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Year 2000: A Reality Check

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TUTORIAL

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ABSTRACT

This paper examines the risks, cost, size, implications, and likely outcomes of the Year 2000 or "Y2K" Problem, as well as the lessons learned, opportunities, and silver linings of Y2K projects. The MIS academic community has largely missed a unique opportunity to be relevant to practitioners as well as our communities. Fortunately, it is not too late since knowledgeable and rational voices are needed to help communities, and the people and enterprises in them, intelligently deal with the challenges of Y2K. Strangely, in spite of billions of bytes of data about year 2000 problem appearing each week, we still know surprisingly little about the reality of the Y2K risks we face. And there is little chance that a complete assessment of even the greatest risks faced by our enterprises and communities can be made, let alone repairs completed. Then there are the global risks of Y2K, and the thorny fact that most Y2K risks are beyond our direct control anyway. So what can ethical, conscientious, and concerned MIS professionals do about this situation? How can we help our communities reduce risks, appropriately plan for contingencies, and quickly manage failures? With only a few months to go, this may be the last chance we have to be relevant, enhance our collective credibility, and genuinely help improve IS practices.

KEYWORDS: Year 2000 problem. Y2K, risk, cost, success, defect removal, best practices, contingency planning, community preparedness.

INTRODUCTION

The year 2000 is near at hand and with it the Year 2000 or "Y2K" Problem. The problem is well understood, although its risks and implications are not. In brief, the historical savings made over the years in costs of processing, data entry, and storage by recording years with two digits (e.g., 87) rather than four digits (e.g., 1987), a practice that has outlived its economic usefulness in most cases by 20 years or more, came at the expense of a new problem – the inability to deal easily with year data in 2000 and beyond. The problem involves making accurate comparisons and calculations involving year data. Thus, where a person's age could be computed in 1999 by taking the difference between the two-digit current year and their two-digit birth year (e.g., 99-57=42), the same person's age in the year 2000 would be computed as (00-57 = -57) rather than the correct 43. If this problem was isolated to a few occurrences, or if standardized application components for date data were widely used, there would be little difficulty in making the changes. Unfortunately, our highly computer-based world is filled with billions of date-related calculations that lead to erroneous results.

The Year 2000 Problem (Y2K) has two aspects. On the one hand, there is survival, response, and recovery. That is, information systems must live beyond the next New Year. Responses to the problem must be in place. Where those responses are not achieved in time, it must be possible to recover from the damages that result and ensure continuity of operations. Yet, competitiveness and quality must be maintained or, even better, improved. That is, as the fundamental issues of survival, response, and recovery are solved, quality and competitiveness issues need to be resolved as well.

Clearly, the Year 2000 Problem introduces risk. Regrettably, most Y2K risk is beyond the control of the individual. It is, however, the individual's responsibility to manage the risk and to reduce uncertainty. Contingency planning and continuity planning are essential to the health and vitality of communities, of enterprises, and individual careers.

However, all is not gloom and doom. As we shall see, the Y2K problem carries with it many benefits and opportunities. The purpose of this tutorial is twofold:

1. provide a reality check on the risks and extent of the problem; and,
2. provide information on how individual information systems professionals, particularly faculty who teach IS, can help in coping with the problem.

The following sections of this tutorial are divided into two parts. In the first part, we discuss the technical and organizational considerations. Sections describe the risk (Section II), the estimated extent of the problem (Section III), the implications for software projects (Section IV), and the lessons learned (Section V). In the second part we examine how individuals can work to improve the situation in their own communities (Section VI).

II. RISK

Y2K risks are both internal and external (Figure 1, from Kappelman 1999), As the risk moves from being internal to being external, the amount of control and experience diminish.

ENTERPRISE RISKS

The extent of specific risks at the enterprise level is shown in Table 1. The contents of Table 1 are technical in nature. Distilled into managerial terms, these place at risk the operations, market share, profitability, customer satisfaction, and value of the organization.

