

HIGH-RESOLUTION METERING FOR GAS METERS

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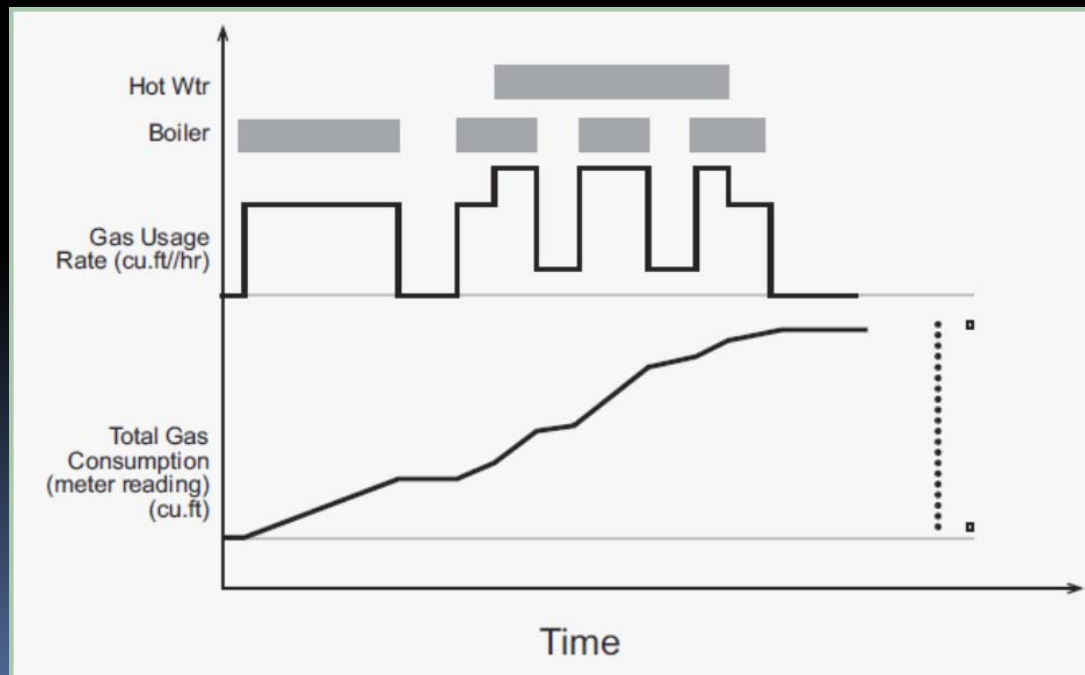


Problem Statement

- Desirable to monitor usage of gas appliances:
 - Usage/cost reporting to consumer
 - Efficiency / suggestions for cost reduction
 - Leaks / theft / problems
 - Energy budgeting
 - Appliance-specific rates (\$ heat < \$ drying)
- Current billing of 1/month too coarse to make meaningful energy adjustments
- Even AMI/AMR data too coarse to determine behavior of single appliances

The S.M.A.R.T. Concept

- SMART - *Single-Meter Appliance Resource Tracking*
- Most gas appliances use gas in a binary (on/off) fashion (boiler, hot water, dryer, pool heater, oven)
- Small number of gas appliances ($N = 4$)
 - Total combinations of appliances = $2^N - 1$ (7 for $N = 3$; 15 for $N = 4$)
 - Manageable!
 - By monitoring usage signal of each appliance, can determine usage

