An Introduction to Parallel Supercomputing

Pete Beckman

Argonne National Laboratory

MCS Division meeting c. 1983

- "If our R&D is going to be relevant ten years from now, we need to shift our attention to parallel computer architectures"
- "Los Alamos has a Denelcor HEP: let's experiment with it"

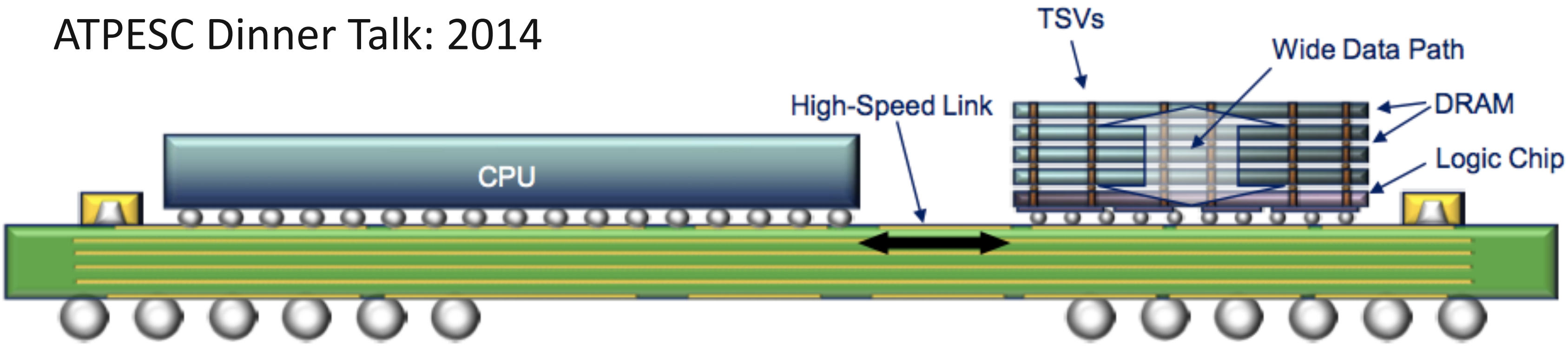
POOMA Project: 1996
John Reynders

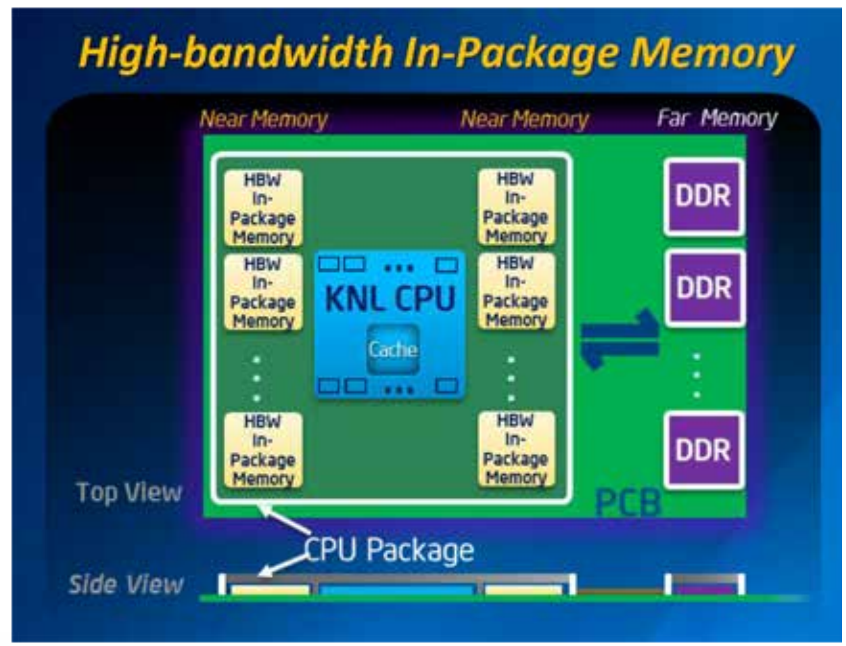
Parallel Platform Paradox

> "The average time required to implement a moderate-sized application on a parallel computer architecture is equivalent to the half-life of the latest parallel supercomputer."