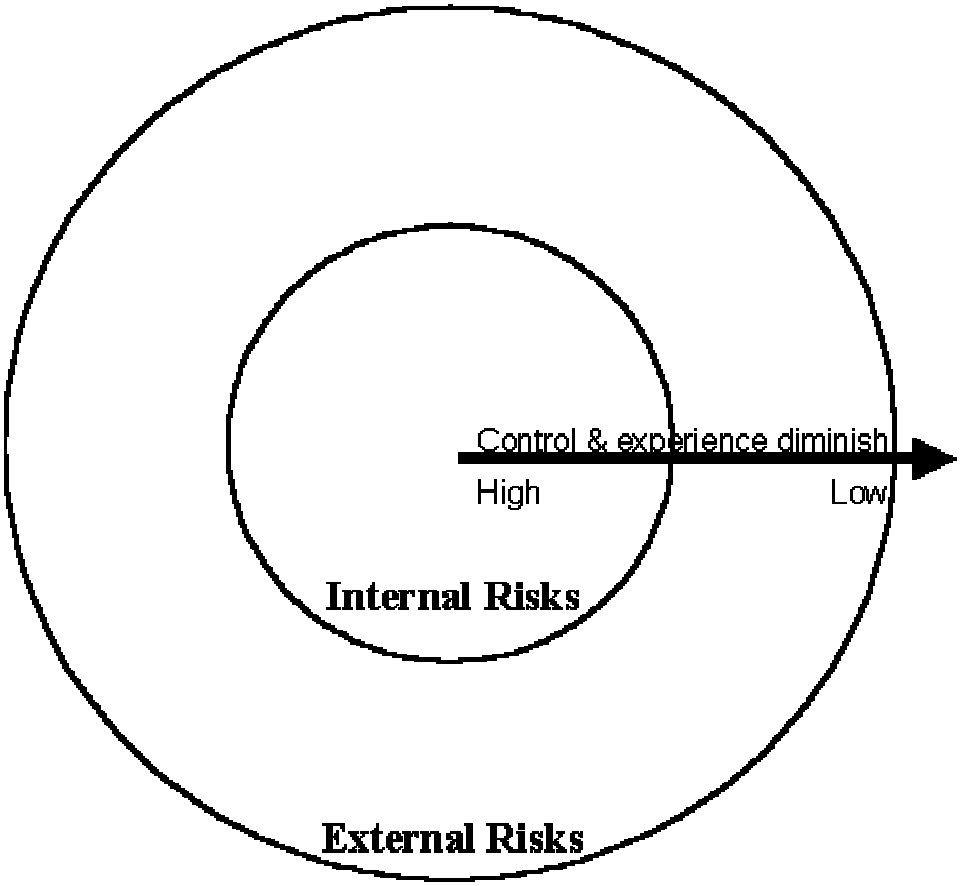

Figure 1. Internal and External Circles of Risks

Table 1. Risks at the Enterprise Level

Programs	Made and bought; old and new; legacy; user-developed; payroll, inventory, accounting, logistics, DSS, etc., …
System software	Operating systems, backup, scheduler, performance monitoring, etc., …
Data	Internal, external, old, new, etc., …
Hardware	All platforms, peripheral devices, etc., …
Manufacturing, process control	Machinery, environmental protections, water and sanitation, etc., …
Links	EDI, EFT, etc., …
Other	PBX, HVAC, elevators, security, etc., …

Clearly the viability of the enterprise is at risk. The list in Table 1 is troubling enough by itself. However, it represents only a portion of the many elements of the enterprise in which computers play a central role.

GLOBAL RISKS

At the global level, the risks involve the various infrastructures that we take typically for granted. We consider the following seven layers of infrastructures: Economic, Transportation, Communication, Manufacturing, Energy, National Defense, and Life Support. These major infrastructures can be further broken down as shown in Table 2. Notice that as you read down the list the potentiality of problems goes from the disruptive to the destructive.

