# What Really Happened in Y2K?

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Livery Company Professor of Information Technology

# In the 1990s …

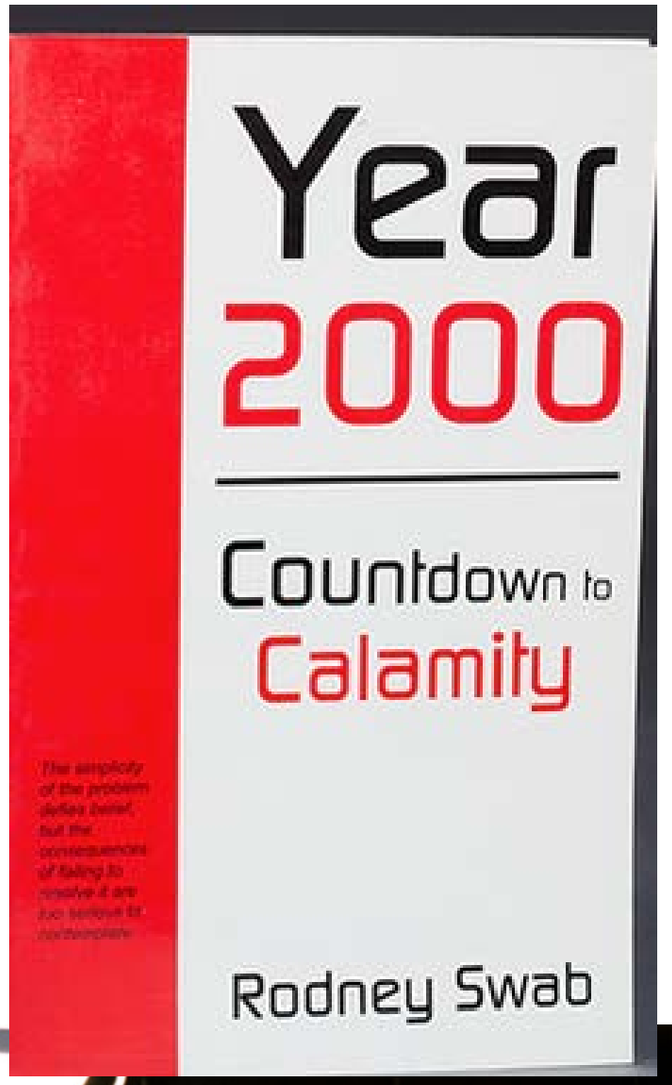
- A growing number of warnings, books and headlines about the *Millennium Bug*.

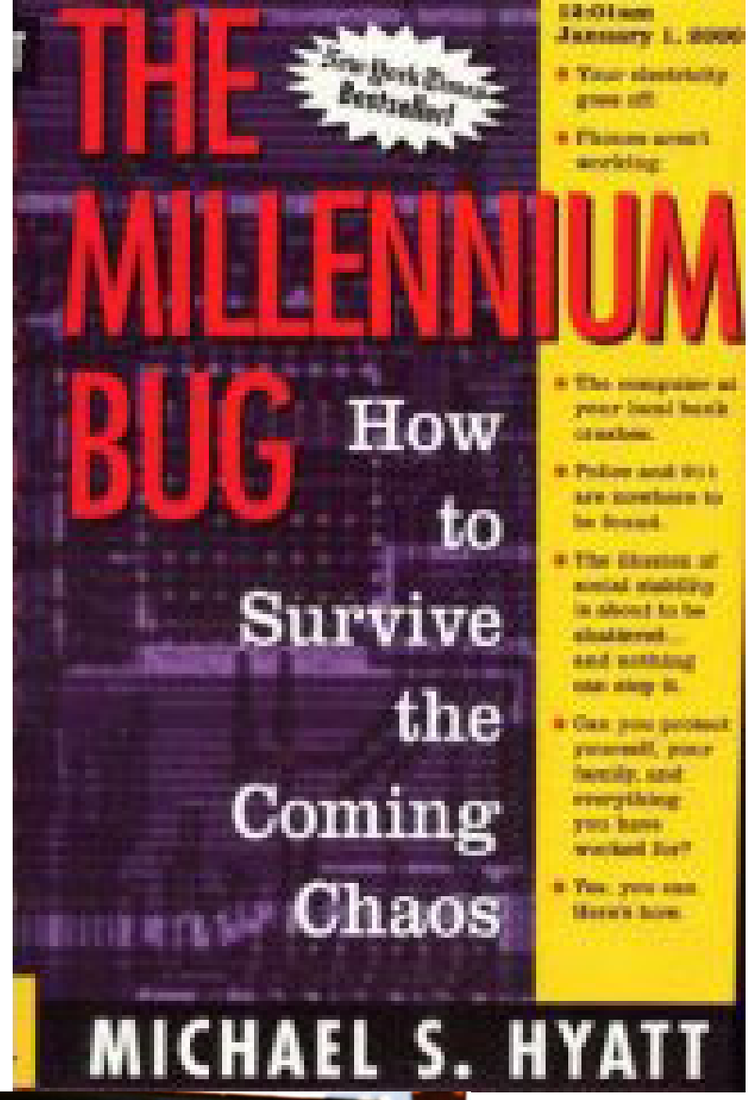
- This was a software problem that could be a common point of failure for a huge number of systems

- There were fears that power and water would be cut off, banks and company systems would fail and bank accounts would be wiped out

- Survivalist sects and some religious groups predicted Armageddon …


WEEKLY WORLD
NEWS
THE COMPUTER CRASH OF THE MILLENNIUM!
JANUARY 1, 2000
THE DAY THE EARTH WILL STAND STILL!
ALL BANKS WILL FAIL!
FOOD SUPPLIES WILL BE DEPLETED!
ELECTRICITY WILL BE CUT OFF!
THE STOCK MARKET WILL CRASH!
VEHICLES USING COMPUTER CHIPS WILL STOP DEAD!
TELEPHONES WILL CEASE TO FUNCTION!
DOMINO EFFECT WILL CAUSE A WORLDWIDE DEPRESSION!


