

Faith, Funds, & Fate

Prerequisites for the development and
transfer of new technology

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MOSIS as a case study

- The stages of MOSIS as I know them now.
 - Developing the concepts at Xerox PARC.
 - Creating descriptive and educational material.
 - Initial trials to prove out the new concepts at PARC.
 - Scaled up trials at multiple Universities.
 - Recognizing the value of MOSIS to the silicon industry.
 - Transfer from PARC to USC-ISI.
 - 30 years of continuous improvement and use.

Why start with **Faith** and **Funds**?

- A research organization is a **faith**-based entity.
- Someone has enough **faith** to believe that spending money now might enhance the future.
- Executing a research program requires **funds**.
- Payback for the expense is not yet obvious.
- Courage is required to authorize the expense without immediately evident justification.
- **Faith** writ large!

The legacy of **faith** behind MOSIS

- XEROX Corporation in PARC. (George Pake)
- ARPA in USC and ISI. (??? + Keith Uncapher)
- PARC in its **System Science Laboratory**. (BertS)
- PARC SSL in its staff. (principally Lynn Conway)

Why include **Fate**?

- Retrospectively we can recognize the situation at the beginning of significant events.
- Key people were fortuitously in place without explicit planning for the significant event. **Fate**
- Some key people had prior experiences very useful to the event. Is that just by accident? **Fate**
- There were important personal past connections and interactions. **Fate**

Prior important connections

- Bert & Ivan – lifelong as brothers
- Ivan & Carver Mead – Caltech
- Bert & Carver – PARC SSL Consultant
- Bert & Keith Uncapher – ARPA and Rand
- Bert & Bob Kahn – BBN times
- Lynn Conway & Herb Schorr – IBM ACS project
- Many more I am sure I don't know about.

Developing the concepts.

- Carver and Lynn simplify VLSI design concepts and constraints – selecting a minimal but covering subset easily understandable by digital system designers.
- Scalable dimensionless design rules based on lithography resolution - all spacing in multiples of “ λ ”, the minimum usable resolution.
- Regular repetition of cell-layouts to create compact digital subsystems.
- Creation of design examples that intuitively suggest a wide space for future architectural innovations.

Creating educational material

- Internal classes at PARC required class handouts.
- First laser printer at PARC could make a pretty good looking textbook prototype. Fool anyone.
- The idea of creating a rapidly-evolving textbook.
- Other invited authors were contributors.
- Many evolving drafts for trial university courses. Implementation and instructor guides as well.
- Ultimately Addison-Wesley professional book.

TRIALS

- Internal classes to PARC researchers
- First University course at MIT in fall 1978
 - **Fate** – Bert then on MIT EECS Visiting Committee.
 - Lynn detached TAD for semester at MIT. Bert's **fun**ds!
- Half semester was class work, half project design.
- PARC implementation tools created for support.
- Data transmittal over ARPA net.
- PARC paid for masks, HP Labs contributed fab.

More trials

- Summer courses for college instructors.
 - Instructor guides created and printed.
- Fall classes planned at a dozen Universities.
- PARC offered to implement ALL class projects, in a huge ARPA net happening called “MPC79”:
 - Automated e-mail handler and design-file-merging system was created (an early e-commerce system).
 - Designs sent over the ARPA net to PARC.
 - PARC merged files into MultiProjectChips on wafers. Masks made & sent on to HP for fab and packaging.
 - Chips for 82 projects sent to students 1-month later.

Then on to 30 years of MOSIS

- This was a success-disaster! Way too much!
- PARC needed to withdraw from this activity.
- Keith Uncapher and ARPA decided to continue for the industry's and nation's benefit.
- ARPA had the **faith** to provide the **funds**.
- ISI & Keith had the vision to accept the responsibility for the task.
- The result -- MOSIS has helped foster the silicon revolution ever since!!

Concluding comments

- Using research project results is **HARD!**
 - It requires changing habits and behavior.
 - Recipients don't usually like to change.
 - Recipients do not usually budget for new expense.
 - Developing curricula simultaneously is unusual!
- At PARC this story was a real **HAPPENING!**
 - We didn't plan it all in advance; only Lynn did!.
 - Each successful step lead to the next ad hoc thing!
 - Lynn's tech report has changed it from a
 - **HAPPENING** into **HISTORY!**

<http://ai.eecs.umich.edu/people/conway/VLSI/MPCAdv/MPCAdv.pdf>

Palo Alto Research Center

The MPC Adventures:

**Experiences with the Generation of VLSI Design
and Implementation Methodologies**

by Lynn Conway

XEROX

MAJOR CREDITS as I see them

- **Fate** for providing so many key parts and people ready in place for the happening.
- Carver and Lynn for working out the concepts.
- Lynn for running the trials to prove validity.
- Lynn for creating the educational material and MOSIS prototype that enabled wide adoption.
- Keith Uncapher for leadership accepting transfer!
- An uncountable number of other supporters who contributed so much to the success.

Lynn's email to me after she checked facts in this talk.

- I'm still amazed at how this all happened, given that so much faith and fate was involved. At times it almost seemed like some invisible hand was guiding the events.
- During that Q and A, it would be great if you could help the ISI folks better grasp the HUGE impact of THEIR efforts down these many years. They are owed many kudos for taking the flame and really running with it.

The 3 Bs of my talk — quoting Scott McNealy

- **Be brief**
- **Be finished**
- **Be questioned**

Thank you. **ON TO Q & A**