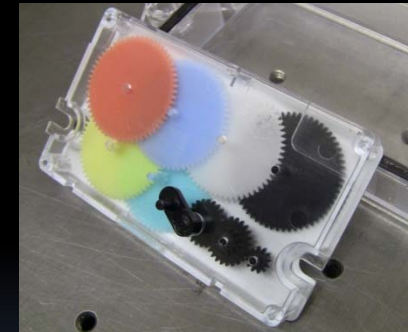
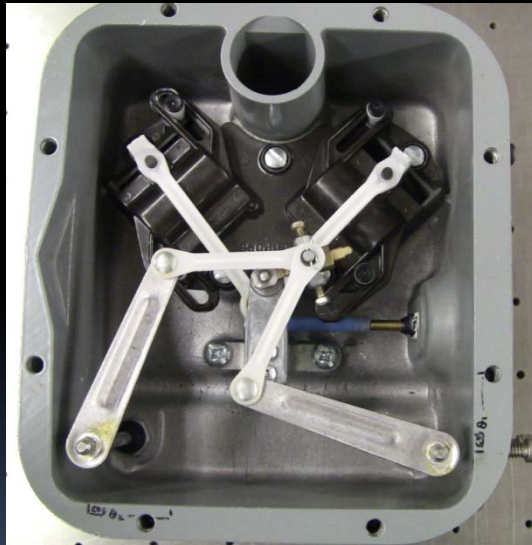


Key Components

- Retrofit to existing gas meter
- Hardware requirements:
 - High-resolution encoder / gear train
 - Microcontroller and clock
 - Housing and power
 - (Standard wireless package for AMI)

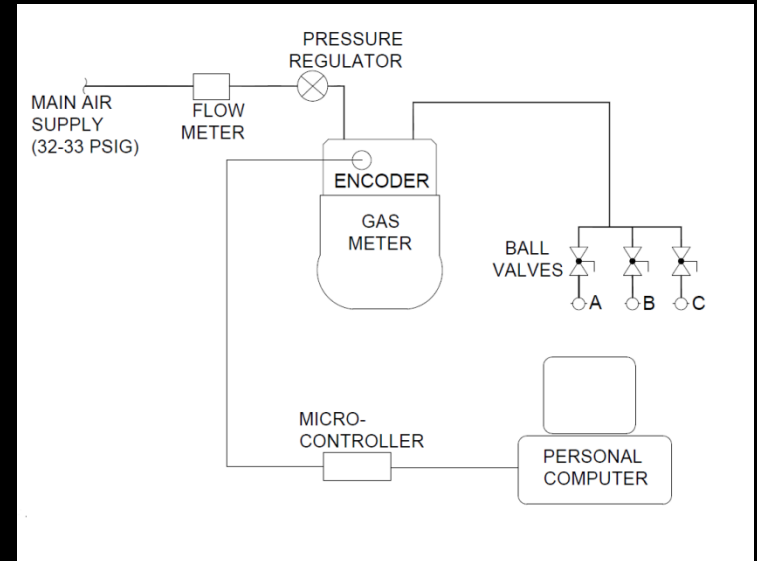
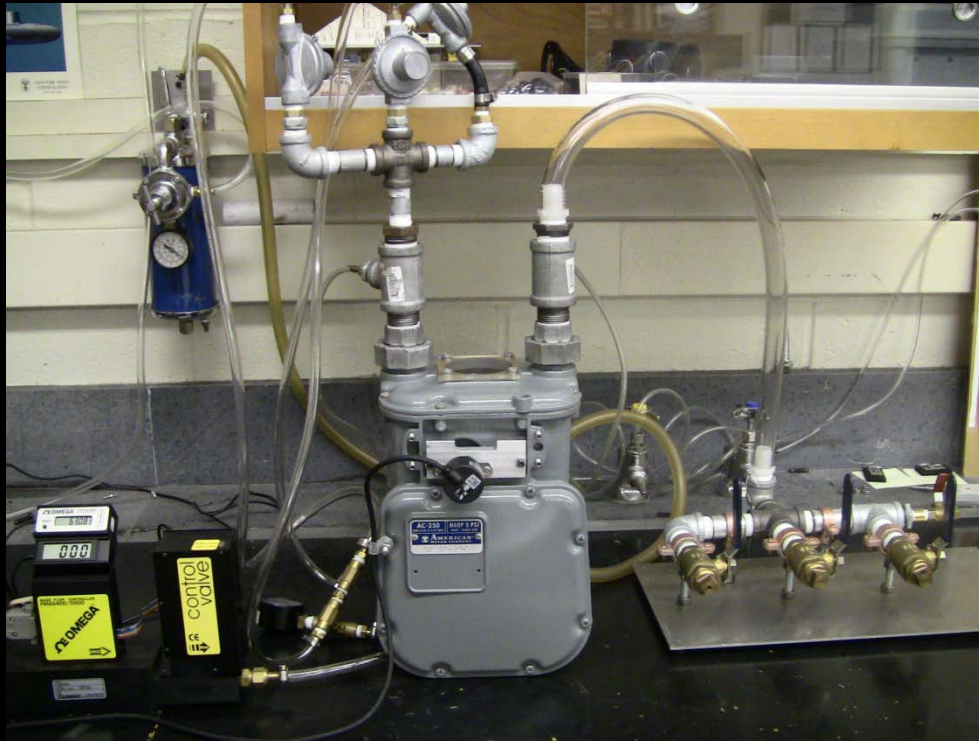