Year 2000
Countdown to Calamity
Rodney Swab


THE MILLENNIUM BUG
How to Survive the Coming Chaos
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6
MONTHS TO GO
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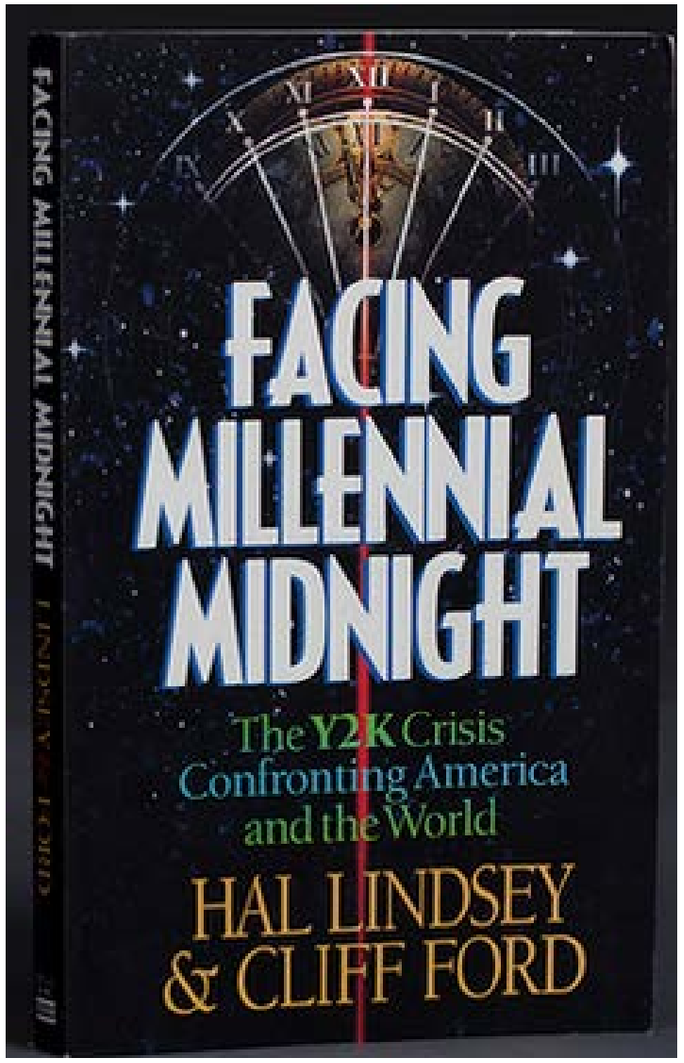
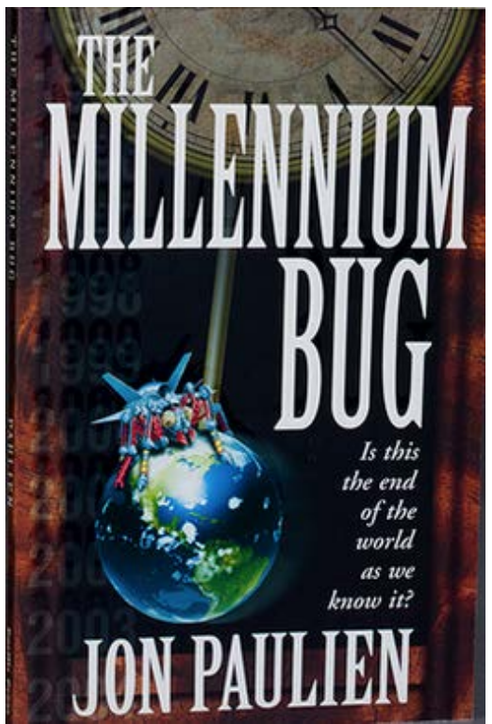
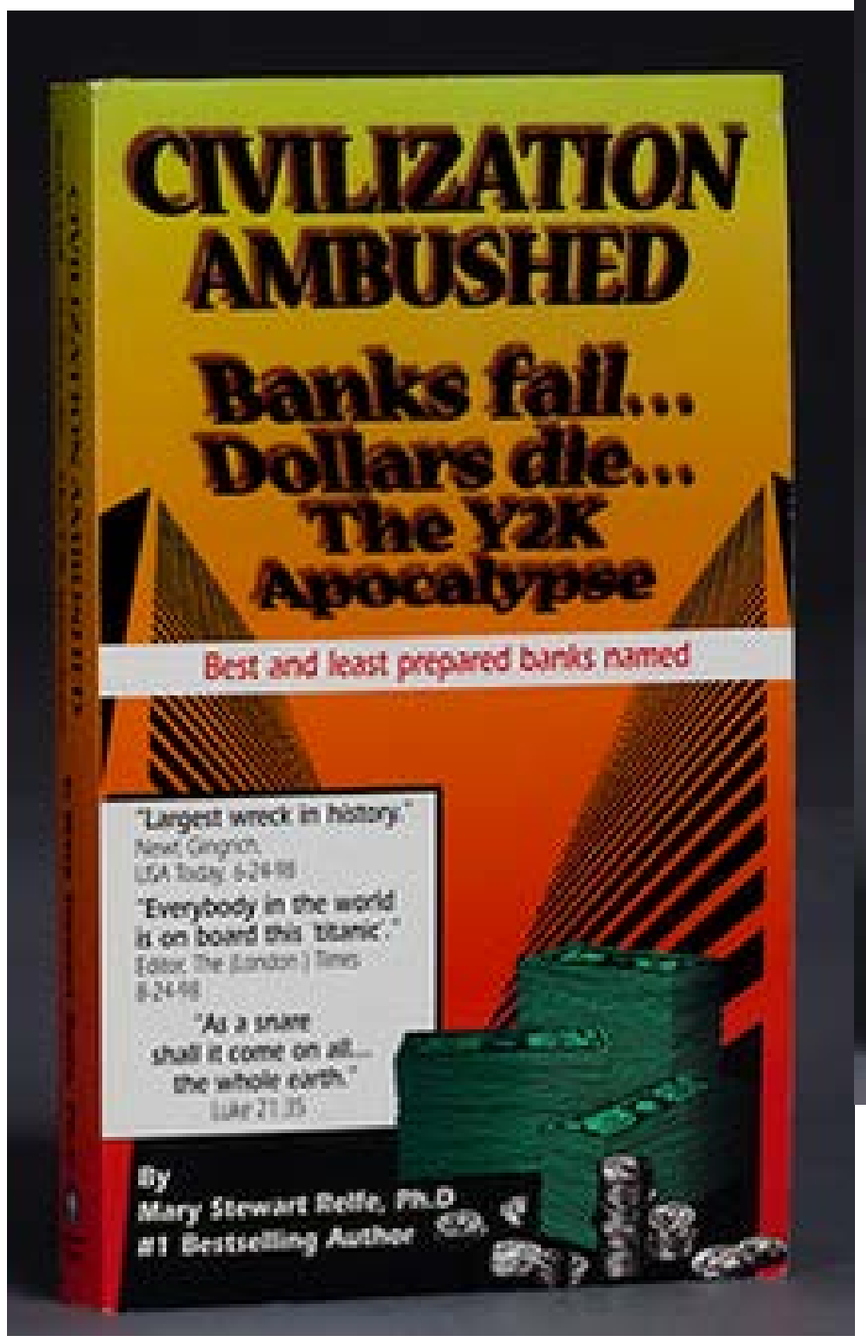
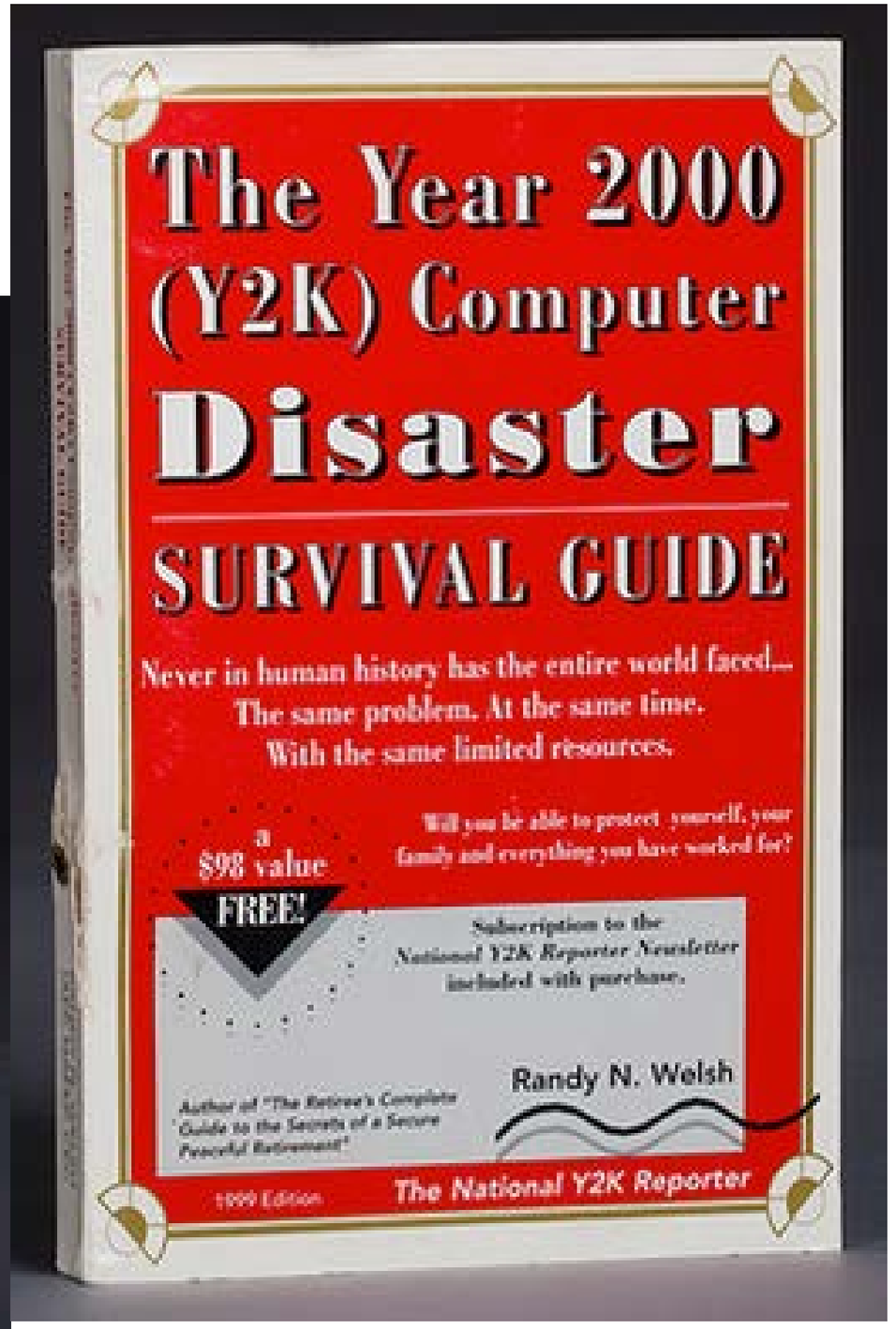

