemical Management group is the number of different chemicals being used; the fewer chemicals used, the easier it is to manage. The Chemical Management group would like to use multi-use chemicals wherever possible.

- A few of GM's plants still don't use CMS because there is not a good business case for that particular plant's production.

CMIS – How it Works

- GM developed a common tool for all of its CMS suppliers to fill out. This data abstract tool, which has now been in use for a year and a half, asks suppliers to provide chemical data for all of the facilities they service, including a summary report

and individual facilities reports. GM is using the same data abstract tool for its waste systems.

▪ GM is instituting a CMIS system called FACTS (Facility Activity Compliance and Tracking Systems), which is a tool for chemical managers. FACTS draws on data from the monthly data abstract reports, which are filled out by chemical managers. Currently, the company surveys CMS providers once a month to obtain chemical use and cost data.

▪ FACTS is replacing GM's Environmental Management Information Systems, which the company developed in the late 1980s. It has been an evolutionary process to update that system. FACTS should be finalized by the end of 2002.

▪ FACTS is a proprietary software product of Quantum in Ann Arbor, Michigan, and GM outsources data analysis to Quantum. Quantum modified FACTS to meet GMs needs.

▪ FACTS provides data both for the Chemical Management group and for the Regulatory Resource Program, which is charged with regulatory reporting. GM is trying to put the onus onto CMS providers to provide the data that are the basis for regulatory reporting.

▪ FACTS provides a repository for regulatory data, transactional data (i.e., chemical purchases), and data on chemical and materials usage. Current use of FACTS is primarily chemical usage for regulatory reporting purposes.

▪ FACTS also includes a static knowledge center, which includes contracts, specifications, procedures, and the audit process.

▪ FACTS tracks chemical volumes in process as well as in inventory, but it doesn't track costs and currently has very little capability to provide business data. Over the next few months, the Chemical Management group will be working on feeding FACTS data into a cost analysis tool. GM would like to be able to compare staffing and management costs among suppliers or between regions and platforms.

▪ GM is creating a database that tracks how much chemical product is used, and the company is working to create a budget for chemicals that will set limits for usage and cost. GM is also relating chemical categories to specific processes.

▪ GM has asked its CMS providers to provide chemical data in a specific format to populate FACTS. GM is considering a Lotus Notes based system that will collect data from CMS providers.

CMIS – Benefits

- FACTS will save money and time by streamlining the data collection process.

- GM's motivation in adopting FACTS was to streamline data collection and provide information in a more useful form.

- GM is hoping that FACTS will enable suppliers to populate the tool with data automatically. The company is trying to avoid constantly asking its CMS providers for data, which is a burden both for GM and for the CMS suppliers. By defining desired data points and allowing suppliers to enter data automatically, GM is hoping to streamline the system considerably. GM is ensuring that CMS suppliers have input into defining the data points.

- GM has found that when it queries its CMS providers for data, often the data doesn't match up. For example, GM would send out one survey for regulatory reporting purposes on a monthly basis. Then on a quarterly basis the Chemical Management group would send out a separate survey to CMS providers on chemical use. The responses from the CMS providers would often be inconsistent, and then GM would spend a considerable amount of time cleaning up the data and trying to make sense of it. Interestingly, often the CMS provider would report lower volumes of chemical use on the monthly regulatory reporting survey. Now, the FACTS system will provide a unified way of collecting data with defined, standardized data points resulting in more accurate data, since interpretation will not be left to the supplier.

- FACTS will allow the Chemical Management group to break plant activities down into cost centers, so they can determine who should be paying for chemicals on a transactional basis, and what chemical categories are being used in each process. Chemical Management is working with GM's business units to develop process and chemical categories.

- One benefit of FACTS is its project tracking capability. GM sponsors projects to test new practices (e.g., piloting a new stripper in a paint booth). The project tracking system tracks the project number, its priority, the chemicals involved, cost, water use, materials use, quality of project, the chemical manager, the GM staff person, status, and project chronology. The project tracking system helps identify best practices and then disseminate them. It also helps prioritize projects and get resources for the chemical manager to implement the project.

- Cost savings from the CMIS come from standardization of data within facilities and increasingly between facilities. Until now, the Chemical Management group has done a good job at managing chemicals at the plant level, but it has been difficult to analyze chemical use between plants. Now, the group is trying to compare chemical use between GM plants with similar production processes. Also, some CMS

suppliers are more efficient at one plant than at another, and so GM wants to drive them to a standard level of performance.

- The ultimate tool would be one that tracks chemicals throughout the product life cycle. For example, the Chemical Management group would like to be able to quantify what it costs GM to bring a new chemical into the manufacturing process in terms of testing, storage, training, inspections, repairs, disposal, and the like. It would be helpful to calculate the cost of change for bringing in a new chemical, but it's difficult to calculate a mass-balance analysis. In the next generation of CMIS, GM would like to include life-cycle cost information of chemicals, but for now the data are not there to plug in.