Table 2 Risks at the Global Level

Economic	Securities and financial markets Government payments Credit cards and licenses Paychecks	Electronic payments Bank accounts, investments Tax deposits and refunds Pensions
Transportation	Global positioning Maintenance mgmt. systems	Air traffic control Dispatching systems
Communications	Phone networks Satellite tracking systems LANs	PBX systems Internet WANs
Manufacturing	Oil refineries	Chemical plants
Energy	Power plants Nuclear power and waste dumps	Power distribution Oil and gas pipelines
National Defense	Military weapons systems	Defense logistic systems
Life support	Sewage plants Medical devices	Water treatment plants Medical services, facilities

LOCAL RISKS

It is at the level of the individual enterprise and the local community that we can expect that a particular Y2K problem will do the most damage. Yet, although there are large statistical data banks that try to assess the potential damage and the extent of remediation at the national and international levels, good local data are not available. Thus, the individual must determine which of

the various global risks pose the greatest risks to their own enterprise and to their own community.

III. EXTENT OF THE PROBLEM

The estimates of the extent of the problem, measured either in terms of either dollar costs or the extent of the remediation, vary widely. The one thing that can be said with certainty is that the numbers are big. In this section we present some estimates that appear in the public domain.

Dollar estimates for the total global cost, the national cost in the United States, and the enterprise level cost are shown in Table 3.

Table 3. Estimated Costs of the Y2K Problem

Level	**Source**	**Amount (in billions of $)**
Global	Gartner Group	300 to 600
	Software Productivity Research, Inc. (SPR)	1,335 plus $300 in litigation
	Society for Information Management (SIM) Y2K Working Group	408 to 616 +
U.S. National	Gartner Group	200
	SPR	177 plus 100 in litigation
	SIM Y2K Working Group	158 +
U.S. Government	Gartner Group	30
	SIM Y2K Working Group	10.3

Note that the SIM Y2K Working Group's estimates are based on the average 38 percent of the total annual IS budget spent on Y2K by firms in the U.S. as determined in their 1997 study (Kappelman, Fent, Keeling, and Prybutok, 1998). In looking at the individual enterprise, it is useful to examine the results of the SIM Working Group's study in more detail as shown in Table 4.

Table 4. SIM Year 2000 Working Group Estimates at the Enterprise Level

	Mean	Median
Total No. of Applications	1398	100
Percent of Applications Affected	66%	80%
Total No. of Data Files	17000	184
Percent of Data Files to be Modified	36%	20%
Annual I/S Budget	$45M	$15M

IV. IMPLICATIONS FOR SOFTWARE

LIFE CYCLE

Year 2000 remediation is a software maintenance project on a grand scale. Hence, we can use the analogy of the life cycle to list the sequence of steps needed. Everyone has their own unique version of the steps in the life cycle, and we are no exception. From our point of view, the six steps, as shown in Figure 2 (Kappelman and Cappel, 1996), are as follow:

1. Raise awareness and come to acceptance
2. In depth Inventory, risk assessment, and impact analysis
3. Plan, budget, and schedule
4. Conversion: do the work
5. Test
6. Implement and test

These steps are described in detail in the "help for you" section on the SIM Working Group's website (http:/www.unt.edu/) in an excerpt from the Group's book (Kappelman, 1997).

