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Paper Session I-A - The Year 2000 Problem

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THE YEAR 2000 PROBLEM

It has been called the "Millennium Time Bomb, Doomsday 2000, the Double-Naught Disaster" and a multitude of other catchy titles. A quote from Harris N. Miller, President of the Information Technology Association of America (ITAA) states: "The Year 2000 software conversion is arguably the largest and most complex global information management challenge society has ever faced". What exactly is the Year 2000 problem?

The year 2000 problem stems from the common use of two digit year indicators in many software, hardware and firmware installations, which will cause systems to recognize the '00' in 2000 as 1900 or some other random date and cause calculation errors or computer shutdowns. Many computer programs use an MM/DD/YY format for the date. Some of these programs will not accept '00' as a valid year or they cannot compute that '00' follows 99. Also, will the world's computers be able to handle the three zeros in the year 2000 date?

The year 2000 computer problem is global, affecting businesses as well as governments worldwide. Some modern computers may have problems handling dates later that December 31, 1999, but it is the older legacy systems that will be the most difficult and costly to fix. Many 1960s era mainframes using the COBOL language still churn away in government computer rooms, often running the original software that is sometimes older than the technician tending the machines. Much of this older software and outdated hardware can not be fixed to be year 2000 compliant.

Large corporations are about to learn just how much their organizations depend upon computer-based systems to run their day-to-day operations and the importance of data quality. While some programs might not work at all, a greater danger is posed by programs that begin processing incorrect information. For example, for a person born in 1955, subtract 55 from 00 and his age is calculated incorrectly to be minus 55, instead of 45. This is a serious problem, where such errors could take months to disclose and could conceivably put some companies out of business.

THE NEW MILLENNIA

It is important to note the new millennium actually begins on January 1, 2001. A millennium is a period of 1000 years. The sequence of years going from BC to AD did not include Year 0, therefore the first year of the first millennium was 1 AD. The first day of the second millennium was AD 1001. Just as 1997 will not end until 12 months pass, we will not see the end of this century until its full 100 years pass. The 100 years will end with the last day of the year 2000. Thus, the new millennium does not actually begin in the year 2000 but in 2001. For purposes of this paper however, the new millennium as stated refers to the year 2000.

PROBLEM ORIGINATION

The origin of the problem stems from the early years in the industry when storage space was restricted to 80 or 90 column punch cards and computer memory was limited to 8,000 characters. These restrictions resulted in a standard practice of representing the year portion of dates as 2 digits. This 2 character year saved storage space and reduced the amount of keystrokes to enter a year, as well as saved 2 positions on a display screen.

The practice of storing dates in a six-digit format (MMDDYY) uses 25 percent less storage space than the eight-digit date format (MMDDYYYY). The savings in human resources, expensive disk space, computer memory, and hardware by using only the two digits for the last 40+ years is in the billions of dollars. Most programmers and project leaders figured that their programs would not last into the twenty-first century. In hindsight, much of this old code is still in use today.

DATE RELATED PROBLEMS

The date related problem affects more than mainframe and work station software applications. Date references can appear in programs, data bases, functions, operations, queries, procedures, screens, libraries, datasets, data definitions, jobs, transactions, and load modules. It also invades client server and network applications and can be imbedded in the firmware. Firmware can be imbedded in all electronic control equipment and can have faulty logic using 2 digit character years. This can include: telephone switch systems, building security access devices, elevators, heating and air conditioning systems, etc. We need to be asking the responsible people some questions concerning how this equipment will function beyond 1999.

Some examples of other technical problems resulting from the millennium change are:

- Leap Year Calculations: To further complicate the problem, the year 2000 is a leap year. The leap year rule states that century years should only be leap years when they are divisible by 400. Not all computer programs do calculations or set calendars based on this rule. Directly related to this is the day of the week projection which is important in scheduling and planning resources. If the leap year calculation logic is incorrect, the resulting day of the week projection will be faulty.