- GM does currently track some high volume, high toxicity chemicals. For example, for TRI chemicals, GM tries to understand the full cost of the chemical. But this analysis is not standard, and is conducted on a special, case-by-case basis.

- The cost of the CMIS is far outweighed by the benefits, especially for a company the size of GM.

- Over the long term, FACTS may free up some of GM's staff time.

Notes from September 13 Interview with Sarah Broadbent, Corporate EH&S Director, Seagate

Background

- Seagate is using CMIS in its facilities in Minnesota as a pilot for the whole company.

CMIS – How it Works

- Prior to adopting CMIS, Seagate's information tracking varied by facility, and information was scattered between facilities. In order to get key information, Seagate staff used to have to pick up the phone and call each other. Now, all of the information is tracked in a database that integrates information across all of Seagate's facilities.

- Seagate has a two-part CMIS system. Facilities in Minnesota are piloting a chemical management tracking system that has been outsourced to URS/Radian. The remainder of Seagate's facilities use an in-house, online EHS system. All chemical information relevant to EHS is linked to this EHS system.

- In the Minnesota pilot facilities, URS/Radian CMS staff generally purchase chemicals, unless the purchase is for a one-time need, in which case Seagate can order the chemicals through a centralized website.

- URS/Radian has incentives to reduce cost and use of chemicals, so they generally analyze chemical usage data.

- In the Minnesota pilot facilities, URS/Radian generally collects all waste, and a separate waste management company comes in to handle treatment and disposal.

- URS/Radian is a partner on emergency response.

- Seagate has a separate system for review and approval of proposed chemical use. Seagate's approval system is more elaborate than that provided by URS/Radian, and so Seagate has kept their own system separate.

Life Cycle Stage	CMIS Data Tracked
Procurement	This is the responsibility of the chemical manager
Inspection	Data on inspection completion and results
Inventory	Expiration dates
Delivery	Delivery date. It is possible to track chemicals from the point they are ordered until delivery.
Use	Chemical usage and cost. Seagate only focuses on cost per unit if production levels change.
Waste Collection and Disposal	Hazardous waste per unit product and aggregate solid waste data is tracked. A summary figure for corporate-wide waste is tracked monthly.
Liability	Seagate conducts risk assessments that are stored in a separate, secure location.
Emergency Preparedness	Emergency response plans are on the website for the Minnesota pilot facilities.
EH&S	All MSDSs are online.

CMIS – Benefits

- Segate's motivation for undertaking the chemical management system came from the company's president. He sponsored a project to track all aspects of chemicals within Seagate, such as what information is available to employees, standard policies and procedures, and purchasing information. Eight different teams were set up to look at different aspects of chemical information tracking. A key motivation for undertaking this work was to protect employees and provide a safe workplace. Other companies that have not been as careful have been sued by employees for improper chemical exposure.

- A key benefit of the CMIS is integrating information across facilities. With the CMIS in place, Seagate can pull up chemical reviews and reports with very little effort.

- As a result of implementing the CMIS, data links with purchasing have become much stronger. Manufacturing staff are able to get the amount of chemicals used per product produced. EHS staff can spend more time tracking waste.

- Seagate used to have a lot of chemical product wastage due to obsolescence. Now the company generally does not buy chemicals until the point at which they are added to the equipment, and so inventory is mostly kept off-site. URS/Radian tracks chemical expiration dates. As the expiration date approaches, URS/Radian tries to locate another facility (either inside of outside of Seagate) that can use the chemical This approach has cut down product wastage to zero.

- The CMIS system provides information on the total cost of chemicals, not just the cost of purchasing. Understanding the total cost of chemicals – especially the cost of chemical management – is helping the company drive down its chemical costs.

- URS/Radian is helping the company identify cost-cutting measures. For example, URS/Radian currently has six-eight proposals in to the Minnesota facilities in order to reduce costs through improved chemical management. Some of these proposals include a capital outlay, and there may be one proposal involving chemical substitution (although this is more difficult due to product specifications).

- As a result of its new chemical management systems, Seagate has made improvements in its wastewater treatment. The company has been able to make wastewater treatment systems more efficient, because including an outside management company has required staff to formalize their procedures for handling wastewater and plan ahead for changes in wastewater discharges.

- The CMIS has allowed Seagate to reduce chemical wastage because chemicals are tracked more closely and they do not get "lost" in inventory.

- Using the CMIS, Seagate is able to do the same chemical management job with fewer people. In the Minnesota facilities, URS/Radian hired Seagate's chemical management staff and gave them specialized training before redeploying them in the Seagate facilities.