Anatomy of a Gas Meter

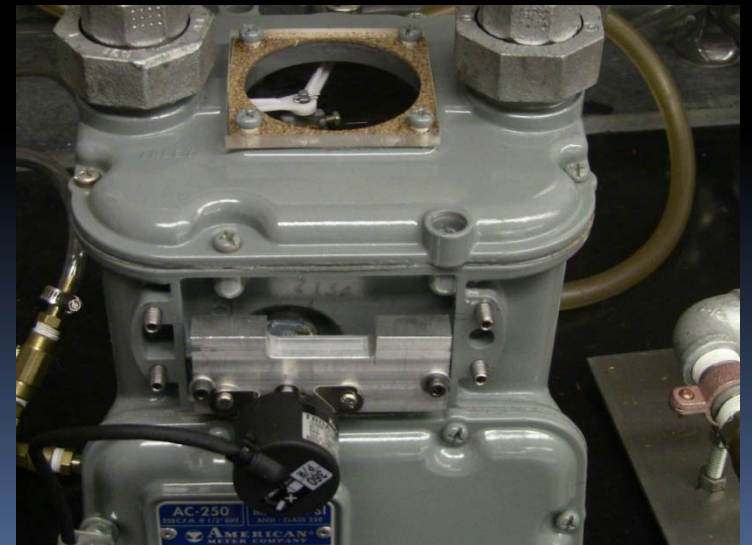


- American Meter AC-250. Standard diaphragm / bellows design
- Internal gear ratio 18:1
- Output shaft: 1 revolution (360°) = 2.0 ft^3 of gas