- Date Reversal Problems: For computer calculations, in the year 2000, the future becomes the past. In two-digit fields, 00 is the lowest number and 99 is the highest, so when you subtract 99 from 00, it does not work. For example:
1997-1962=35 or 97-62=35 / 2000-1962=38 but 00-62=-62

- Date Obscurity Problems: When a computer sees 97 on the screen, it represents the year 1997; however when we see 00, does it mean the year 2000 or does it mean the field is empty. For example, a credit card with the expiration date of 00 may be interpreted by the computer system software as having already occurred. Some power companies use the code "00" to shut down power grids.

- Date Field Labeling Problems: Some programmers give their date fields ambiguous and random names. For example, the word "dog" was used in one program every time a date field was required. Often programmers will create logic to fill unused data fields, such as "if year =00, delete the file". This will create extensive failures if this logic is not changed.

- Indexing Using Date Related Fields: Listing the data in some logical order to utilize indexing to display the data in date sequence. The two character year standard has been used to index, for example package delivery schedules and credit card transactions, but the "00" date could cause problems.

- Imbedded Date Problems: This concept of using "stealth" dates that are imbedded in date related code into other data such as employee numbers or document serial numbers. These fields are manipulated and indexed with some significance to the date sequence. Imbedding 0's can results in erroneous retrievals.

- Classifying/Sorting Dates: Sorting routines that sort on two-digit year fields will cause the 00 date fields to sort out before the 99 date fields. On spread sheets, the logic of categorizing and sorting records by dates, if it has 00, can lead to faulty results.

- Archived Data Problems: Software typically calculates expiration dates using two character years. For example, magnetic tape libraries can manage tapes until 1999 but they may expire in 00. Some tape management software uses 00/00/00 as the scratch tape indicator and the retention tape portion only used the 2 digit year portion to pull scratch tapes so a tape with the 5 year expiration of 12/31/00 is incorrectly pulled as expired to use as a scratch tape.

To further complicate the situation is the sheer size of the problem. Dates are everywhere, which means that all program code must be examined to determine if a change is necessary. Most large corporations and government agencies have thousands of programs containing millions of lines of code. However, one cannot only worry about their dedicated systems. You must review all of those internal and external areas that supply you with data and that you supply a product to. Because computer systems interoperate and share data, the modified systems must be tested together. Also note, the fixes must be made while the current system continues to operate.

Today's government agencies and businesses have developed an integrated interdependence through their information systems and computer controlled processes. There is a tangled web of interrelationships that exists among organizations. Businesses must not only consider their customers, but their suppliers, insurance carriers, financial consultants, telecommunications networks, electric power utilities, government agencies, and many other service providers. If one fails, there is typically a cascading effect on many other related arenas. Failure to address this integrated interdependence will compromise many year 2000 projects.

YEAR 2000 COMPLIANCE DEFINITION

So far, a single formal definition of year 2000 compliance does not exist. The latest definition from the federal government was issued in the General Services Administration (GSA) interim rule that is contained in a new Federal Acquisition Regulation (FAR), Federal Acquisition Circular 45. The FAR interim rule defines compliance as "information technology that accurately processes date/time data (including, but not limited to, calculating, comparing and sequencing) from, into and between the [20th and 21st] centuries, and the years 1999 and 2000 and leap year calculations."

LACK OF RESOURCES AND EXPERTISE

Years of downsizing have cut many data processing staff levels to the bone. Today there may not be enough people to maintain existing applications and create new functionality, let alone make millennium changes. The biggest problem is likely to be that there will not be enough people or time to fix all of the problems. End users who have created numerous programs and reports discover that they are unable to meet the task of updating these programs. As the millennium change absorbs available resources many managers are forced to turn to the outside for help.

The solution may include new employees, tools, outsourcing services, and contractors. The problem is most companies willing to hire experienced programmers and personnel are having difficulty finding these people. The demand is so high that the salary requirements have sky rocketed.