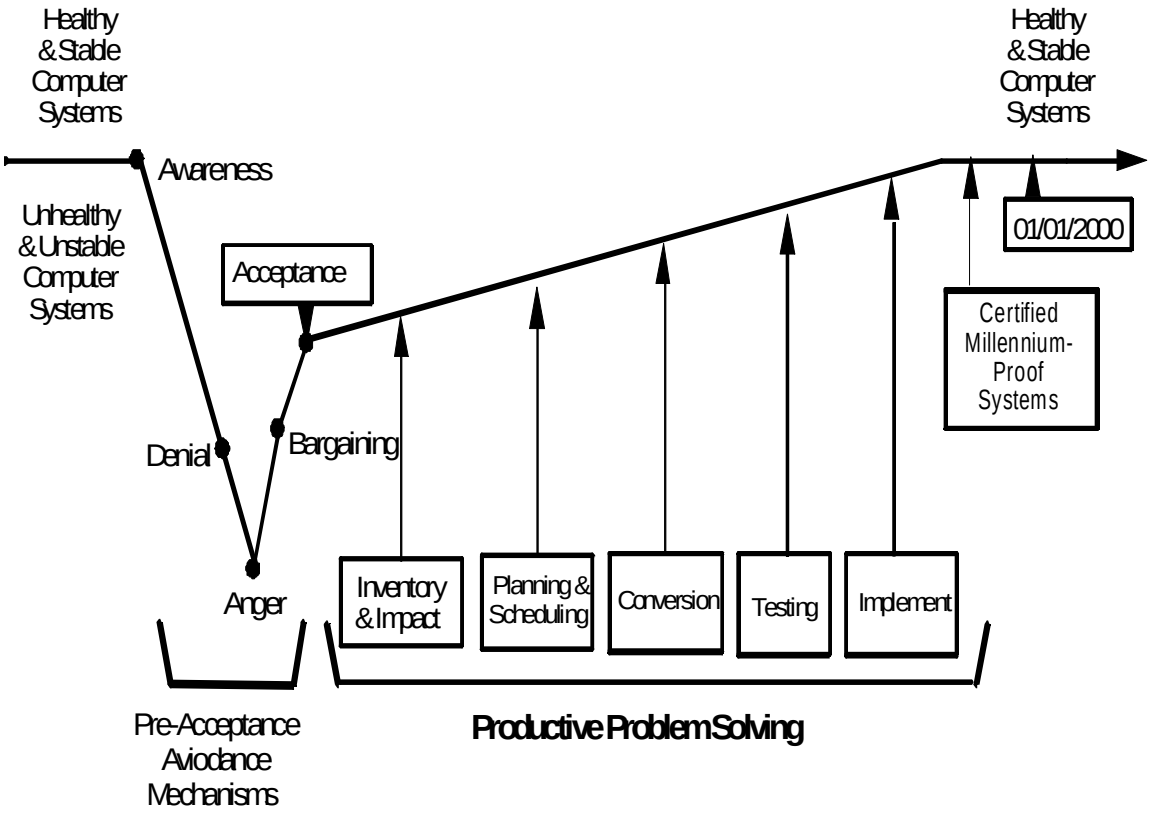

Figure 2. Year 2000 Response Model

REALITY CHECK

In estimating the magnitude of a Y2K project, it is necessary to recognize that this project shares the characteristics of all software projects. Perhaps most important is recognizing that:

- Software projects are typically late. The larger the project, the later they tend to be delivered.
- Software quality practices are, at best, mediocre.

Thus, it is likely that Y2K projects scheduled for delivery in December 1999 (or even earlier) are quite likely to miss the January 1, 2000 deadlines. Some indicators of the extent of the delay is shown in Tables 5 and 6, and the likelihood

of latent defects in Tables 7 and 8, based on Jones (1996, 1999). Four aspects are considered:

- Meeting schedule
- Project outcomes
- Efficiency in removing software defects
- Efficiency in removing Y2K defects

For convenience projects are characterized by their size in function points.

Table 5. Planned Versus Actual Project Schedules (actual findings)

Size* / **Schedule****	**<<100**	**100-1000**	**1000-5999**	**>5000**
Planned schedule	6	12	18	24
Actual Schedule	6	16	24	36
Difference	0	4	6	12

***Size is measured in function points; **Schedule is measured in months; Based on Jones 1996

Table 6. Project Outcomes by Size of Project (actual findings)

Size*Schedule**	**<<100**	**100-1000**	**1000-5999**	**>5000**
Canceled	3%	7%	13%	24%
Late by > 12 months	1%	10%	12%	18%
Late by >6 months	9%	24%	35%	37%
Approx. on time	72%	53%	37%	20%
Completed early	15%	6%	3%	1%