"Although a strict definition of "half-life" could be argued, no computational physicist in the fusion community would dispute the face that most of the time spent implementing parallel simulations was focused on code maintenance, rather than on exploring new physics. Architectures, software environments, and parallel languages came and went, leaving the investment in the new physics code buried with the demise of the latest supercomputer. There had to be a way to preserve that investment."

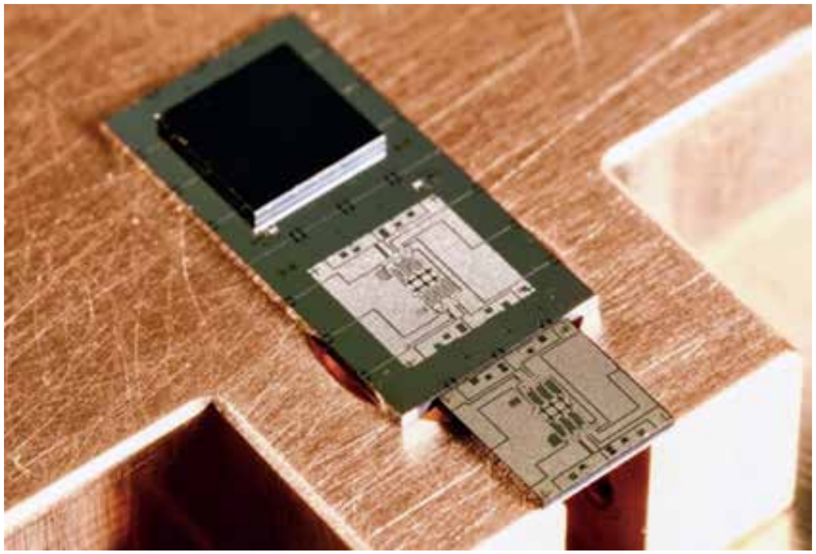
ATPESC Dinner Talk: 2014

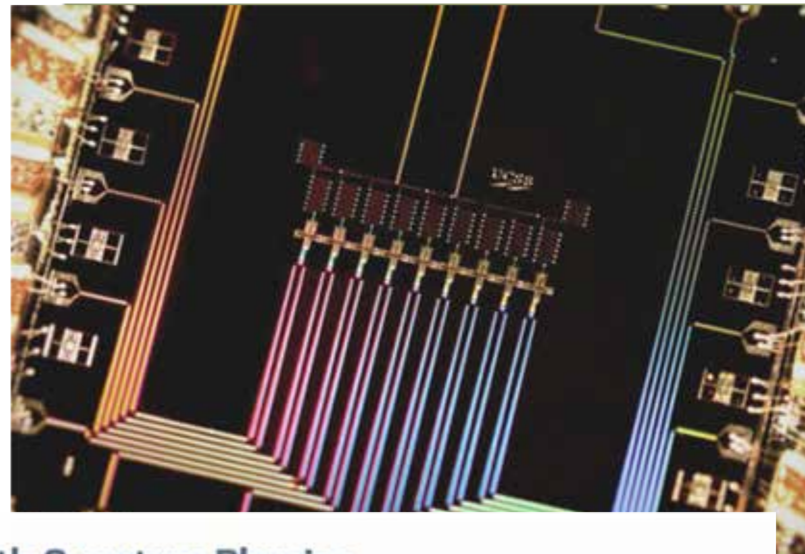


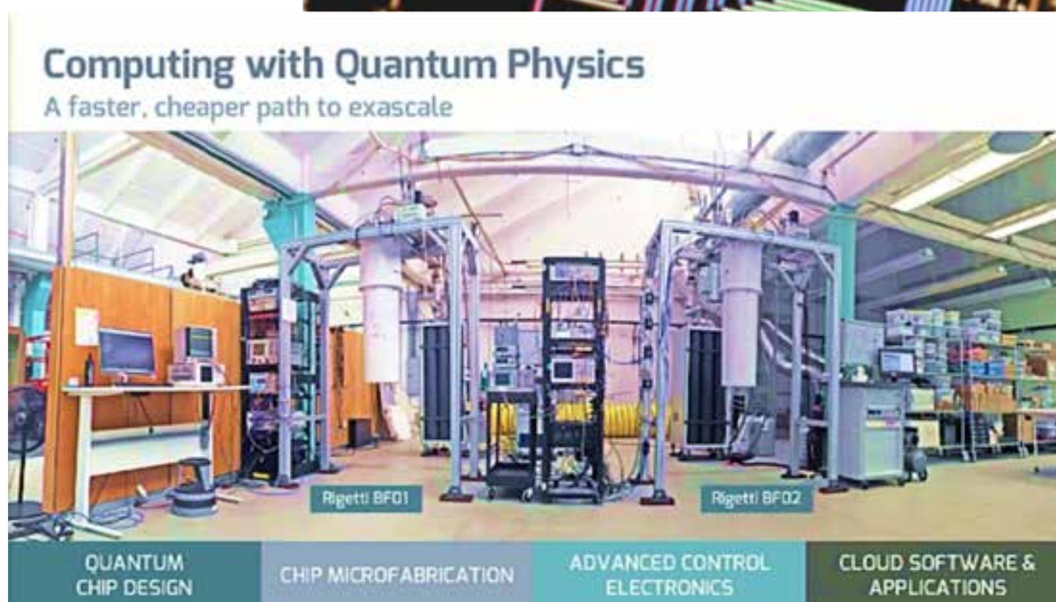


Today…

Quantum?

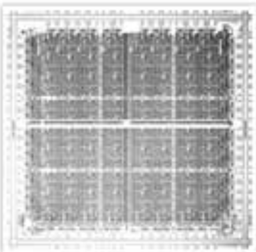





Computing with Quantum Physics
A faster, cheaper path to exascale
Rigetti BF01
Rigetti BF02
QUANTUM CHIP DESIGN
CHIP MICROFABRICATION
ADVANCED CONTROL ELECTRONICS
CLOUD SOFTWARE & APPLICATIONS

INTEL MARRYING FPGA, BEEFY BROADWELL FOR OPEN COMPUTE FUTURE

March 14, 2016 Nicole Hemsoth



For those who read here often, there are clear signs that the FPGA is set to become a compelling acceleration story over the next few years.

From the relatively recent Intel acquisition of Altera by chip giant Intel, to less talked-about advancements on the programming front (OpenCL progress, advancements in both hardware and software from FPGA competitor to Intel/Altera, Xilinx) and of course, consistent competition for the compute acceleration market from GPUs, which dominate the coprocessor market for now

Last week at
might fit int
announcem
Xeon chip. I
Broadwell E
diagram ma

ADOPTION OF INTEL FPGAS FOR ACCELERATION OF ENTERPRISE WORKLOADS GOES MAINSTREAM

FPGA….

