

“Game Changer”

TempusFlow™ Overview

By: Anonymous

So, “Game Changer” is a bold and sometimes overused claim, however, that seemed to be the best description when trying to explain TempusFlow™ and its impact on cost efficient flow or waste management IoT (Internet of Things) systems. The tracking of, and waste of, product is vital for efficient use of energy, consumables and agricultural yield. As we continue to improve our treatment of the planet, we need to bring efficiency down to every level of the ECO process, including @ the “Point Of Pour” or “Point Of Waste”. As Lord Kelvin (Sir William Thomson) once said; “if you cannot measure it, you cannot improve it” (his actual quote was much longer, as he was a verbose individual, but point the same). The flow of material through a valve/tap can be simply broken down into the pressure of the flow of product through an orifice, calculated as the amount of product over time, or a flow rate. Most “Industrial Smart Valves” today cost about \$2,500 plus another \$1500+ for the plumbing and installation (don’t even get me started on DoD/Government upgrade costs...). Most “Smart Valves” are based upon some type of physical measurement sensor that is placed in the flow of the actual product moving through the valve orifice; Paddle Wheel, Propeller, Laminar Flow, Ultrasonic, Pressure Differential...TempusFlow™ is just another tool in the sensor toolbox focusing on legacy infrastructures & transition to future integrated smart/green systems. As such, it is designed to share information and coexist with other existing smart valve management and automation systems such as; SCADA, AWS IoT, IBM Watson, Microsoft® Azure, Cloud...and also adds value to other “Smart(er) Valves/Devices.” But what is different...

TempusFlow™ is a **Non-Invasive** Flow sensor and offers many unique advantages such as:

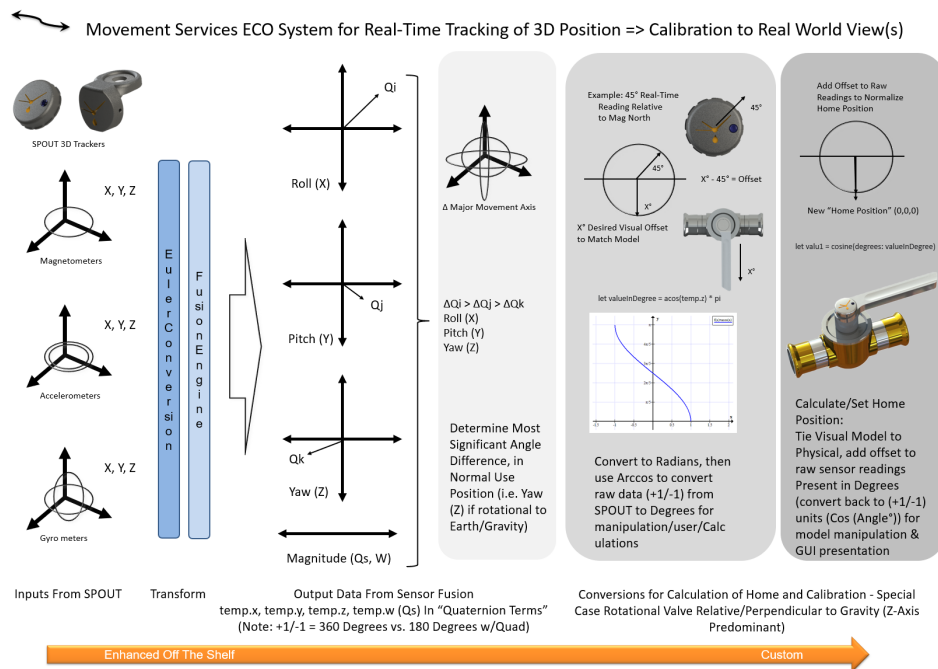
- No New Plumbing Required.
- Retrofit to Any Existing Motion “Dumb Valves.”
- ~1/10th the cost of traditional “Smart/Green Valve” Tech.
- TempusFlow™ does not touch the actual product and therefore it is not subject to clogging, nor is it a factor in the cleaning process or safety profile of the underlying materials being distributed. From extremely caustic to food grade/fresh water; whether a gas, fluid, or dry bulk material; it can accurately measure flow without coming in contact with the product.
- Efficient Portable/Mobile/Fixed & Remote valve flow measurement system (works on and corrects for moving platforms such as Trucks, Maritime Vessels, Aircraft, Portable Systems...).
- TempusFlow™ can measure actual yield of product delivered at the “Point Of Pour,” especially when correlated with a “Point Of Sale” system.