***Size is measured in function points; **Schedule is measured in months; Based on Jones 1996

Table 7. Software Defect Removal Efficiency (actual findings)

DEFECT ORIGINS	DEFECT POTENTIALS	REMOVAL EFFICIENCY	DELIVERED DEFECTS
Requirements	1.00	77%	0.23
Design	1.25	85%	0.19
Coding	1.75	95%	0.09
Document	0.60	80%	0.12
Bad fixes	0.40	70%	0.12
Total	5.00	85%	0.75

Data are actual average software defect removal efficiency expressed in percentage of defects removed. Based on Jones 1999

Table 8. Y2K Defect Removal Efficiency (estimated findings)

DEFECT ORIGINS	DEFECT POTENTIALS	REMOVAL EFFICIENCY	DELIVERED DEFECTS
Year 2000 Dates	0.15	95%	0.0075
Bad fixes	0.05	70%	0.0150
Total	0.20	95%	0.0225

Data are estimated average software defect removal efficiency expressed in percentage of defects removed. Based on Jones 1999

Examining Tables 5 through 8 shows that even with high efficiencies in performing Y2K remediation it is almost a certainty that some projects will be late and that a large number of mistakes are bound to slip through. Some will come from failing to make changes, others from making wrong changes or injecting new defects. Even if a large fraction of the problems that slip through are not critical, it is clear that some critical errors will get through. It is those errors that will make the headlines in the year 2000 and beyond.

The implications of these data are that there will likely be many disruptions and failures, despite some excellent efforts by the IS community. However, in additions to the failures, there are opportunities and some silver linings available when Y2K is done right. We now discuss these positive aspects.

Y2K OPPORTUNITIES

In business terms, a firm that does Y2K will find the following opportunities:

- The firm's competitiveness will increase if it solves Y2K and its competitors do not. This increase comes from three sources:
    1. The firm is functioning when its competitors are not.
    2. While competitors continue fixing Y2K, the firm is able to undertake new initiatives.
    3. The competitor's costs become prohibitive.
- The firm's market share will increase.
- The firm will be able to obtain assets and people at sale prices. That is, it will be able to expand while competitors are forced to downsize.

SILVER LININGS

The increased competitiveness of the firm is derived from increased efficiency and effectiveness in IT development and operations. The firm should expect:

- Lower costs
- Reduced cycle time
- Ability to provide better service.
- Specifically, IT operations should be improved in the following dimensions:

• IT asset management	• Communications and cooperation
• IT's attitudes about itself	• People management skills, techniques
• IS development and maintenance	• IT alignment with enterprise
• Knowledge and experience	• Attitudes about IT in organization
• Project management	• External relationships

LESSONS LEARNED

As companies went through the process of fixing their Y2K problems, they learned a number of lessons. The opportunities and silver linings just discussed, for example, come from the lessons learned. The relationship is illustrated in Figure 3.