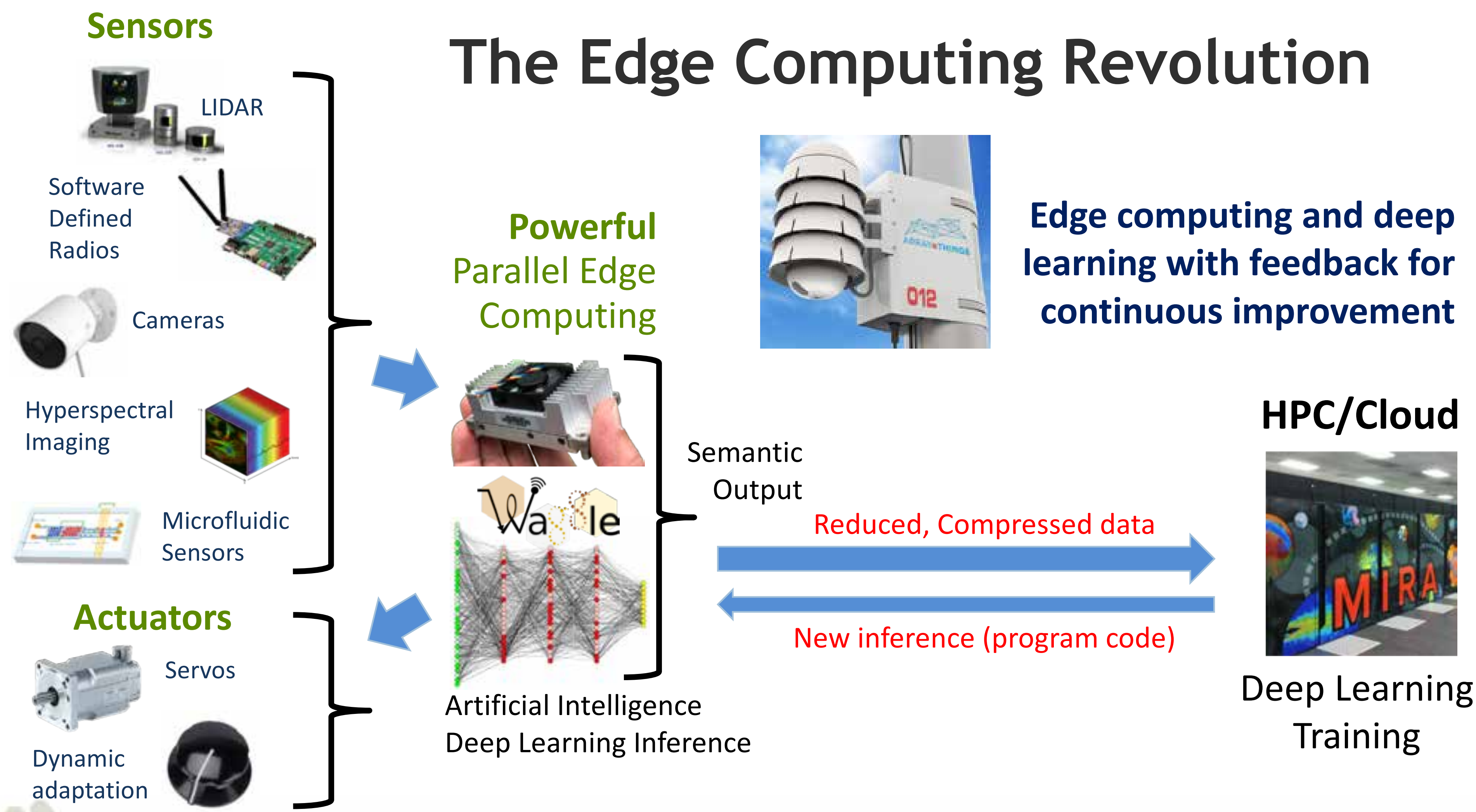
Microsoft Catapult

FPGAs:

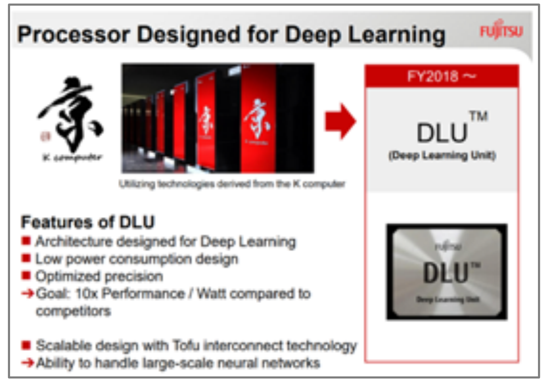
- Biggest win: SDN goes into FPGA/NIC
- All servers since 2015 deploy this
- Cloud providers recognize we need ”fluid” systems, but HPC lags behind…