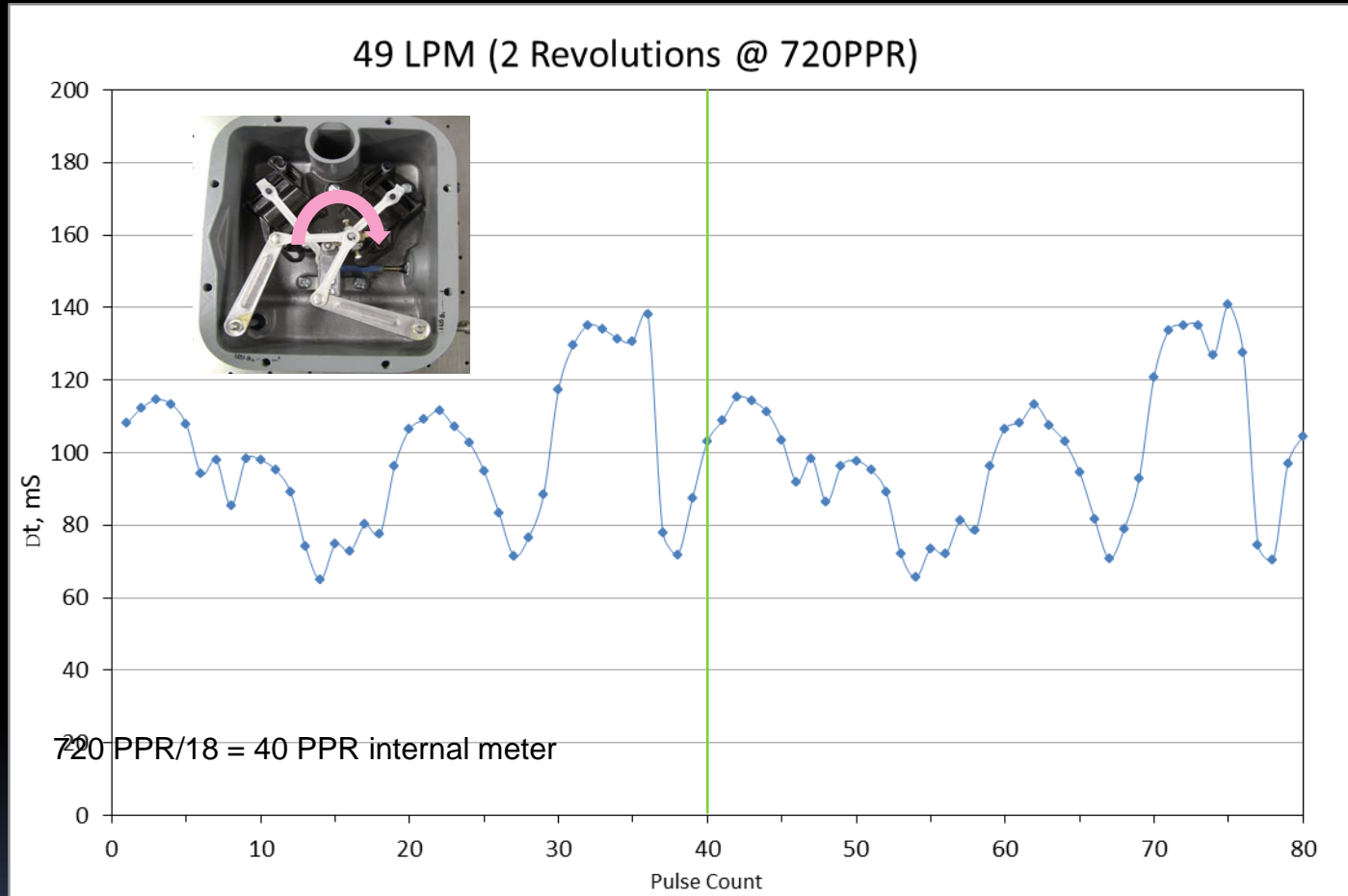
Experimental Setup



- Replicate actual flow rates and pressure with compressed air
- Independent flow meter for validation
- Uses commercial 720 PPR optical encoder
- Clear plastic top to visualize motion