TempusFlow™ is a 3-Dimensional Flow Measurement Sensor System. It uses Real-Time 3D tracking of the valve handle position, correlated to Orifice Size and Timed Flow. When we first started this project (~5 years ago), there were a couple of promising technologies both emerging and in the academia space that we knew would become mature during the time of development. Most notably, the miniaturization and sophistication of Ultra-Low Power Integrated 3D tracking devices and the push for resiliency/multiple connect/beacon mode/secure/mesh type BLE (Bluetooth Low Energy) devices. This, along with the algorithms, filtering, and real-world adaptation (embedded secret sauce), has now made TempusFlow™ ready for primetime.

TempusFlow™ 101 – What is it?

Positional tracking systems (“tags”) using integrated “Tri-Axis” - Accelerometers, Gyrometers & Magnetometers (Perhaps an available GPS signal) have been revolutionized over the past 10 years. They have improved with better accuracy, smaller size, lower power consumption, better technical/software support and lower cost. Their uses for UAV’s, medical devices and wearable sensors/smart phones, combined with some heavy math, fusion algorithms and relative positioning, can accurately track physical devices with incredible precision. Integrated tracking modules available today that have the computing/comms power for the Edge and are capable of running the firmware & storing the in-flux data, really started showing up about 5-8 years ago (notably; ST Micro systems Sys On Chip families, Texas Instrument “Sensortag”,...). It is incredible and somewhat magical to see the Real-Time tracking of an inanimate object in data/visual form with no mirrors, special camera positioning, controlled environments/lighting, obliqued/obscure angles, games or other tricks involved (“Next Tech Wave” - Anonymous 2021©). All the while, these modules use power in micro-/nano- versus milli-amps and run off of a battery cell for years, versus weeks. They remain in a deep sleep, ready to come alive when someone touches or even comes near it. And of course, on the comms side of “Bluetooth everything & 5G direct, on the horizon,” all of the tech started to coalesce, enabling this new form of derived measurements in the IoT world. 3D positioning of a valve or tap handle can now be efficiently tracked, used and logged in real-time, for further post-processing analysis at a gateway/node server. Meaning that when we add an “Event” gate, a timer, filters, characterization, proximity detection, drift correction and relative calibration to our family of integrated devices sensor firmware, we can accurately calculate flow based upon drive pressure (even gravity), orifice size (calculated, calibrated, defined or learned) and the timing of the handle on/off (or percent “on”) position, thus flow can be measured accurately and change can be monitored. Efficiency improved.

TempusFlow™ 202 – How does it work?



TempusFlow, a TEAM Company Technology

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The current size and thickness of available tracker modules is about 3 Quarters stacked, so the shape and sizes are suitable for just about any valve or tap set-up. From “Consumer” residential to “Commercial” buildings and campuses or large Oil & Gas “Industrial”, simple casework adapts or covertly embeds the SPOUT 3D Tracker device to the valve, tap or flush handle. Add to this, they are light weight ($F=MA$) and they are perfect for harsh rugged environments, including temperature extremes (yes, they have Temp and Press sensors onboard and can also operate typ. between $-40\text{ }(^{\circ}\text{C}/^{\circ}\text{F})$ to $105^{\circ}\text{ }^{\circ}\text{C}$).

The community of developers and investment in the related technologies (especially BLE and low power radios) has enabled TempusFlow™ to reach a technology maturity level, ready for real-world applications. The abridged processing pipeline goes something like this; Accel, Gyro, Mag come from the integrated chips onboard and are manipulated

in Euler angle terms, then run through a fusion engine fundamentally based on a derivative of Sebastian O. H. Madgwick concept (“An efficient orientation filter for inertial and inertial/magnetic sensor arrays”. PhD thesis. University of Bristol, Dec. 2010 and open code contributions). The raw/fused sensor data for the most part is looking like ± 1 imaginary (x,y,z) with a 0 – 1 real component (Quaternion Terms). From here you/we wanted to calculate/calibrate the actual valve handle position and display user information in degrees (3Dimensional scaled/corrected) so we basically convert to Radians & Degrees in 360° /Rotational terms and manipulate in degrees using simple trigonometry on large arrays of sensor data to calculate 3D positioning.