FACING MILLENNIAL MIDNIGHT
The Y2K Crisis Confronting America and the World
HAL LINDSEY & CLIFF FORD


THE MILLENNIUM BUG
Is this the end of the world as we know it?
JON PAULIEN


CIVILIZATION AMBUSHED
Banks fail... Dollars die... The Y2K Apocalypse
Best and least prepared banks named
"Largest wreck in history."
"Everybody in the world is on board this 'titanic'."
"As a snare shall it come on all... the whole earth."
By Mary Stewart Relfe, Ph.D
#1 Bestselling Author


The Year 2000 (Y2K) Computer Disaster
SURVIVAL GUIDE
Never in human history has the entire world faced... The same problem. At the same time. With the same limited resources.
Will you be able to protect yourself, your family and everything you have worked for?
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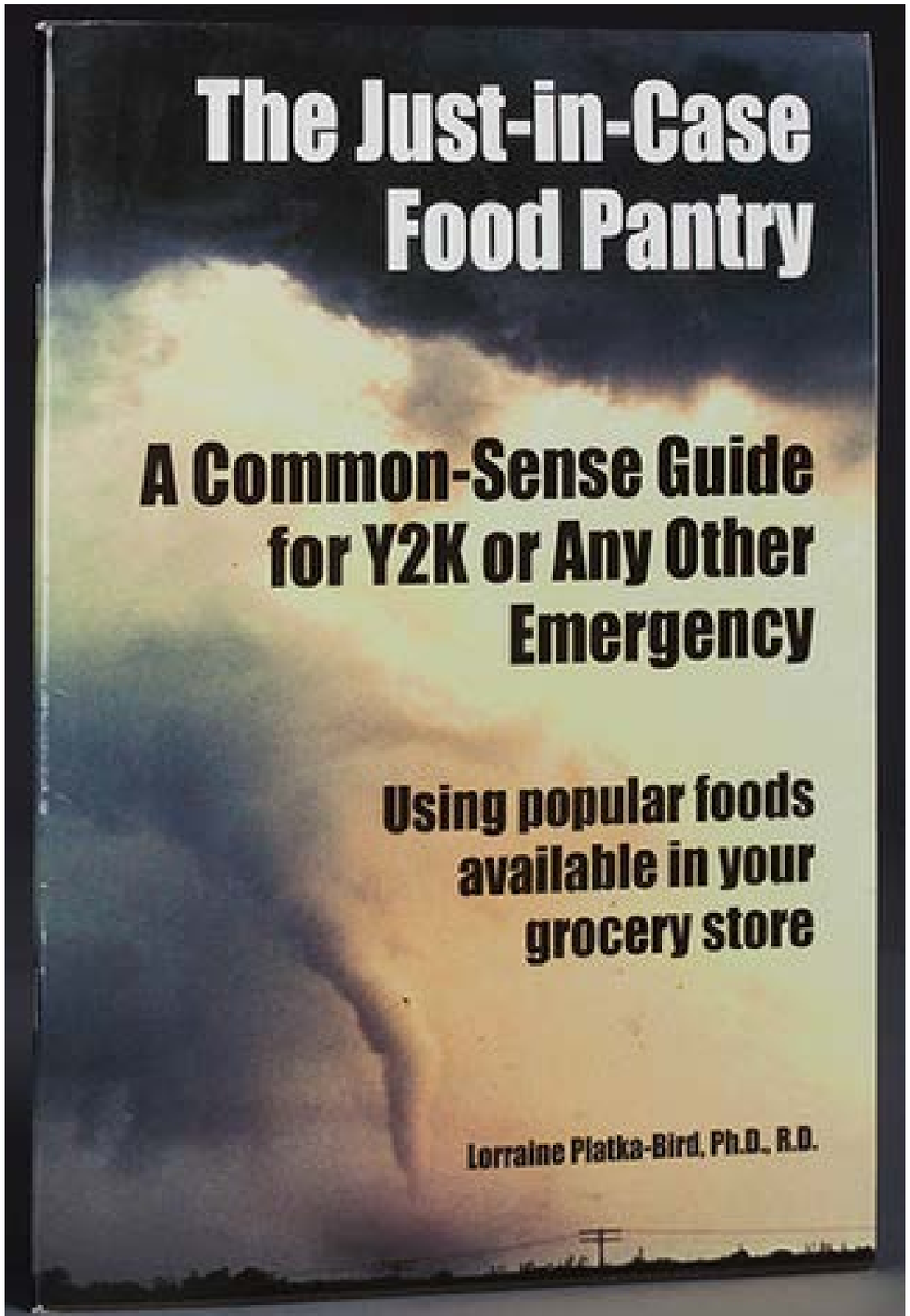
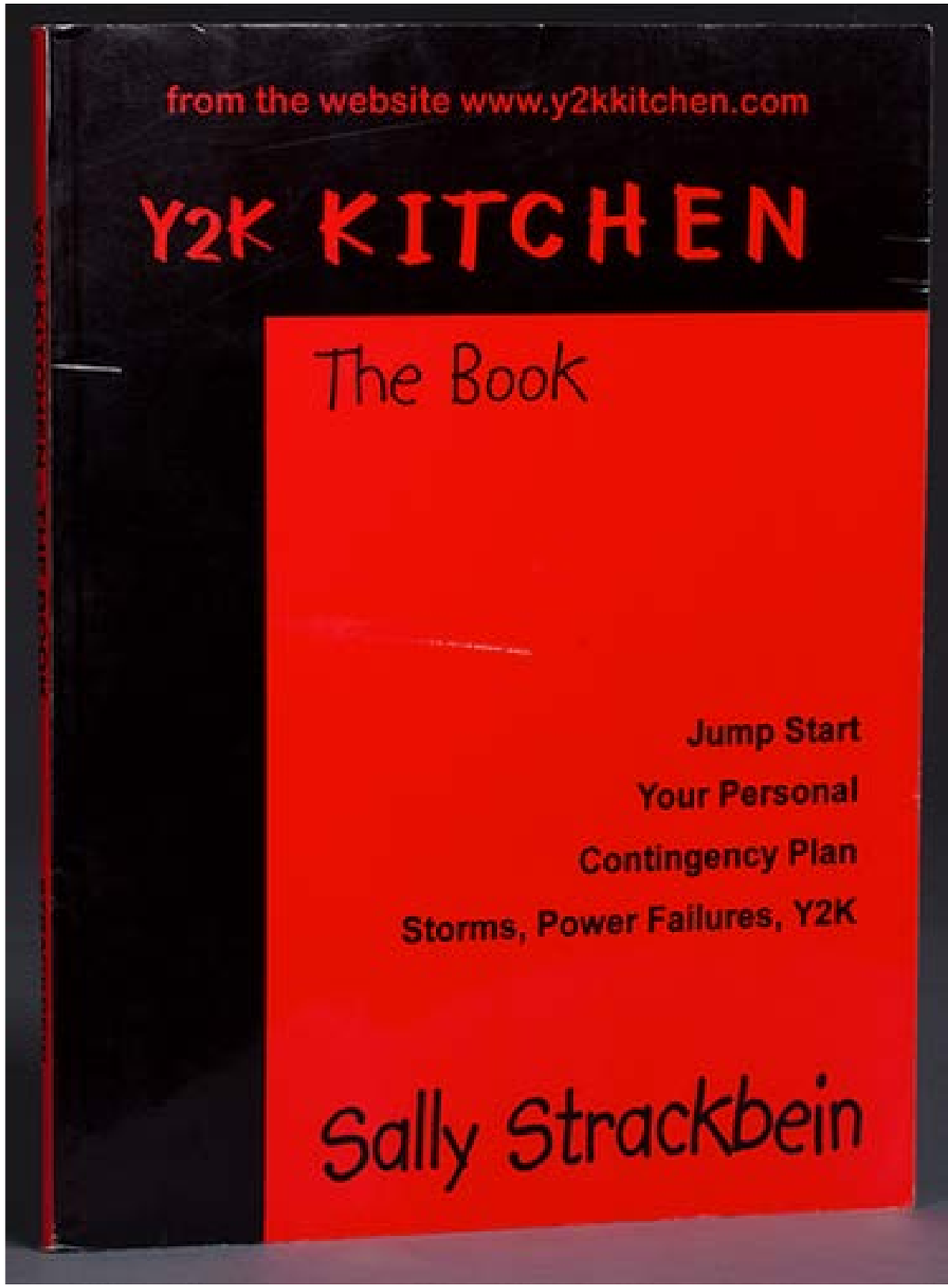
Author of "The Retiree's Complete Guide to the Secrets of a Secure Peaceful Retirement"
Randy N. Welsh
1999 Edition
The National Y2K Reporter