Performing the work in-house carries many risks. Because of the backlog of current projects, many IT organizations do not have the necessary resources to dedicate to the year 2000 conversion. Project management performance is critical to achieving a timely and efficient conversion. To ensure success, people need to be dedicated full-time to the project. Yet, many companies expect their IT staff to share the year 2000 work with other initiatives.

OUTSOURCING VENDOR TOOLS AND SERVICE PROVIDERS

While the year 2000 conversion can be a major effort, many different types of tools are commercially available to help organizations scope the problem, find date references, expand date fields and perform many other useful functions. Just as the conversion process follows a program life cycle, so do the tools automate various phases of this multifaceted activity. Providers offer a variety of conversion services including, conversion planning and estimating; program and configuration management; program inventory; impact analysis; conversion; testing and system migrations. Most tools are geared to a particular operating system and mode of operation. All require substantial human interaction because tools may generate results which are either false or incomplete.

The year 2000 conversion may force organizations to consider postponing or even canceling new system development activities. Outside service providers with year 2000 expertise can be an important extension to in-house capabilities. Many such experienced firms exist, although the availability of the best service providers will decline as the year 2000 approaches. Electing to "outsource" this conversion activity may enable organizations to keep in-house staff focused on new development. Outsourcing to a year 2000 specialist may also save time and money, thereby freeing up the resources necessary for both new development and legacy system conversion.

BUSINESS LIABILITY AND LITIGATION

The Gartner Group, Inc. has estimated that approximately 50% of the companies with this software problem may not become year 2000 compliant in time and will have all or part of their computer systems shut down or start producing incorrect data on or after January 1, 2000. Major software vendors such as IBM, are in the process of issuing year 2000 upgrades to existing software products. For major companies with heavily customized software systems, much of the corrective work will have to be done by the companies themselves. These companies will be responsible for supplying their customers with products and services that are not affected by the year 2000 problem.

Other businesses rely heavily on vendor supplied products or standard Commercial-Off-The-Shelf (COTS) packages. The first step these companies should take is to prepare an inventory of the hardware and software being utilized in its business. Once all software and hardware packages are identified, the license agreements and long-term maintenance agreements should be reviewed relating to all third party licensed software. The company will then be able to identify the appropriate vendor to contact in order to request information as to the availability of year 2000 software upgrades. If the agreement extends past January 1, 2000, the vendor may have an obligation to make its software year 2000 compliant at the vendor's expense.

Various companies and governmental agencies have reportedly revised their standard contract forms to require that any new products purchased will be year 2000 compliant. It is important not to re-introduce defective products into a corrected system.

The impact of systems failure goes beyond the loss of data integrity. What happens when power companies, water treatment plants, 911, police forces, health departments and hospitals, etc. do not address the year 2000 problem? The year 2000 problem is not just a technical issue, it is also a business and public safety concern. The issue can be presented as a business risk issue, i.e. how much risk is your business willing to take that an application will or will not fail? Bad data and systems shutdowns can mean lost revenue, customers, and goodwill. It can also present danger-ous situations for the well being of the general public. The negative publicity can be particularly damaging to businesses. The threat of legal action from customers and shareholders should not be minimized.

The other side to the year 2000 legal issue is the litigation that may result due to product and service problems that may occur when systems are not corrected and businesses begin to fail because of this. It has been stated that the legal litigation costs may actually be more than the cost to fix the problem itself. There are concerns of the potential liability of the officers and directors of a company which fails to disclose a year 2000 problem and then fails to become year 2000 com-pliant in time. Insurance policies which cover "business interruption" may not cover a year 2000 problem because it was a predictable event. T. Capers Jones states: "If the problem is not fixed, then the errors associated with finance, taxation, insurance and even operation of aircraft can lead to the most expensive litigation in human history."