This results in the magical part; a fixed, in real-world 3D space visual data model that has absolute (pretty excellent) sensor & multi-rotational/position accuracy; plus/minus less than a degree or so (depending on lots of things), in any orientation. It is a device sensor that can resolve the handle or tap position (or anything really) relative to its prescribed motion (On/Off Path) and filter out or eliminate other real-world positional changes or anomalies/tampering. All the while, it still knows exactly what the handle is doing, relative to control of the orifice (24/7/365*X).

This scaled and accurate 3D representation is then calibrated to the 3D user data views to place it in real-world, relative terms (correlate actual handle position (Hardware) to GUI Data Model representation to On/Off/Scale presentation => Flow Rate). Of course, from a camera or analysis view, the user can visualize the handle in any relative 3D position, or this can be used for viewing the entire valve (including its rotational handle/faucet component) in its real-world 3D position (as if mounted on a mobile or moveable platform (e.g., Ships, Trucks, Aircraft Portable Generators, Pumps...). Then the real-world motion components, being filtered out of the primary purpose; a flow measurement sensor based upon position of the control handle; relative to flow/valve body.

TempusFlow™ 313 – A brief history of real-world application:

When TempusFlow™ was first conceived, we understood the multiple large-scale applications and industries that could benefit from this technology. So, as engineers, we decided that Draft Beer Management (30-50 Beers on Tap, 7-8 mixed drinks, wine...) and a Beer Tap Handle was the best place to start (we may or may not have been in a bar at the time, I don't remember;)...!



Even though we knew the “Industrial Valve” market was much larger and easier to implement, we chose Beer (did I mention, we are just engineers). Honestly, to think about the billions of “Dumb Valves” in the world and the applications for the underlying tech in manufacturing, buildings/infrastructure, industrial, oil/gas, process automation, mobile/remote, military applications, it made my head hurt. Anyhow, COVID hit, bars closed and in January 2020, we decided to pivot back to the Industrial Valve market and launch there first, until bars & clean initiatives open up and we organize around the multiple new market spaces.

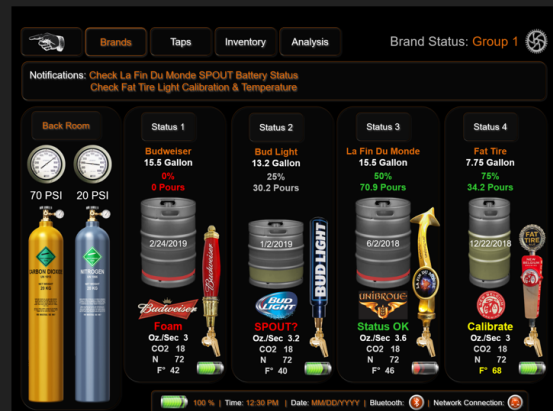


The Draft Beer/Wine/Coffee/Mixed... Drink Management project was technically much more challenging than just a valve or handle position in a factory or field environment. A standard Beer tap handle only moves about 15-17°. Additionally, Bars/Restaurants/Hotels/Casino's/Stadiums are an extremely hostile environment at the "Point Of Pour". They work with a limited supply vessel (Keg) and they are distributing an expensive product, priced @ ~\$.50/Oz.+ and sometimes operate in scarce supply for popular, craft beers. So, product quality (Age, Temp, Pressure, Gas Mixtures, Cleanliness...), yield, pour accuracy, waste, abuse, theft, training, employee turnover and fraud all had to be part of the system design. The individual taps themselves can be used hundreds of times a night or not touched for days, weeks or months. Management of which product/beer is on which tap, how much is on hand, how much should be ordered, what beer is most profitable, which is a loss leader, when does the system need to be cleaned/sanitized...made monitoring and process control of this product market a perfect test environment.

