

New Product Development at TSI

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UNDERSTANDING, ACCELERATED

Agenda

- + About TSI Inc.
- + New Product Development Process (NPD) at TSI
- + Quality Process at TSI
- + Bluesky Monitor
- + Considerations for Low Cost Monitors from Manufacturers' Point of View



INTRODUCTION TO TSI

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- + Founded in 1961 by University of Minnesota graduates
 - + Privately-held company as part of Churchill Industries holdings
 - + Over 850 employees worldwide
 - + Corporate headquarters based in Shoreview, MN with field offices throughout Europe and Asia
 - + Acquired Quest from 3M in 2018 adding noise, heat stress and environmental monitoring to our portfolio



TSI MARKETS

Our unique product line includes over 200 Precision instruments which can be classified into the following segments:

- + **Research and Analytical**
 - Particle Instruments
 - Fluid Mechanics Research
- + **Test and Measurement**
 - Occupational Health and Safety
 - Energy and Comfort
 - Flow Instruments
 - Outdoor Environmental Monitoring

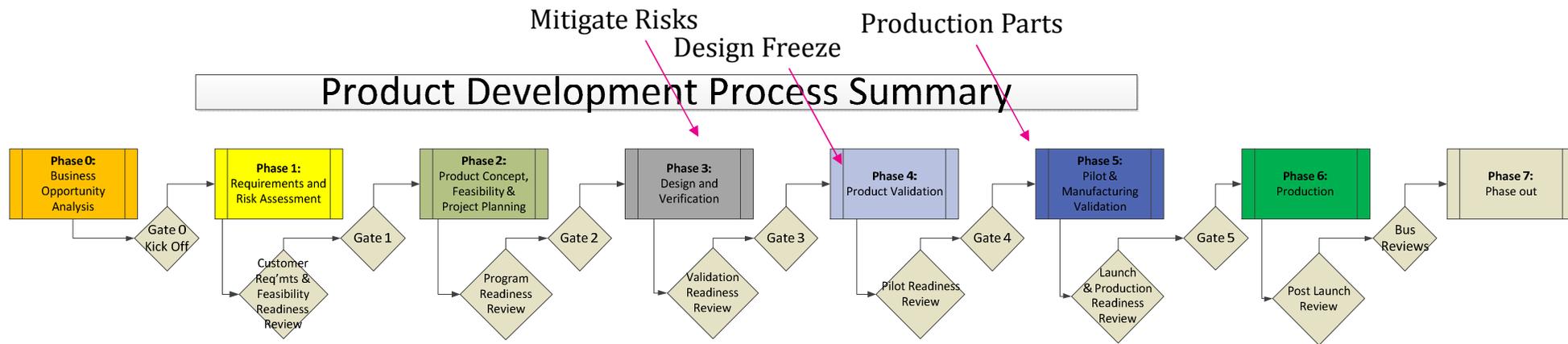


TSI MARKETS

- + **Controlled Environments**
 - Critical Environments Monitors/Controllers
 - Contamination Control
- + **CBRN Defense**
- + **Chemical Characterization**



NEW PRODUCT DEVELOPMENT AT TSI



- + For large/small projects and high/low risk projects
- + Meant to be flexible and cross-functional based on the complexity and risk of the project



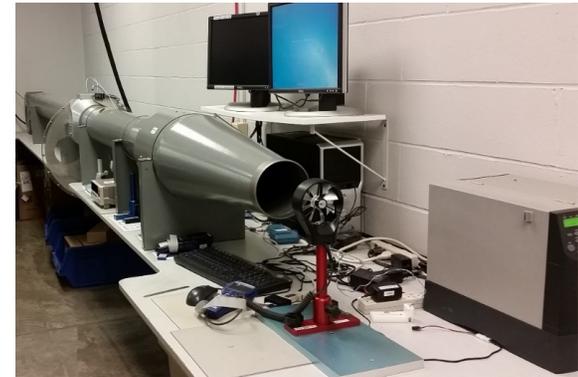
Quality and Calibration Capabilities

- + Robust automated calibration systems
- + Corrective Action Requests (CAR)
- + ECO control
- + NIST traceability for all calibration systems
- + Uncertainty analysis
- + TSI complies with ISO 9001:2015
- + TSI experts help set industry standards
- + TSI is active in standards committees at ASHRAE, ANSI, AIHA and AAAR for a long time!



Why we do what we do?

It takes a lot to develop a device that produces data that customers can trust!