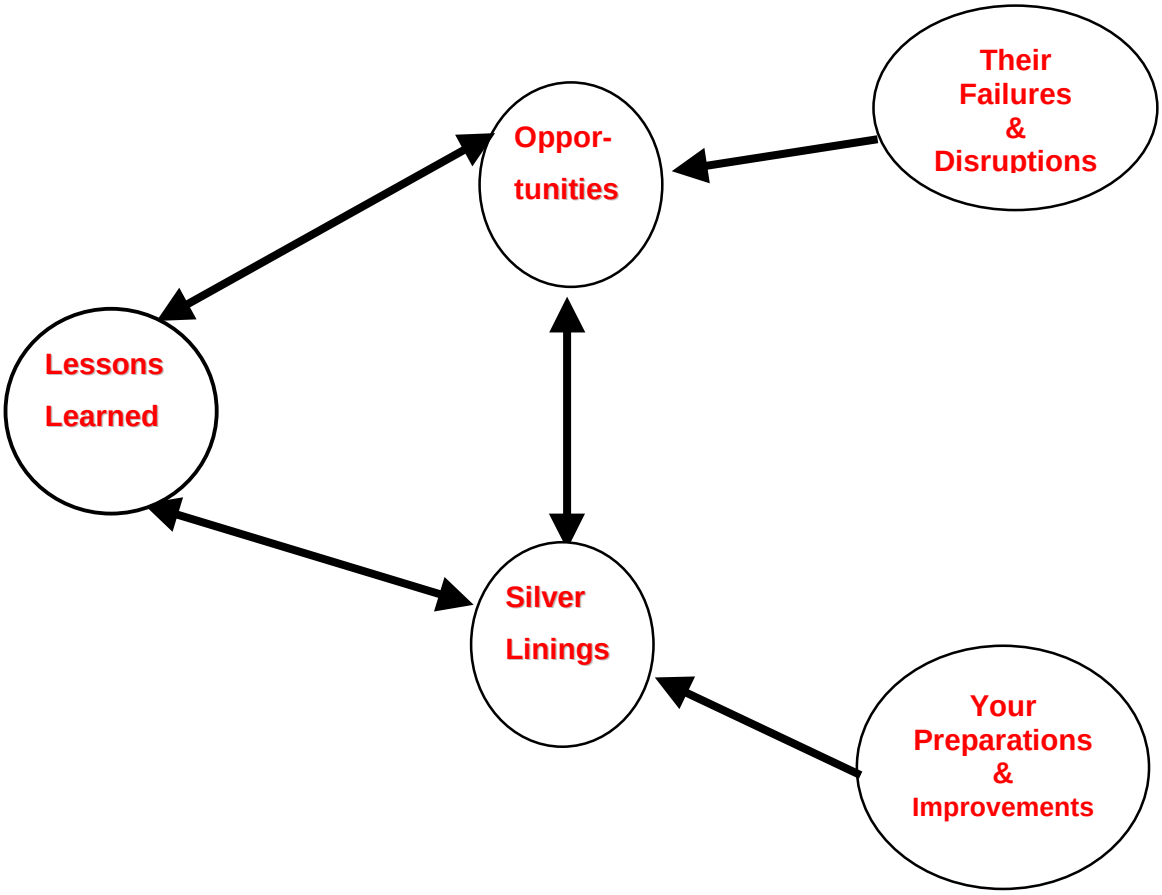

Figure 3. The Relations Among Lessons Learned, Opportunities, & Silver Linings.

These lessons are summarized in the following points.

1. It is necessary for enterprises to know their IT assets. To obtain this knowledge, firms started by creating inventories of their software and hardware and then tracking changes in their assets over time.

2. Management control over changes and versions. As remediation proceeded, firms had to impose stringent controls on changes made and versions created so that they could know what parts of the work were done and what remained to be done.
3. Standardization. Standardization pays. Both the process of remediation and the product are improved when strict standards are enforced.
4. Quality. Quality counts. As indicated in Tables 8, on the average, only 95% of Y2K defects will likely be removed. This number can be increased through testing and by performing verification and validation. The latter refers to the idea that once remediation is completed using a particular tool, the process should be repeated using a different tool. The second tool will typically pick up errors (particularly interaction errors) that the first tool missed. Third-party audits and validations are also valuable quality practices.
5. Simplicity . Simplicity is good. Simplicity involves both IT products and services and business relationships. Y2K forced enterprises to address their internal and external complexities. Often this effort resulted in actual and/or planned simplification of IT architecture and, external business relationships.

In short, it is apparent that IT business as usual is no longer acceptable in many enterprises. Depending on the outcome of Y2K, this view may become even more apparent and widespread. Remember, the best thinking of hardware and software vendors, IS practitioners and academicians resulted in the Y2K problem. Based on the enormous Y2K clean up costs alone, it is clear that improvements are critically needed. Fundamental changes are required in general IT development management practices and processes, the applications and hardware that we make and buy, both our internal and external relationships, and in the attitudes and behaviors of IT people.