The Just-in-Case Food Pantry
A Common-Sense Guide for Y2K or Any Other Emergency
Using popular foods available in your grocery store
Lorraine Platka-Bird, Ph.D., R.D.


from the website www.y2kkitchen.com
Y2K KITCHEN
The Book
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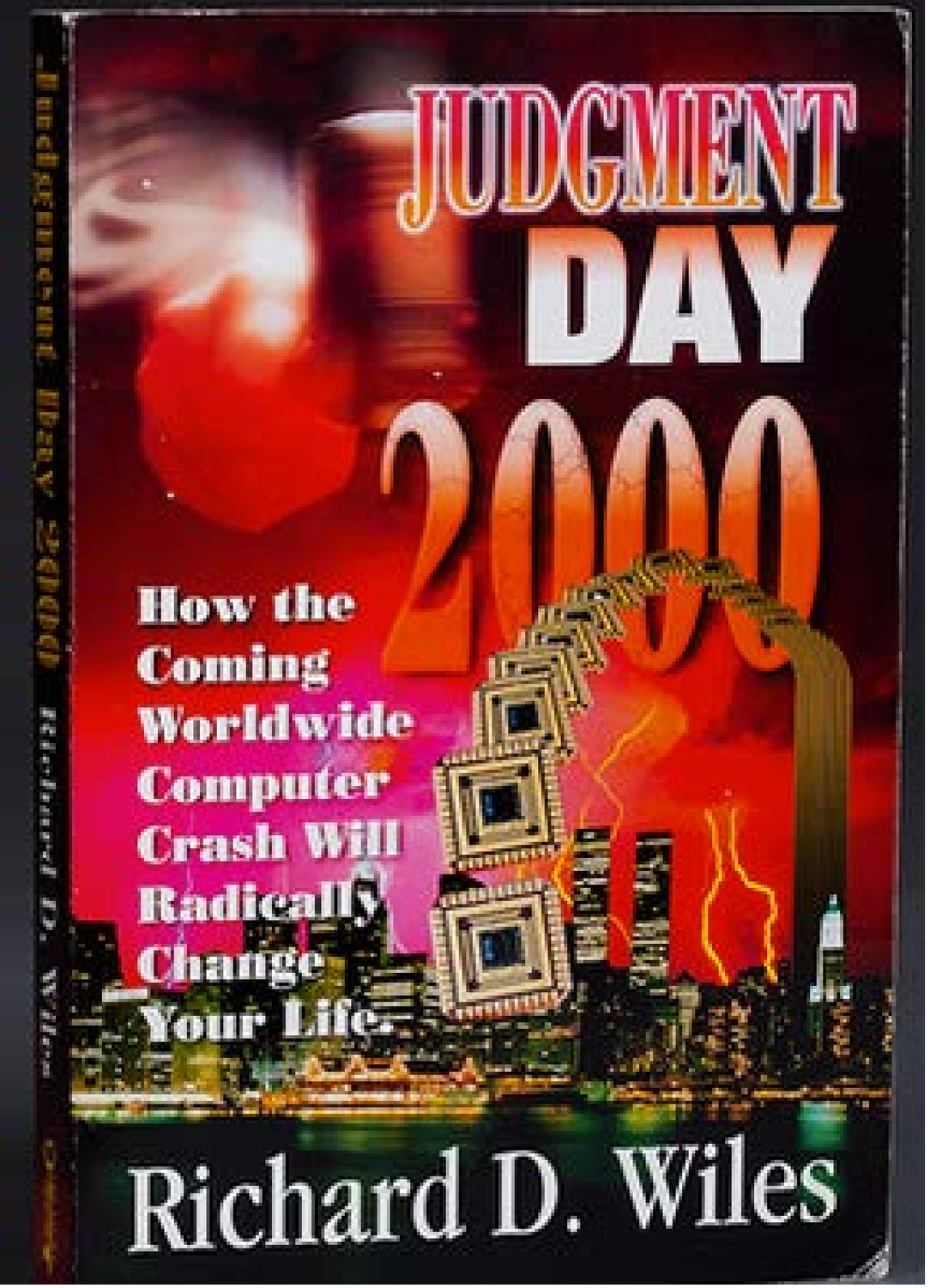
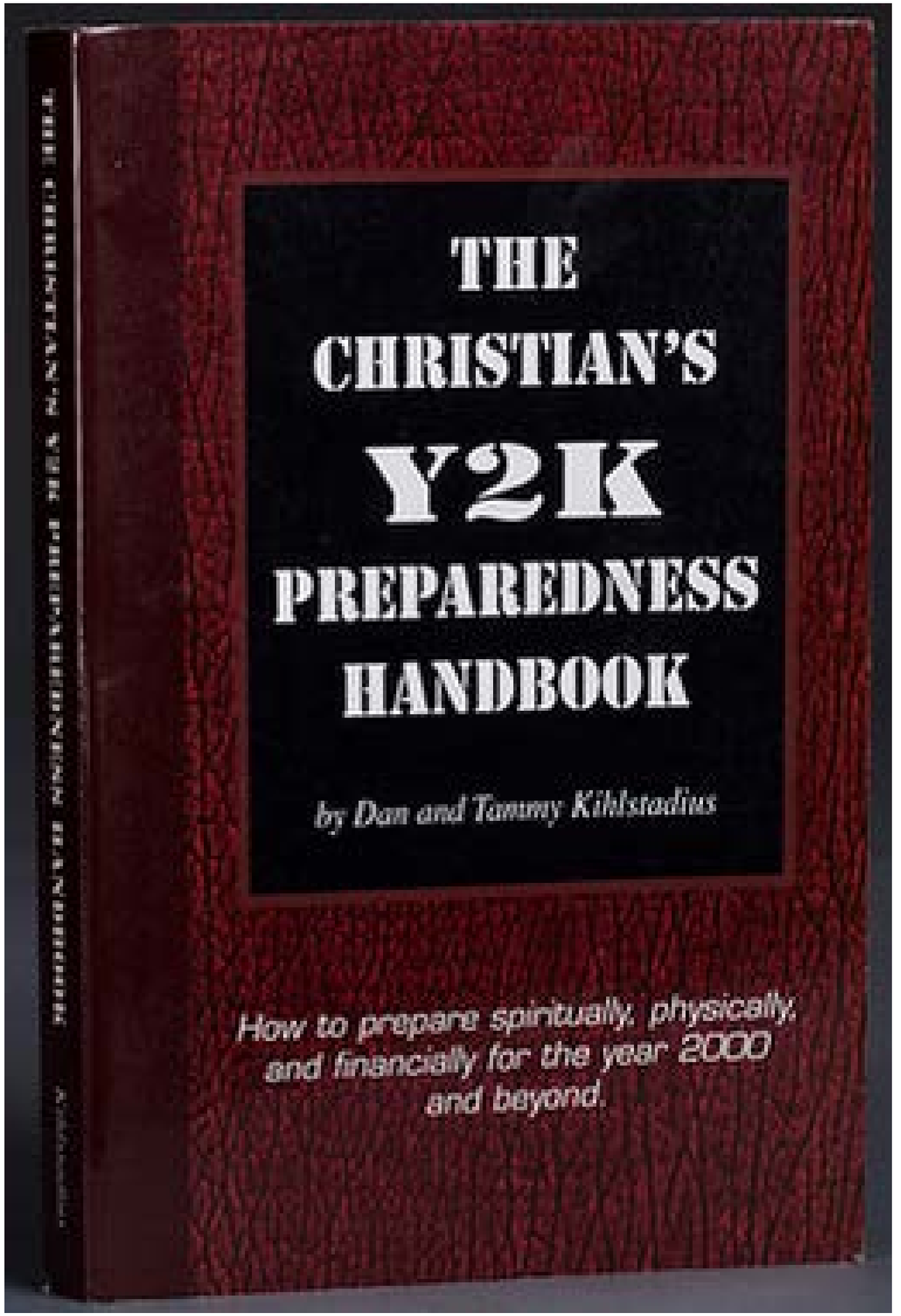
Your Personal
Contingency Plan
Storms, Power Failures, Y2K
Sally Strackbein


