Spreadsheets are Great!
- 2D Grids containing *Billions* of Cells
- Totally Free-Format:
  - Numbers
  - Text
  - Formulae
  - Left Blank
- Automatic Recalculation
- Instant “What If?” Models

Could They Be Better?
- Yes, they are ubiquitous today, and...
- ...yes, we have better tools than back then:
  - More functions available
  - Multipage Notebooks
  - Advanced Graphics
  - Macros (Built-in Programming Language)
- ...but we’ve been using the *same basic layout* since VisiCalc (1978)! [With one exception.]

Some Blind Spots
- Only Two Data Types:
  - Strings
  - Numbers (Double-Precision 64-bit Binary Floats)
- Cell Addresses are Clumsy
  - What does A1 or $B$6 really mean?
  - Named ranges can help, but only so far.
- How Good are the Answers?
  - You get a numeric answer; can you trust it?

A Few Modest Suggestions
- BCD Arithmetic
- Interval Arithmetic or UNUMs
- Extended Data Types
- Built-In Dimensional Analysis
- Expanded (and Corrected) Dates
- Base-Conversion Formats

Rant #1: BCD Arithmetic
- Problem:
  - 64-bit Double-Precision Binary Floats suffer from round-off error in unexpected places (\(\sqrt{2}\) is an infinite fraction).
  - Currency conversions can’t legally have round-off error.
- Solution:
  - Keep each decimal digit as 4 independent bits (Binary Coded Decimal, or BCD).
  - Enough space available in a Double to keep 13 BCD sig figs (but not the 15-16 of a Binary Float).
- Issue:
  - Not as information dense as pure binary.
  - No hardware support (yet), must be done in software.
Rant #2: Interval Arithmetic

- **Problem:**
  - No information about how "good" any answer is.
  - Is there a confidence interval? Error bars? **NO.**
- **Solution(s):**
  - Interval Arithmetic: Carry every calculation as two numbers, a low bound and a high bound, gives confidence interval at end. Answer guaranteed to be in between.
  - Universal Numbers (UNUMs) are an idea that extends Interval Arithmetic to variable-precision binary.
- **Issue:**
  - No hardware support (yet), must be done in software.

Rant #3: Expanded Data Types

- **Problem:**
  - Spreadsheets only deal with strings and numbers.
  - Microsoft badly troweled in complex arithmetic as strings. \( \texttt{=IMSUM("5+6i","3-2i")} \) gives \( \texttt{"8+4i"} \)
- **Solution:**
  - Allow data types such as complexes, polynomials, lists, audio clips, images, video, etc.
- **Issue:**
  - Basic spreadsheet engines have to be completely rewritten from scratch.

Rant #4: Dimensional Analysis

- **Problem:**
  - Any spreadsheet model involving units have to be carefully analyzed to avoid conversion issues (multiplying gallons times miles can’t be detected).
- **Solution:**
  - Attach units to quantities, have spreadsheet maintain, as in: \( 2.54(\text{cm/in}) \times 10(\text{in}) = 25.4(\text{cm}) \)
- **Issue:**
  - Basic spreadsheet engines have to be completely rewritten from scratch.

Rant #5: Expanded Dates

- **Problem:**
  - Dates don’t go earlier than January 1, 1900.
  - Persistent error claiming 1900 is a leap year.
- **Solution:**
  - Extend model back at least to October 15, 1582 (start of Gregorian Calendar).
  - Maybe even go with Julian Day numbers.
- **Issue:**
  - Compatibility with current spreadsheets.

Rant #6: Base-Conversion Formats

- **Problem:**
  - Numbers can’t be shown in different bases (there are a few functions that return equivalent strings in different bases, but not as cell formats).
- **Solution:**
  - Extend formats (General, Currency, Percent, etc.) to include at least Binary, Octal, Hex, etc.
- **Issue:**
  - ?? Shouldn’t be that hard!

Your Responsibilities

- You are a consumer of high-tech products.
- It’s your money!
- It’s your time!
- It’s your life!
- You should **demand** better tools.
But Hasn’t Anybody ever tried to do this Before?

• There were spreadsheets other than Microsoft Excel, Lotus 1-2-3, or Borland Quattro.
• I’ve even written a few spreadsheets myself with weird capabilities.
• 3D Spreadsheets (early 1990s).
• Lotus Improv for NeXT (1988).

The NeXT Computer (an aside)

• 1984: Apple releases Macintosh, Steve Jobs thrown out of Apple, Jobs goes away.
• 1988: Jobs announces NeXT ($5000):
  – Fastest Processor chip then used on Macs,
  – 16 megabytes of memory (PCs had <1 megabyte),
  – 1024×1024 display (PCs were 320×200),
  – CD-quality audio (PCs could go “beep”),
  – Built-in networking (neither PCs nor Macs),
  – Laser printer standard (PCs used dot-matrix),
  – Lotus Improv spreadsheet.

Lotus Improv Spreadsheet

• Hypercube instead of 2D grid.
• Up to 12 dimensional data.
• View data from along any axis.
• Names rather than cell addresses.
• Genesis of Multipage Notebooks used today.
• Never very popular, tech folded in as pivot tables in modern spreadsheets.

Cut to the Video...