TempusFlow™ 442 – The Marketing and Value Add Opportunities:

1st Market Channel Draft Beer, Mixed Drinks... & Fluid Management

- Developed underlying **TempusFlow™** technology, based upon tracking and managing product; waste, abuse, fraud and theft of Draft/Craft Beer Inventory Management Systems
- Secured IP for **3Dimensional** tracking of a "valve handle" & time to calculate **flow** of product, while not being part of the product flow (non-invasive)
- Integration of IoT Technology, extreme low power, secure communications & compatibility with upstream data sharing



TempusFlow

2nd Channel Smart Industrial Valve Market



ABOUT



Fluid Handling

Crane's Fluid Handling segment is a global provider of industrial fluid control products and systems, including valves, pumps, lined pipe and instrumentation. The segment is an

Why Itron Solutions Customers Partners Developers Resources Company

INDUSTRIAL IOT

Intelligence for the industrial world.

Delivering smarter solutions to revolutionize energy, water and city services.



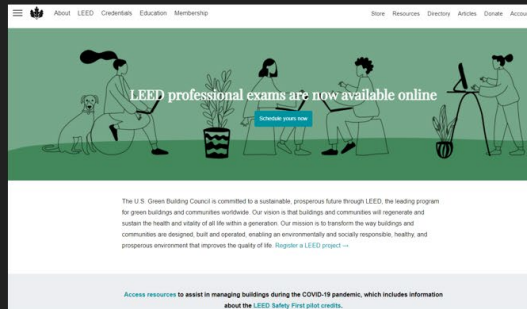
VALVES

The Flowserve valves offering represents one of the most comprehensive lines in the industry. Our valves can be custom engineered to perform specific functions for our customers' unique flow control environments.

The Prime Integrators/Suppliers are always looking for innovative technologies to solve real world situations @ a lower cost

TempusFlow

3rd Smart Government Valve Market



the opportunity:



4th Smart DoD Valve Market

Unique Military Requirements:

- Willing to Invest R&D to mature new promising technologies
- Integration of IoT Technology w/Special Secure Requirements
- **TempusFlow™ is "0"** Impact to ship's current structure and upgrade path to all remote, monitored valves; from "important to hadn't been touched in years"



the opportunity:

TempusFlow™ Non-Invasive Wireless System

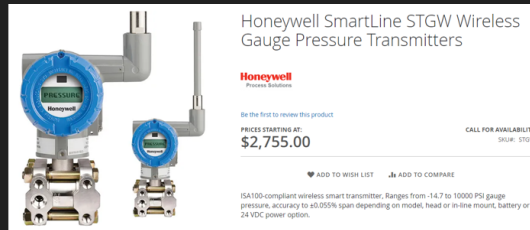


- Fits on existing Ball, Rotational, Butterfly... “dumb valves”
- Uses 3D space position of handle to measure product flow
- Ultra-Low Start-up & Operational Cost
- No New-Plumbing or Modifications, 5 Minute Calibration
- Open Compatibility with Upstream IOT Systems/Cloud/BLE
- Extreme 24/7/365*X - Remote Measurement & Management

< \$400 all in cost per valve – including 1 Year Support



vs. Existing Invasive Smart Valves



Valve Price \$1-3K + Plumbing/Installation/Integration \$1,500

About the Author:

I am a 40-year plus Electrical/Systems Design Engineer, Product Design/Development Business Owner, Inventor & Investor. I am Anonymous only because I prefer not to be on any public forum nowadays! My background is mostly high-tech military systems. I ran an advanced technology group for a \$16B defense contractor for about 15 years b4 acquiring my own design company in 2011. I also did a stint as a manufacturing engineer (thus the fascination with automation and process control) and voluntarily started voiding warranties, immediately after acquisition, when I was about 8 years old. If you have an interest in a deep dive of TempusFlow™ or want to talk about becoming a development partner as we scale, or if you are a large valve distributor/integrator that would like to talk about the business case/strategy/arrangements/licensing/rollout, or you are an investor/group that understands and can add value to the potential of this “game changing” technology, please send me a quick e-mail at public@tempusflow.com and we can follow-up with each other. Please, no solicitations for your products or services. Of course, should you follow-up and research the underlying utility patent(s) for TempusFlow™, you will know who I am, but at least I have stayed ahead of the bots (for now...).