JUDGMENT DAY
2000
How the Coming Worldwide Computer Crash Will Radically Change Your Life
Richard D. Wiles


THE CHRISTIAN'S
Y2K
PREPAREDNESS
HANDBOOK
by Dan and Tammy Kihlstadius
How to prepare spiritually, physically, and financially for the year 2000 and beyond.

# Slowly, action was taken

- Government, UN / World and industry committees were formed

- Companies launched projects to check and repair their systems.

- Auditors questioned the *continuing business* basis for audits

TONY LONG 12.30.09 8:00 PM

# DEC. 31, 1999: HORROR OR HYPE? Y2K ARRIVES AND WORLD TREMBLES

https://www.wired.com/2009/12/1231-y2k/

**1999**: The world braces for chaos as midnight approaches. Will computer systems crash when the calendar switches over to 2000?


Although the answer turned out to be "no," and the so-called Y2K crisis never materialized, the potential for disaster seemed real enough in the days and weeks leading up to the final day of the 1900s. Fears within the computer

# And then ... ?



# Y2K is no-show for new year in Big Apple

## City keeps a sharp eye

By PETE DONOHUE and KEVIN McCOY
DAILY NEWS STAFF WRITERS

New York rang in the new millennium with huge merry-making crowds and booming fireworks — but no immediate signs of the Y2K bug.

"Y2K is Y2-OK," Deputy Mayor Joseph Lhota said early today.

The outcome appeared to validate the $400 million-plus city and state effort to fix a bug that affects older computer software. Without the correction, officials said many computers, originally programmed to express dates in two digits, might have malfunctioned or crashed when their internal clocks clicked into 00 for 2000.

Subways and buses ran normally throughout the city after the traditional ball-dropping celebration in Times Square signaled the start of a new year, century and millennium.

"In New York City, if you decide to throw a party, we will get you there and get you back safely," said Transit Authority spokesman Al O'Leary.

Similarly, no problems were reported on Long Island Rail Road and Metro-North Commuter Railroad trains running shortly after midnight.

"The trains are rolling," LIRR spokesman Brian Dolan said.

Con Edison and other utility officials reported a virtually problem-free rollover into 2000. About 150 Con Ed customers lost power in Middle Village, Queens, around midnight. But Con Ed officials said the outage was caused not by Y2K but by a blown fuse that would be quickly repaired.

Lhota said there were no problems or abnormal increase in 911, Emergency Medical Service or Fire Department calls.

The Securities Industry Association reported a smooth computer transition into 2000 for all financial exchanges and brokerage firms.

Before joining a throng of more than 1 million for the ball-dropping, Mayor Giuliani summed up the city's Y2K battle by declaring New Year's "a normal day" from a computer standpoint.

"There's not a lot to report. Things are going smoothly," said Jerome Hauer, head of the city's Office of Emergency Management.

Wanda Olthoff was in the air aboard an Atlanta-to-New York Delta Airlines flight when U.S. air traffic computer systems, programmed on Greenwich Mean Time, clicked into 2000 at 7 p.m. The 40-year-old traveler said she had no fears about the flight.

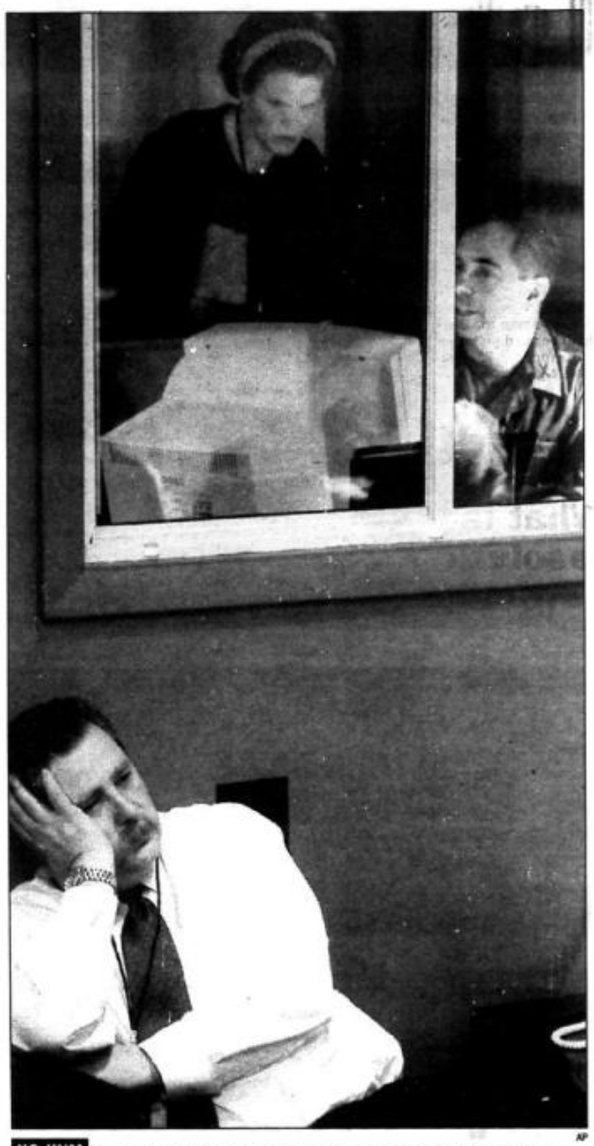
"My husband, Dan, is a pilot and he said there's nothing to worry about," said Olthoff after landing at LaGuardia Airport. "I took him at his word."