Andrew Putnam

The Edge Computing Revolution



Google TensorFlow Processors



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GRAPHCORE

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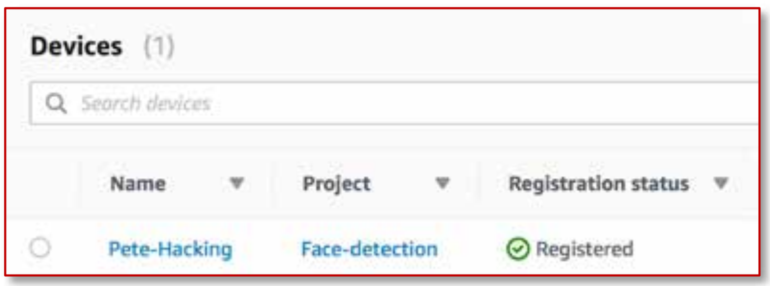
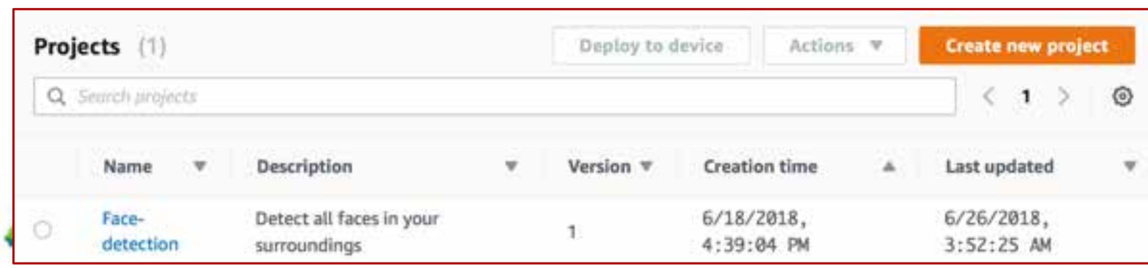
MYTHIC

