A Brief History of Quantum Design’s Products

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Selecting A New Product

* Will people want to buy it? How many?
* Can we sell it for a reasonable price?
* Can we build it for a reasonable price?
* Can we afford to develop it?
* Can we afford not to develop it?
MPMS
Preliminary Considerations

* Marketing survey - called our friends
* Total market - about 6 units / year
* $100K / unit * 6 units / year ÷ 4 men = $150K / man-year
Materials Selection

* Ceramic coil form - SQUID detection coils
* Commercial silicon-copper alloy tubing
* Phenolic magnet core
* Manganin heater wire
* Yellow mylar tape
CURIE LAW PARAMAGNETISM

\[ \chi \propto \frac{1}{T} \]

\[ \Delta \chi \]

\[ \chi \]

\[ \Delta T \quad T \]
Digital R/C Bridge by Quantum Design

- Full computer control via IEEE 488
- Excitation powers
- Expanded dynamic range with ultra-low resistance and conductance modes provided
- Feedback control signals
- 16-bit resolution for both sensor readout and control
- Four sensor channels and two 15-well controller
- Ultimate flexibility in precision temperature control
MPMS - The Real Thing

* QD SQUID control system
* Magnetic Field - 5 Tesla / improved control
* Temperature - 1.9 Kelvin / improved control
* Improved automation
* New PC-based software
* Began developing additional options

Quantum Design - July 2000
MPMS - The Calm

* Dec 1985 - Allen Goldman, Univ. of Minnesota
* Feb 1986 - Brock University (Canada)
* Mar 1986 - Dean Taylor, Los Alamos Nat. Lab
* Jul 1986 - Bob Shelton, Iowa State
MPMS - The Wind

* Aug 1986 - SHE discontinues VTS
* Sep 1986 - High-Tc materials are discovered
* Mar 1987 - APS “Woodstock for Physicists”
* Aug 1987 - Serial #11 and 12 at NTT, Japan
* Dec 1987 - Shipped Serial #15
Quantum Design

With compliments

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Measured Feb 7, 1987

First magnetic confirmation of 92-K superconductor. Quantum Design SQUID used.
MPMS - The Storm

* Jan - Mar 1988 - Shipped 11 units
* Apr - Jun 1987 - Shipped about 15 units
* Apr - Jun 1987 - Accepted >$4M in orders
* Delivery schedule went to over 15 months
The QD Business Plan - Dave Cox

* Start a company
* Develop a really nice instrument
* Pray for a miracle
MPMS Options Developed

* Transverse Axis Measurement
* AC Option: 0.1 Hz to 1000 Hz
* 800 Kelvin Oven
* Extended Dynamic Range

Quantum Design - July 2000
What Do We Do Now?

* MPMS is an established product
* Annual revenues >$5M
* Some government (SBIR) research
* 1988 - Formed Quantum Magnetics
Where’s the SQUID?

* Precision temperature-controlled sample chamber
* Precision magnetic field control
* Quantum Design - defined by MPMS
* Customers expect complete solutions
THE PPMS MEASUREMENT FAMILY

- DC RESISTIVITY
- AC/DC MAGNETISM
- CRITICAL CURRENT
- AC RESISTIVITY
- I/V MEASUREMENTS
- HALL EFFECT
- ULTRA-LOW FIELD
- USER'S EXPERIMENTS
- VERTICAL ROTATOR
- TRANSVERSE MAGNET
- 14 TESLA MAGNETIC FIELD
- STM/AFM
- MAGNETIC ANISOTROPY (ROTATOR)
- TORQUE MAGNETOMETER

AC TRANSPORT OPTION

BLUE - NOW AVAILABLE
RED - UNDER DEVELOPMENT
GREEN - POSSIBLE NEW OPTIONS

\(^3\text{He} \ 0.5 \text{ KELVIN} \)
Helium-3 System

Quantum Design

Sample mounts
Resistivity & Heat Capacity
The MPMS-XL

* Temperature Control
  - Temperature slewing
  - Continuous operations for $T < 4.2$ kelvin
  - Improved thermometry

* Measurement Control
  - Oscillating sample measurement (RSO)
  - Data collection during temperature sweep
  - Faster data collection

Quantum Design - July 2000
MPMS & PPMS
Liquid HE Consumption

* Operating expense (continuous operation)
  – US - $10,000 / year
  – Japan / Europe - $20,000 - $40,000 / year

* Limits market for the instruments