Computer experts and chief information officers of corporations have long known of the year 2000 problem from a technical point of view. Failure to address the legal issues surrounding the prob-lem can lead to delays from third party vendor lawsuits, loss of claims against vendors who other-wise might be required to pay for year 2000 corrective costs, legal liabilities for the company, and personal monetary liability for the company's officers and directors.

GOVERNMENT YEAR 2000 EFFORTS

The Federal government's computer systems rely on accurate date fields to calculate age, trans-fer money, and determine maintenance schedules for national security systems. Without convert-ing these fields to interpret the turn of the century, government systems could potentially eliminate the transfer of money, erase database systems needed to send checks to eligible benefit recipi-ents, and adversely impact critical missions, such as those conducted by the Department of De-fense (DOD). The cost estimate to remedy the year 2000 problem for the Federal government has been estimated to be as high as $30 billion.

At the present time, the federal government has not enacted any statutes or regulations requiring any private sector companies to become year 2000 compliant as a matter of law. However, bills have been introduced recently in both the U.S. House of Representatives and the Senate autho-rizing appropriations for the Department of Defense, including a mandate on the Secretary of Defense, to ensure that all Information Technology (IT) acquired and used by the DOD be year 2000 compliant.

The Office of the Comptroller of the Currency (OCC) has recognized that this computer problem could wreak havoc in the banking industry. In June 1996, the OCC issued an Advisory letter to the

CEO's of all national banks, advising them that their banks should correct the year 2000 problem by the end of 1998, leaving one full year for testing.

For NASA agency wide, the impacts identified to date are estimated to be over $32 million dollars. Johnson Space Center (JSC) has been designated as the office of primary responsibility for International Partner Year 2000 cleanup and this includes the difficult task of assessing the Moscow Mission Control Center for commanding and other functions performed at that site for year 2000 compliance. Kennedy Space Center (KSC) submitted an initial impact assessment of just over $6 million to convert the Space Shuttle Ground Operations and related work to become year 2000 compliant. Both centers first priority is to ensure that all mission critical systems have been corrected.

The House of Representatives has also held extensive public hearings on the year 2000 problem, since federal agencies make extensive use of mainframe computers, and reportedly account for a significant percentage of the total corrective cost in the United States. A Year 2000 Interagency Committee has been established and a COTS subcommittee has been named to review vendor products and COTS testing issues.

BASELINE CONVERSION PROCESS

A year 2000 conversion requires extensive planning, organization, commitment and follow through. This task is a project management and integration nightmare to ensure that every system is year 2000 compliant. The following is a process description conversion and testing plan that includes procedures that can be used by each organization to develop their individual implementation plans for the impacted systems. Detailed schedules should also be included with each system's Conversion Plan. A year 2000 conversion should be schedule driven, because the deadline is immovable. Each organization is responsible for prioritizing and showing the work that will be required to convert and test each system that has a year 2000 impact.

The Conversion Process can be customized based on each organization's system structure and conversion requirements. It follows a phased modular methodology. The following are generic steps to follow:

Complete Portfolio Inventory - OBJECTIVE: Gather detailed information on all applications and develop impact assessment. Perform a comprehensive systems inventory and begin setting the system priorities. Identify status of vendor products and determine required vendor upgrades. Contact external data sources that exchange data with your system and may be affected by year 2000 fixes.

System Review - OBJECTIVE: Attain the highest level of accuracy in identifying date occurrences and impact.   Identify at a detailed line of code level, date fields and affected code. Review documentation and identify any missing source code. Determine if there are systems to discard/ retire or not be upgraded.

Determine Optimal Conversion Methods - OBJECTIVE: Determine the impact of all date occurrences in order to specify required changes and develop standards. Establish your system baseline and the year 2000 compliance criteria. Once all date occurrences have been identified, determine the impact of these dates and the types of changes required. Determine repair methods, for example, expanding date fields, century code indicator, windowing, packing the year (4

digits into 2 bytes). Determine initial test plan prior to beginning code conversion and establish testing milestones. Recommend performing a pilot conversion on a small system before beginning larger conversion efforts. Be sure to follow standard Configuration Management procedures.