REALITY CHECK: WE'RE IN THIS TOGETHER

A key lesson learned is that it is not enough merely to fix your own systems. Because of systemic interdependence, it is in your best interests to help others, particularly those in your supply chain and those in your community. Individuals both in your organization and the community at large are affected when Y2K problems are not fixed. In the next section, we discuss what members of the IS community can and should do.

VI. WHAT YOU CAN DO

To think your way through how you can make things better, ask yourself three questions:

1. Where can I receive and where can I give help and information?
2. What can I do to protect and improve my enterprise?
3. What else can I do to protect my community?

INFORMATION SOURCES

Information about Y2K abounds. For example, the Appendix to this paper reprints the Coalition 2000 Community Planning Page (Davis 1998), which describes available information sources and many of the steps that should be undertaken. The Millennium Alliance is another good source of information about Y2K community preparedness (http://www.TMA2000.org). Table 9 lists a variety of sources where you can get and give help and information.

Table 9. Y2K Information Sources

Working groups	Websites
User groups	Discussion groups/lists
Professional societies	Published reports and papers
Trade organizations	Your current vendors of hardware and software
Conferences	Year 2000 service and product providers

YOUR ENTERPRISE

The Y2K lifecycle discussed in Section IV is a guideline. Since this article appears in mid-1999, you should be well beyond the awareness and acceptance stages. The Y2K problem has to be a priority if it is to have any hope of being completed on time. Table 10 lists the people inside and outside your organization who need to be contacted and involved to make Y2K an enterprise priority and control Y2K risks.

Table 10. Those to Involve to Establish Priority & Reduce Risk

CONTACTS INSIDE THE ENTERPRISE	CONTACTS OUTSIDE THE ENTERPRISE
• Top management/board of directors	• Customers you work with
• Chief Financial Officer	• Suppliers you work with
• Functional & divisional user management	• Government officials
• Legal	• All financial enterprises you work with
• Audit	• Enterprises in which you own stocks & bonds
• Manufacturing	• Enterprises that place your community at risk
• Risk management	

Contingency/Continuity Planning. Your role is not only to help solve the problem, but also to plan for contingencies and for maintaining continuity. These contingencies include what to do for each type of Y2K error that is not resolved by your remediation efforts, or by those efforts of others upon which you depend. Like the Y2K problem itself, contingency and continuity planning is a business issue first and a technology issue second. The planning goals are:

1. Prevention. Reduce the risk and the impact.
2. Control. Minimize the duration and the severity of the problem. Make sure that there is continuity of products and services.
3. Protection. Make certain that the people, assets, investments, and mission of the enterprise are protected. Jobs, the enterprise, and the community should remain stable.
4. Simplicity. Reduce the complexity and facilitate the coordination of any recovery tasks that may be required.

Remember that Y2K events are potentially quite unique. Thus, we have little experience in coping with them. Worse yet, as shown in Table 11, Y2K does not create a single problem, but a whole host of systemically interrelated problems and risks.

Table 11. Characteristics of Y2K Events for Which Planning is Required

Characteristic	**Explanation/Description**
Internal and external	Many risks have to be anticipated
Multiplicity	Failures and disruptions can be multiple
Simultaneity	Many failures can occur simultaneously
Geographical dispersion	The failures can occur at many different locations
Cascading	Ripple effects, where one failure leads to others
Extended time frame	Although many failures will become evident on January 1, 2000, some are already occurring and others may not be encountered for days, weeks, months, or years.

Contingency planning involves several dimensions.

1. The first step is *vulnerability assessment*. Here the focus is on determining what can go wrong. The list in Table 11 indicates the areas that require considerations.
2. The *business impact* of contingencies must be analyzed. Here it is desirable to perform triage, putting first things first. Risks should be subdivided into categories such as critical, essential, necessary, and desirable. Table 12 (adapted from Davis and Olson, 1985) lists the human and organizational needs that matter divided into these four categories.
3. Knowing the risks and their importance, *prevention planning* can be undertaken.
4. Even when the best prevention plan is implemented, adverse effects can arise. Therefore, prevention planning must be supplemented by *resumption planning*. The factors that are included in a resumption plan are:

- Response: assess damage, contain, and control the problem.