Still, authorities didn't leave anything to chance.

About 150 police, FBI, government, utility and other authorities continued to check for any Y2K-related problems as they staffed the city emergency command center on the 23rd floor of 7 World Trade Center overnight. The monitoring was scheduled to continue through the holiday weekend.

Upstate, government, police and emergency officials maintained a similar alert at the state's underground emergency operations bunker in Albany. During an afternoon briefing there, Gov. Pataki said no state in the nation "is more ready than we are to deal with any potential problems."

Custodians also were scheduled to check each city public school building today and tomorrow to ensure that all heating, lighting, fire and security systems are working for Monday's resumption of classes.



AP

**HO-HUM** Massachusetts' emergency-response team members in readiness mode yesterday at state emergency operations center in Framingham.

# World's cyber fears amount to zero

By KEVIN McCOY
DAILY NEWS STAFF WRITER

The lights shined in Sydney, Australia. The banks seemed fine in Hong Kong. Jets landed safely in the Middle East. And the president quit but the nukes stayed put in Russia.

The Y2K-bug fears that gripped much of the world and prompted billions of dollars in fixes for a simple yet near-universal computer flaw evaporated as the millennium opened with few reported glitches.

The Federal Aviation Administration declared Y2K victory shortly after 7 p.m. as computers controlling aircraft traffic — set to Greenwich Mean Time — worked flawlessly.

FAA Administrator Jane Garvey, in one of 2,415 jets flying over the U.S. at the time, relayed the news to President Clinton in a telegram that echoed flight pioneers Orville and Wilbur Wright nearly a century ago.

"Success. Stop. Inform the press. Stop," wired Garvey.

The computer bug was virtually a nonfactor amid millennium celebrations around the U.S. and the world. The industry association representing automated-teller machines reported the units were doing just fine.

John Koskinen, the White House Y2K coordinator, seemed defensive as he declared the costly preparations worthwhile. He stressed that the best test would come Monday when companies reopen for business.

The concerns focused on a shortcut used in older software that showed dates in two digits, such as 99 for 1999. The fear was that when computers hit 2,000, they would read the date as 1900.

The bug still managed to bite in a few places. One Wisconsin power utility suffered a minor Y2K-related problem when its computer clocks inexplicably jumped ahead 35 days. There was no service interruption.

In Japan, officials said three Y2K-related failures occurred in a system that measures radiation leaks around the Asian nation's Shiga nuclear power plant, about 170 miles from Tokyo. Officials said there was no effect on electricity generation or reactor operations.

China, where the new Year of the Dragon won't open officially for another month on the lunar calendar, rang in midnight with no reported disruptions.

U.S. and Russian military officers also worked side-by-side last night at arms centers in each other's homelands to guard against the possibility of any Y2K-triggered nuclear-missile launch. Russian officials said the precaution, while prudent, proved unnecessary.

With News Wire Services

Saturday, January 1, 2000 • DAILY NEWS

# Hoax? Scam?

- **The *six* Year 2000 problems**
- **When and how was the threat recognised?**
- **What needed to be done, and how?**
- **What failures do we know were prevented?**
- **What failures actually occurred?**
- **Why were the failures less serious than had been feared?**
- **What did it all cost?**
- **Have the right lessons been learnt?**

# The *six* Year 2000 problems

- 2-digit years in programs and data
- Real-time clocks in PCs and PC software
- Clocks in Programmable Logic Controllers
- The first century Leap Year since 1600!
- Special uses of dates
- Fixed centuries in print routines, on printed cheques and other stationery and even cast in stone …

# This was a Business Problem

- Most commercial data processing systems use dates
- In 1996, a UK Government Report estimated there were 7 Billion embedded systems worldwide.
- Tests in 1997 showed typical embedded system failure rates of 5%, rising to 50% or higher in complex systems.
- Customers and suppliers might fail
- There could be liabilities, but insurance was not available
- The world shared the deadline and needed the same resources

# The *six* Year 2000 problems #1
# 2-digit years in programs and data


Two digit years were widely used to save space – and still are

But you may need the century if you have to do arithmetic

# Alan Greenspan told Congress:

*I'm one of the culprits who created this problem. I used to write those programs back in the 1960s and 1970s, and was proud of the fact that I was able to squeeze a few elements of space out of my program by not having to put a 19 before the year. Back then, it was very important. It never entered our minds that those programs would have lasted for more than a few years. As a consequence, they are very poorly documented. If I were to go back and look at some of the programs I wrote 30 years ago, I would have one terribly difficult time working my way through step-by-step.*

# What systems were affected?

## Almost everything that used dates

- Anything that calculated someone's age, checked expiry dates of passes or licences, sell-by or use-by dates, calculated trends or averages, checked maintenance periods and last-maintained dates …
- PCs, security equipment, barcode systems, switchboards, lifts, vending machines, entry systems, barcode systems, safes and time locks, vehicles, building management systems, factory equipment, medical equipment, process monitoring … and much more

# The *six* Year 2000 problems #2
# Real-time clocks in PCs / PC software

- The early IBM PCs did not maintain the date when switched off. The IBM PC XT added a Real Time Clock but it did not update the century.

- DOS assumed that system dates were between 1980 and 2099, otherwise it reset the date to 1 April 1980.

- Different BIOSs handled the Y2K rollover differently: when tested, many PCs displayed 1 April 1980 on the first boot after Y2K. Some failed spectacularly – the Award v4.50 BIOS required a new ROM BIOS chip

- Lots of PC software (including Windows 95) would fail.