Code Conversion - OBJECTIVE: Convert all applicable applications without disrupting normal maintenance. Apply actual changes to the applications; these activities may be highly repetitive as each program, file, utility, etc. is changed; use any automated tools that are available. Perform unit test on each converted module and conduct regression tests. Update documentation as it pertains to date conversions.

Testing - OBJECTIVE: Verify conversion and ensure system integrity and functionality. It may be a highly repetitive process to validate that the repairs made in one application or segment do not adversely affect other applications. Perform integration/intersystem testing to ensure that files created by one process can be properly used by the subsequent process. Conduct focused date testing for pre/during/post year 2000 to ensure applications run properly. Validate repairs and ensure that system integrity and functionality have not been compromised. Document all errors and repairs.

Maintenance and Production Support - OBJECTIVE: To prevent introduction of any new year 2000 problems into the converted systems. Upon completion of testing, the applications are ready to be returned to a production environment. Ensure that the standards developed during the transition are communicated and followed during future development and enhancement. Ensure vendor and COTS purchases meet Year 2000 standards.

THE GOOD NEWS

Businesses that are well into the millennium update are reaping significant benefits from their efforts to fix the problems. In some cases, IT budgets that have been tightened over the last few years are being relaxed. This is allowing some organizations to update software that is lagging versions behind and may not even be supported. Hardware obsolescence has always been a problem for IT professionals. Fixing the year 2000 problem is allowing some organizations to replace old hardware with newer technology.

Many organizations are using the year 2000 update as an opportunity to improve the overall quality of their software inventory. The year 2000 effort is forcing a system inventory clean-up. The inventory assessment phase allows the organization to gain knowledge and experience about the environment.   Many older legacy systems will no longer be required and can be discarded. Outdated programs and applications that are not in use anymore can be deleted. With adequate funding, systems can be re-engineered and migrated to new, less expensive platforms. Restructuring and re-engineering error-prone modules can lower maintenance costs. Remodularized applications are generally easier, safer, and cheaper to maintain by more than 50%.

This is a good time to be in the software and data quality business. Most COTS vendors are converting their planned releases to deal with the year 2000. The project will allow organizations to identify their true mission critical applications and critical "one-of-a kind" exposures. It will also help to educate staff, programmers, and users to apply standard programming and documentation practices. Through standardization, they are reducing the dependence on experienced staff and reducing the time required to familiarize new staff.

The year 2000 problem is forcing businesses to employ a variety of "best practices". These "best practices" include, but are not limited to: configuration control, version control, source code maintenance, use of standards, formal documentation, regression testing, project management, cost estimating, and the use of automated tools. Practicing "best practices" on a day to day basis gives organizations some continuity and stability in this fast paced information technology industry.

CONCLUSION

The Year 2000 problem is both far reaching and costly. Every organization needs to begin its year 2000 conversion now if it has not already. The problems represented by the date change will not go away; on the contrary, they will only grow as the time to deal with them shrinks. The Information Technology Association of America (ITAA) Year 2000 committee believes the conversion cost per line of software code ranges from $1 to $1.50 and will increase as time goes on. They estimate the global cost of solving the problem is in the $600 billion range. The business impact of not making the conversion, whether in global terms or individual lines of code, is impossible to calculate. T. Capers Jones states: "Because this problem is embedded in millions of aging software applications, the costs of fixing the year 2000 problem appear to constitute the most expensive problem in human history."

The year 2000 will be the first century change ever faced by an automated society. This deadline is real, immovable and cannot be missed. This is one schedule that can not be slipped. Whether or not the new millennium brings economic disruption because of two-digit date codes is a matter of speculation. One thing is certain: January 1, 2000 is a Saturday; we will all know for sure on Monday morning, January 3, 2000.

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