Table 12. What Matters for People and Organizations

	Human Needs	Time to serious effect	Information Needs	Time to serious effect	Effects
Critical	Oxygen	Minutes	Transaction processing Process control	Minutes/days	Operations
Essential	Water, sleep	Days	Daily reports Inventory/ ordering	Days/weeks	Operational control
Necessary	Food	Weeks	Financial reports Planning & control	Weeks/ months	Managerial control
Desirable	Emotional support	Months/years	Long-term trends Strategic planning systems	Months/ years	Strategic planning

- Functional area recovery management teams to deal with problems in specific organizational areas.
- Technology and systems 'SWAT' teams to cope with problems that transcend organizational units or involve technology.
- Planning, testing, implementation, and maintenance to be performed in response to each problem.

The elements of contingency and continuity planning are similar to those routinely followed by most organizations. The new element is that this kind of planning must be done explicitly for the Y2K problem, whose dimensions as indicated in Table 11, are often much broader and more complex than other kinds of problems.

COMMUNITY PREPAREDNESS

As experts in information systems, members of AIS and subscribers to CAIS, we have a responsibility for preparedness not only for our own organization but also for our community. The notion of an ethical duty in this regard has been suggested (Kappelman, 1999). The tasks that need to be done for the community parallel those for the organization, be it a firm or a school. In brief these responsibilities include:

1. Keeping the focus on Y2K risks

2. Helping the community manage these risks
3. Finding the greatest risks. Here the focus should be on the critical needs and greatest risks of the community.
4. Providing realistic information and communications. This work includes managing expectations on what will be achieved and where failures may occur.
5. Obtaining private sector and citizen involvement through speaking, writing, and talking to groups
6. Helping prepare contingency plans and maintaining preparedness.

Note: IS professionals who want to become actively involved in Year 2000 planning in their community should consult the Coalition 2000 web page, which may be found at http://www.coalition2000.org/commplan.htm/ This web page is maintained as a free service by Steve Davis, Davis Logic, LLC. It contains lists of action plans, free resources, affordable resources, and other initiatives. You will find an example of how a public-private partnership involving IS professionals is helping Y2K preparedness efforts around the world at http://www.year2000.unt.edu/kappelma/candle.htm .

VII. CONCLUSIONS

The basic issue addressed in this tutorial is how individuals can help with the Y2K problem. Specifically, this tutorial recommends that you:

- Become more knowledgeable.
- Protect your enterprise and your community.
- Raise awareness through speaking, writing, and talking.
- Advise and assist local government and not-for-profits.
- Share your experience and what you know.

It is apparent that as surely as contingency and continuity preparations are needed for enterprises and communities, such plans may also be appropriate for individuals and families. Just as you manage your investment portfolio in light of

your situation, goals, and risk propensities, your approach to personal Y2K preparedness is an individual matter. Guidance is available from the Red Cross (http://www.redcross.org/disaster/safety/y2k.html) and the Federal Emergency Management Administration (FEMA; http:/www.fema.gov)

Y2K may mark the end of the public's unquestioned faith in high technology. But the reputation and credibility of IS professionals need not suffer if we do the right thing now. The choice is ours -- each and every individual one of us will make that choice. Our ability to react in the face of immediate problems has been one of our strengths. Whether we have the capability to be proactive in the face of eventual problems remains to be seen.

Editor's Note: This paper was received on May 16, 1999. It was with the author approximately one month for one revision. It was published on July 7, 1999.

LIST OF ACRONYMS

DSS	Decision Support System
EDI	Electronic Data Interchange
EFT	Electronic Funds Transfer
HVAC	Heating, Ventilating, Air Conditioning
LAN	Local Area Network
PBX	Private Branch Exchange
SIM	Society for Information Management
SPR	Software Productivity Research
WAN	Wide Area Network
Y2K	Year 2000

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