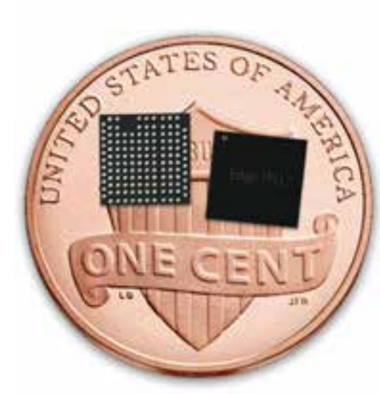
Intel Myriad

NVIDIA TX2

Amazon DeepLens





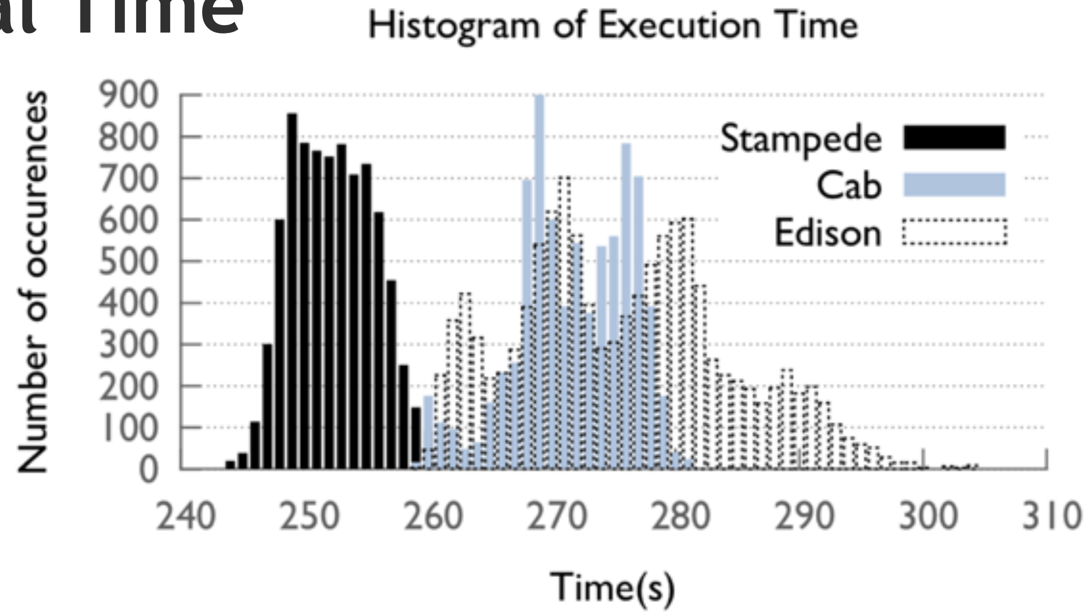


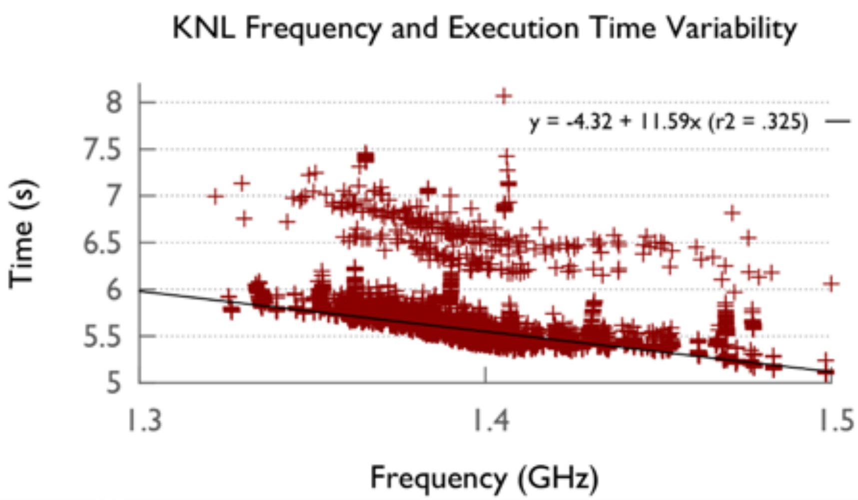
Google Edge TPU

July 2018

"Edge TPUs are designed to complement our Cloud TPU offering, so you can accelerate ML training in the cloud, then have lightning-fast ML inference at the edge. Your sensors become more than data collectors — they make local, real-time, intelligent decisions."

Equal Work is not Equal Time





Courtesty Bilge Acun: Dissertation, UIUC, 2018

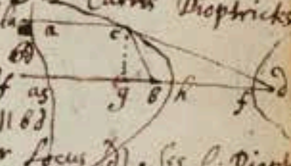
Pete's Investment Recommendations

- **OPM (Other People's Math (libraries))**
- **Encapsulation**
  - Parallelism & Messaging & I/O
- **Embedded Capabilities**
  - Debugging
  - Performance Monitoring
  - Correctness Detection
  - Resilience
- **The Two Workflow Views**
  - Science: (problem setup, analysis, etc.)
  - Programmer: (mod, testing, document, commit)
- **Automation**
  - A+ Build system, nightly test and build, configuration
  - Embedded versioning and metadata
- **Community: web, tutorial, email, bug tracking, etc**

Memory
Heterogeneity
Variability

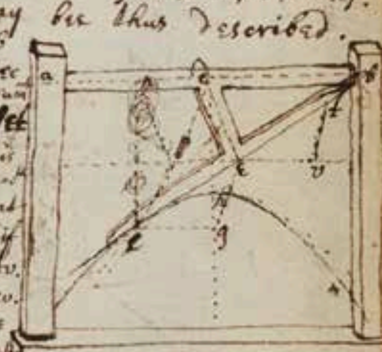
Of Refractions.

1 If ye ray ac bee refracted at the center of ye circle acdg towards d & ab ⊥ bg ⊥ gc ∥ ed. Then suppose ab : ed :: d : e. See Cartes Dioptricks