- The most valuable aspect of the chemical management system overall, from an EH&S perspective, is that Seagate has people handling the chemicals that have the right training, and that burden of responsibility is lifted from Seagate's EHS department.

- From the perspective of information management, the most important benefit of the CMIS is the ability to get reports on anything. Seagate does not have to generate its own reports – rather it can use standard reports that URS/Radian provides.

- There has been a cost to adopting the CMIS. Seagate has had to buy software and design web pages for its non-Minnesota facilities that are not a part of the URS/Radian pilot. Ms. Broadbent has ended up serving as an information technology manager for these projects. However, this approach has allowed Seagate to modify its software. And the overall effect has been positive on labor and staffing needs.

Seagate has been streamlining its operations, and the CMIS has allowed Seagate to reduce its staffing in some areas.

▪ Seagate would like to see some additional features added to the CMIS, such as making the web pages cleaner, simpler, and easier to use by eliminating information that is relevant to URS/Radian but not essential to Seagate. Also, Seagate would like more information on global inventories (total amount of chemicals used and staff using those chemicals throughout the company).

Interview Notes from September 24 Interview with Brian Ross, UTC

Background

- United Technologies Corporation (UTC) manufactures aircraft engines, heating and air conditioning systems, elevators and escalators, aerospace systems, helicopters, and fuel cells.

- Mr. Ross is a commodity manager for chemicals, industrial gases, and environmental concerns. He is also one of 17 project managers for UT500, which is a UTC initiative to realize $500 million in savings for non-product expenditures.

- UTC has 110 sites in the United States.

- Spending on chemicals at all sites for non-products is between $25-$28 million; spending for product chemicals is between $15-20 million.

- UTC initially signed up with one CMS provider, but after three years UTC decided to switch providers, in large part because its original provider did not have sufficient information technology capabilities. Seven of UTC's facilities are launching CMIS with URS/Radian, while two Carrier sites have been working with Henkel for about nine months.

- UTC mostly uses chemicals in batch form.

CMIS – How it Works

- The CMIS tracks purchasing, CAS, and environmental report data (including chemicals of concern that UTC is working to phase out).

- In UTC's CMS ,title for chemical ownership changes from the supplier to UTC when the chemical crosses the dock door. UTC is not yet to the stage of contracting chemical ownership to the point of use, in part because of union issues, and in part because this is a new system and the company needs to "walk before it runs."

- Materials are typically sent to labs for certification. Now UTC is having its CMS provider do quality tests and keep paperwork.

- UTC expects to minimize its chemical inventory by 90% through daily chemical delivery.

Life Cycle Stage	CMIS Data Tracked
Procurement	Purchase price variance (today's price compared to price paid with last order or average price paid over previous year), part number, description, shelf life, purchase size, manufacturer, distributor, PO cycle time
Inspection	Certificate of analysis or certificate of performance (to ensure quality).
Inventory (UTC defines inventory as closed drums or closed containers, not chemicals in active use)	Quantity
Delivery	On-time delivery schedule
Use	Quantities used for a particular work area and employee, cost, quantity, process improvements
Waste Collection and Disposal	Not tracked in CMIS
Liability	Not tracked in CMIS
Emergency Preparedness	Not tracked in CMIS
EH&S	MSDS validating and updating

CMIS – Benefits

- One of UTC's primary motivations for purchasing CMIS services is that its 110 facilities use many of the same chemicals, but UTC was paying different prices at each site. Across its facilities, UTC had eight different purchasing methodologies, which led to inefficiencies. Moreover, the old purchasing system was not user friendly.

- The CMIS provides UTC much better control in adding new chemicals to its operations.

- Anticipated benefits of the CMIS include easy access to reports (at the push of a button), flexible reporting that can be customized to user needs, and a user friendly interface.

- Chemical use information will be used to drive P2 programs.

- Improved data on chemical use may allow UTC to limit some title V air permits.

- UTC expects to gain new insights from the data. For example, Boeing (a UTC customer) called a UTC division about a mandate from Europe regarding a certain chemical. UTC needed to locate all use of that particular CAS number. The division sent a message to UTC's EHS department and to URS/Radian. URS/Radian responded within hours, while EHS still hasn't responded and it has been several weeks.

- UTC is also anticipating that the CMIS will drive costs down.   On average, UTC expects to save over 15% of its annual chemical costs.

- UTC expects to be able to reduce its labor and staffing in purchasing, inspections, warehousing, disposal, and EH&S. Usually staff persons are rotated to another position within UTC. UTC did not stipulate in its contract that URS/Radian would hire any of UTC's staff.

- UTC does not see any disadvantages with the CMIS