BlueSky Low Cost Monitor

+ Applications

- Community activists/Citizen Scientists
- Municipalities
- Air Quality professionals
- IAQ
- Researchers



BlueSky Low Cost Monitor

- + 4" x 3.5" x 2"
- + Highly Configurable
- + Performance Specs



PM Sensor	Specs
Aerosol Concentration Range	0 to 1000 $\mu\text{g}/\text{m}^3$
Measurements	0.3, 0.5, 1.0, 2.5, 5.0 and 10.0 μm along with PM1.0, PM2.5 and PM10
Screen Resolution	1 $\mu\text{g}/\text{m}^3$ increments
Counting Efficiency	50% at 0.3 μm and 98% at 0.5 μm
Accuracy	$\pm 10\%$ @ 100 – 500 $\mu\text{g}/\text{m}^3$ $\pm 10\mu\text{g}$ @ 0 – 100 $\mu\text{g}/\text{m}^3$
TVOC Sensor	
Range	0.001 – 100 ppm
CO2 Sensor	
Range	0 – 3000 ppm
Accuracy	± 50 ppm + 5% FS
Temperature Sensor Range	-40 to 125°C
Humidity Sensor Range	0 – 100% RH



Key Considerations for Low Cost Monitor Manufacturing

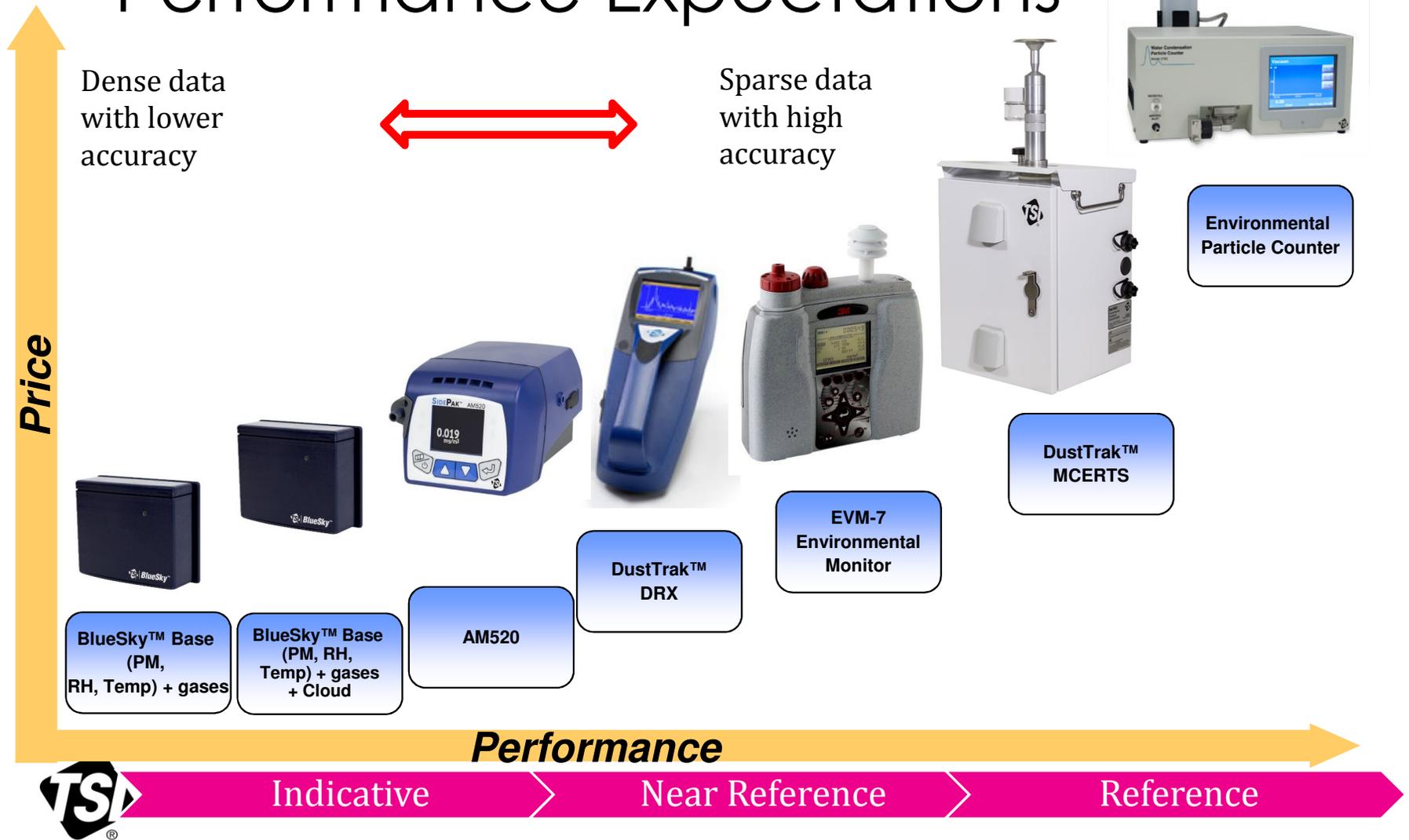
- + Determination of performance expectations versus low cost target
- + Shift from data exchange to data sharing and cloud services (democratization of data!)
- + Shift in service model – limited warranty and service offerings for low cost devices
- + IoT, connected devices and security concerns tend to radically alter the very nature of manufacturing



Challenges with “Low” Cost Monitors

- + Sensor performance – transport losses, accuracy, longevity, repeatability
- + Robustness – performance over wide range of temperatures and humidities, drift, clogging, etc.
- + Purpose - informative to decision making and everything in between!!
- + Established test procedures that all manufacturers can agree upon
- + Harmonization of sensor outputs
- + Advanced diagnostics including detecting failure
- + Data security when these devices are connected to cloud
- + Data interpretation – needs to compliment reference instruments, not contradict them

Performance Expectations



Questions?