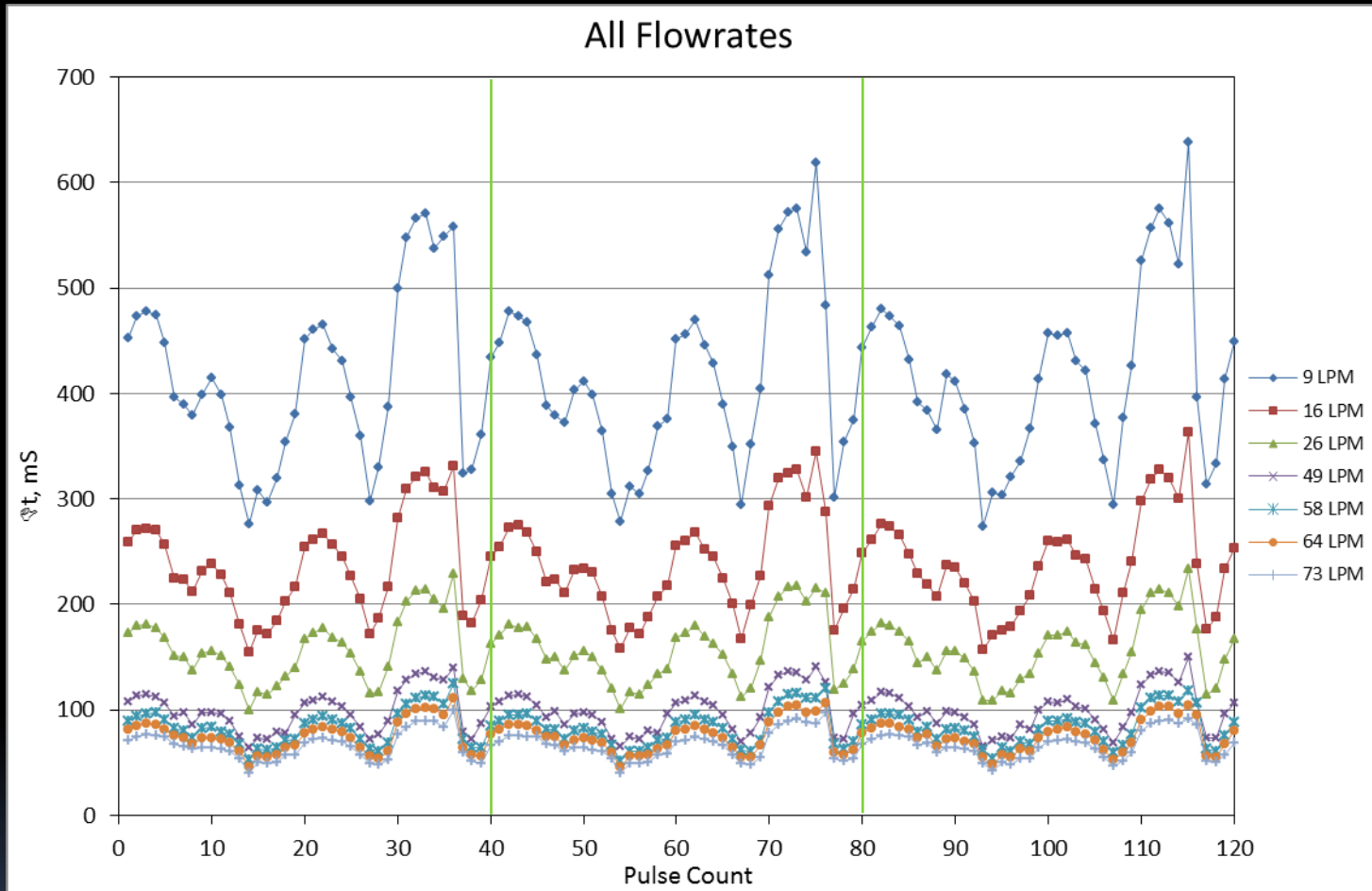


Non-linear Meter Motion



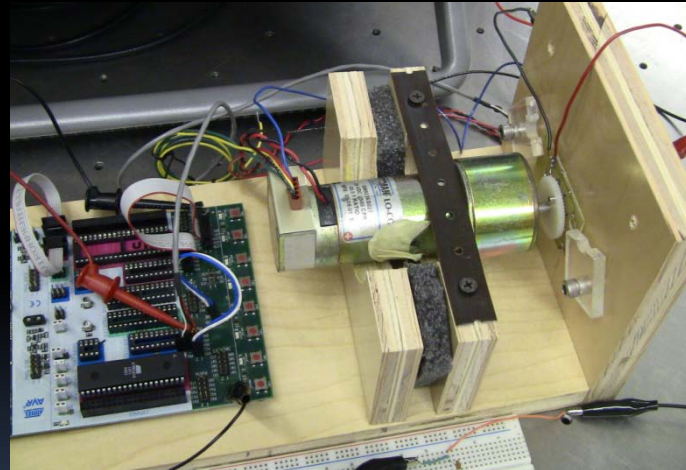
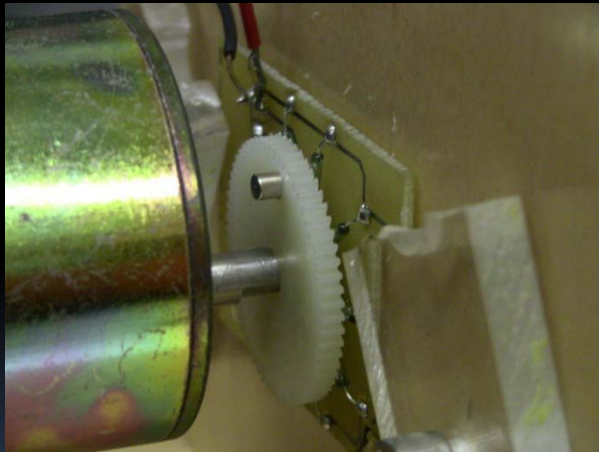
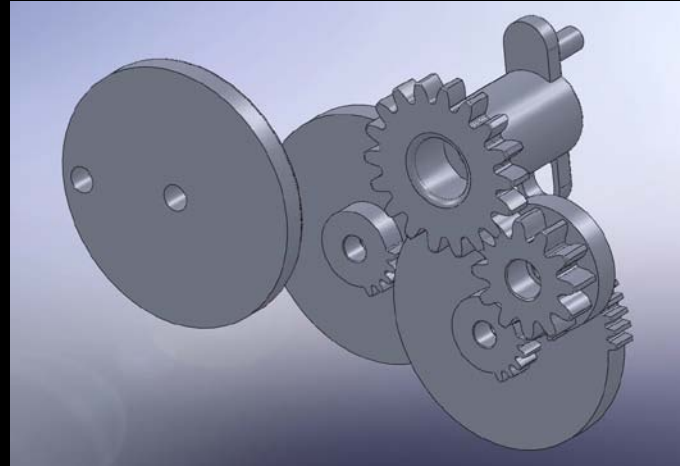
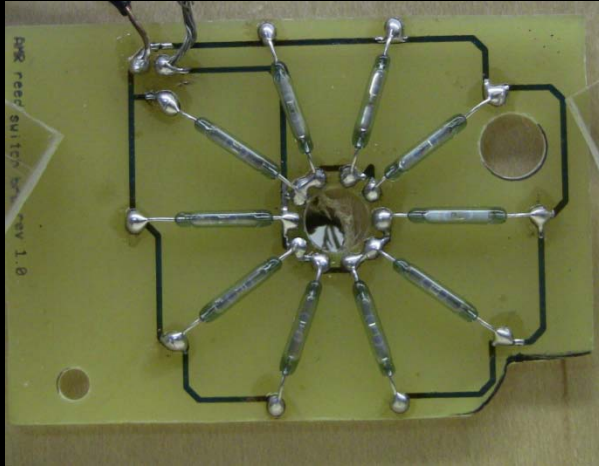
- Constant flow of 49 L/min
- Over 2x variation in mechanism speed!
- Must compensate (software lookup table)

Different Flow Rates



- Reasonable separation for different flow rates
- Data is repeatable over several cycles
- Now doing firmware development for decision making

Encoder Concepts



- Reed-switch based for low power and cost
- Gear train will have 18:1 or 36:1 gear ratio

Challenges

- Stove / grill – non-binary usage
- Two appliances with similar consumption rates
 - Cannot tell apart
 - Can use additional data (time of use), or equip one with a sensor, or simply count both and average
- Backlash, friction and play in gear train
- Battery life
 - Really dictated by electronics
- Cost – must be economically viable
 - Encoder / housing / gear train ~\$10 (in qty)
 - Electronics (microcontroller / radio) ~\$20 (in qty)

Conclusions and Future Work

- Patent filed March 27, 2010 (Stony Brook University)
- Opportunities to Commercialize?
 - Partner with established AMI/AMR company?
 - Partner with smaller company?
 - New venture?
- Funding: NYSERDA “Wireless Utility Monitoring, Control, and Response (MCR) for Efficient Energy Utilization,” Agreement No. 10908 (J. Love)

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