- Rack-mounted PCs were widely used as controllers

# The *six* Year 2000 problems #3

## Programmable Logic Controllers

- PLCs replaced hard-wired control logic in the 1980s
- They controlled industrial plant, including safety shutdown
- They were typically programmed in *Ladder Logic*
- PLCs were often part of larger, bespoke systems that contained other clocks, or linked to SCADA systems
- The documentation was often poor

# The *six* Year 2000 problems

**#4 The first century Leap Year since 1600!**

**#5 Special uses of dates**

**#6 Fixed centuries in print routines,**

**on printed cheques and other stationery,**

**and even cast in stone …**

# When and how was the threat recognised?

- M&S Stock Control found 90 year old beef


- Mary Bandar, the 104 year old infant in 1992

- 999 day retention for backup tapes

# What needed to be done?

## Awareness:

- Even by 1995, UK Government Survey found only 15% of senior managers were fully aware and only 8% of companies had assessed the scale of their risk.

- 1996: *TaskForce 2000*

- *1997: Action 2000 (budget grew to £17m)*

- *1997 most Audit Firms required Y2K compliance for audit clients*

- *1999 UN / World Bank International Y2K Cooperation Center*

# What needed to be done?

## BSI Standard for Date Handling:

- **Rule 1: No value for current date will cause any interruption in operation.**
- **Rule 2: Date-based functionality must behave consistently for dates prior to, during and after year 2000.**
- **Rule 3: In all interfaces and data storage, the century in any date must be specified either explicitly or by unambiguous algorithms or inferencing rules.**
- **Rule 4: Year 2000 must be recognized as a leap year.**

# What needed to be done?

## Project scope

- **inventory, evaluation, remediation, implementation and asset management**.
- The biggest IT project most companies had ever done
- Fixed deadline, shared with the world – with earlier risks
- Many companies could not even locate all source code!
- Shortage of staff – Cobol skills, legacy systems
- Staff turnover as salaries increased dramatically

# What needed to be done?

## Fixing 2-digit years

- Date expansion to 4 digits:
  - Best solution but expensive: needs big changes to many connected systems simultaneously
- Windowing: Guess the century from the 2 digit year
  - Cheaper: only change date routines. Error-prone. Connected systems must use the same windows. Trouble ahead when windows end!
- New Systems: best for suppliers and consultants!
  - Most companies could not resist adding new facilities
  - IT projects usually over-run …

# What needed to be done?

## Testing

- Basic testing was easy:
  - Set the system date to 2001 and see what happens.
  - Set the system date to Dec 31 1999 and watch the roll – over to Jan 1 2000.
  - Test other key dates

# What needed to be done?

## A few of the things that went wrong

- An Aluminium Plant in Western Australia failed catastrophically.
- Chrysler tested the rollover (at Sterling Heights)
  - The security system shut down and wouldn't let anyone in or out. The time clock systems failed. We couldn't pay anyone. *Chrysler Chairman: "We got a lot of surprises".*
- Many Racal credit-card systems failed in December 1999 despite a major Y2K programme by Racal. Retailers claimed $5m losses.

# What failures were prevented?

- **UK *Rapier* anti-aircraft missile system** failed in test
- **Swedish nuclear plant** tested the rollover and the computers shut down the reactor –in summer not January 2000!
- ***Millennium Dome**:* error messages scrolled off the console too fast to read!
- **BP Exploration** found a fault in all its offshore oil platforms: “finding this one fault justified our entire Y2K programme”.
- 10% of **VISA** swipe-card machines were found to fail (1.3 million worldwide).
- **Many thousands of faults were corrected that would have caused failures.**

# What failures actually occurred?

- Despite a professional Y2K programme (*checked by me!*), the RVR systems on all NATS airfields failed at 4am on Jan 1 2000 (no risk created)

- The UN Y2K Co-ordination Center reported many faults, though far fewer than had been feared, some serious, some trivial some amusing.

- for example … …

# Some IY2KCC Reported Failures

- 15 nuclear reactor shut-downs (in Spain, Ukraine, Japan and the USA).
- Many credit card systems rejected valid cards.
- The oil pumping station in Yumurtalik shut down, cutting off supplies to Istanbul.
- There were power cuts in Hawaii and cable television feeds failed.
- The Kremlin press office could not send e-mail.
- In New Zealand, an automated radio station kept playing the New Year's Eve 11pm news hour as most recent.
- Birth certificates for British newborns were for 1900.
- *Many more examples included/referenced in the lecture transcript*

# Why were the failures less serious than had been feared?

- **A huge number of errors had been found and fixed**
- Software and equipment suppliers fixed the most widely-used products in time
- Failures did not cascade because:
  - The biggest supply chains contained the best-resourced and most active companies, so systems were updated
  - Systems proved to be less tightly-coupled than had been feared.
- Later companies and countries caught up because of far better tools and fixes that others had already made
- The threat *had* been exaggerated: it was a serious threat but made too dramatic by headline seekers and those with their own agendas

# What did it all cost?

- Globally, perhaps  $300B to $500B
- There were benefits beyond the avoidance of failures:
  - Most companies learnt a lot about their dependence on IT, their IT inventory and their supply chains.
  - Professionalism of in-house IT improved
  - Board-level representation of IT because more common
  - Many systems were replaced, upgraded and improved

# Have the right lessons been learnt?

- The problem was caused by poor software engineering. *Abstraction, information-hiding and object orientation could have made the necessary changes far simpler*

- **Software is still developed with cost and speed-to-market given priority over security, modularity, robustness and other software engineering criteria**

- **Testing is still the main method for software assurance, even though we know it cannot find most defects.**

# Have the right lessons been learnt?

- Y2K could have caused huge numbers of systems to fail almost simultaneously. Such threats should be systematically avoided
- **GPS is another single point of failure.**
- Redundancy and loosely coupled supply chains provide important resilience
- **Redundancy is increasingly seen as wasted resource**
- **Just-in-Time supply chains are very tightly coupled**

# Have the right lessons been learnt?

- Y2K showed the power that regulation and audit standards have in compelling board-level action
- *There is no political will to use regulation to drive improvements in the quality and security of software*

# Conclusions

- Y2K was not a hoax or a scam (though some suppliers took advantage of Y2K to compel unnecessary system upgrades)

- **Y2K should be seen as a near miss. A *signal event*. A serious threat that was caused by poor software engineering but avoided by focused attention, considerable hard work and international co-operation.**

# The threats are greater today

- Supply chains are far more complex and more tightly coupled
- We continue to introduce dependencies on single points of failure (e.g. GPS and widely-used software components and subsystems)
- Cyberattacks are a serious and growing threat
- Almost all software developers still do not use rigorous engineering methods, so the amount of vulnerable software increases every month.

Some people point to the Y2K problem to argue that we shouldn’t trust expert warnings about climate change!

# What should we learn from Y2K?