2 If there bee an hyperbola the distance of whose foci bd are to its transverse axis kf as d to e. Then ye ray ae ∥ bd is refracted to ye exterior focus (d). See C. Diopt.

3 Having ye proportion of d to e, or bd : kf. The Hyperbolas may bee thus described.



1 Upon ye centers a, b let ye instrument adbtec bee moved in wch instrument observe yt ad ⊥ de ⊥ ce of yt the Beame ce is not in ye same plane wth adbe but intersects it at ye angle tev soe yt if tv ⊥ ev, then d : e :: et : tv. Or d : e :: Rad : sine of ∠tev. Also make de = q/2 i.e. Half ye transverse diameter. Then place ye plate chm in the same plaine wth ab. & moving ye instrument adbect to & fro its edge ce shall cut or weare it into ye shape of ye desired Parabola. Or the plate chm may bee filed away untill ye edg ce exactly touch it every where.

2 By the same proceeding Des-Cartes concave Hyperbolicall wheele may bee described by being turned wth a chissell &c whose edge is a straight line inclined to the axis of the mandrill by ye angle wch angle is found by making d : e :: et : tv :: Rad : sine of ye

3 By the same reason a wheele may be turned Hyperbolically concave ye Hyperbola being convex. Or a Plate may bee turned Hyperbolically concave