

A stylized illustration of a drone or aircraft with long, thin arms, set against a blue background with a white grid pattern. The drone is shown in a dynamic, angled position, suggesting flight or maneuvering.

How Insitu's Practical Operational Experience is Affecting Next Generation UAS Capabilities

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Success To Date

- To date, Insitu has been successful by providing what the customer wants at a price that makes them happy
- Over 500,000 combat hours making what matters happen:



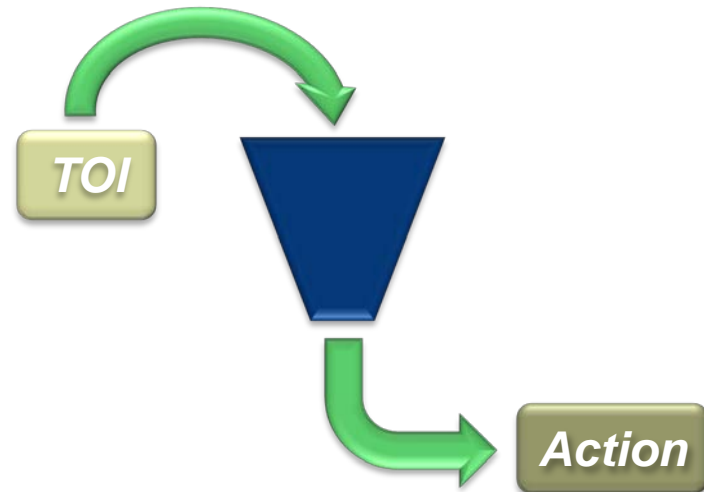
Capt Richard Phillips and Boeing/Insitu ScanEagle Team
USS Bainbridge NE Indian Ocean

Important Points

- **CONOPS and Cost of Ownership (CoO) are related**



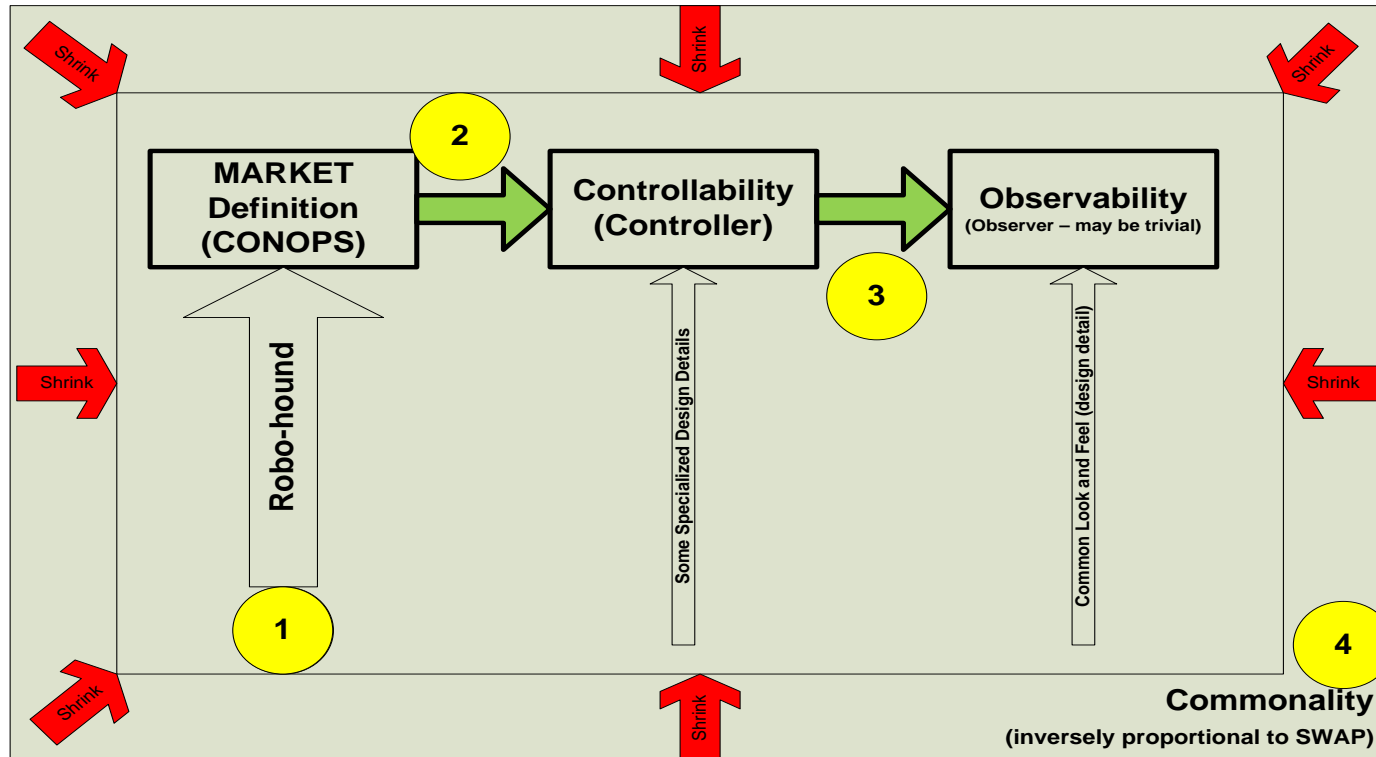
- **Concept of a PIK Factory**
- **Efficiency saves lives and costs less to operate**
 - **PIK = Precision Information Kernel = any datum about which we want to collect data.**



Measurable, Constantly Improving Performance is Success

Capital Equipment Markets

Autonomous Product Definition and Approach to Implementation



Bottom Line: Align the “Science,” and the Business to make a better robot



It's About Signatures Recognition

- **UAS ↔ Robotic Warfighter Support (think robotic Hound Dog)**
 - Acquire
 - Develop Reusable-Positive-ID (difference between this and 'radar tracks')
 - Track (Fixed or Moving) PIK's
 - Provide Continuous real-time state updates

- **UAS-Brain-Inputs ↔ Sensory-based payloads**
 - EO / IR / MWIR/ SWIR
 - SIGINT
 - HyperSpectral
 - SAR / ISAR

Automated Signatures are a Means to a Well Defined End



How Does a Hound Dog “Sniff”?

(with his/her nose)

- **Olfactory Glands** \Leftrightarrow **Lower Bound on Compressive Sensing Signal Reconstruction (# of olfactory receptors)**
- **Odor Molecules** \Leftrightarrow **Planar pixels (or more specifically groups of pixels that are rotationally invariant)**
- **Multi-receptors per odor** \Leftrightarrow **Need to account for improving SNR most odors activate more than one type of odor receptor**
- **Instantaneous Simultaneity** \Leftrightarrow **Real-time synchronicity is not just desirable; it is essential**
- **Scent-lock** \Leftrightarrow **Target-lock** \Leftrightarrow **Actively maximize SNR (maintain unique probabilistic signature)**

Probabilistic Noise-immune Multi-state Detector

What does the Math Say?

(mimic the dog)

- Theorem 1 \Leftrightarrow 3 or more domains of attraction necessary to detect random signal effectively
- Theorem 2 \Leftrightarrow useful signals are sparse
- Theorem 3 \Leftrightarrow non-sparse signal probabilistic signatures are Gaussian and not so unique; the fewer basis functions utilized efficiently, the better the SNR and the more unique the signature
- Butterfly Algorithm \Leftrightarrow Target-sniffing \Leftrightarrow Target-lock/track

Synchronous Application of T1 + T2 + T3, Butterfly

means

Robo-hound

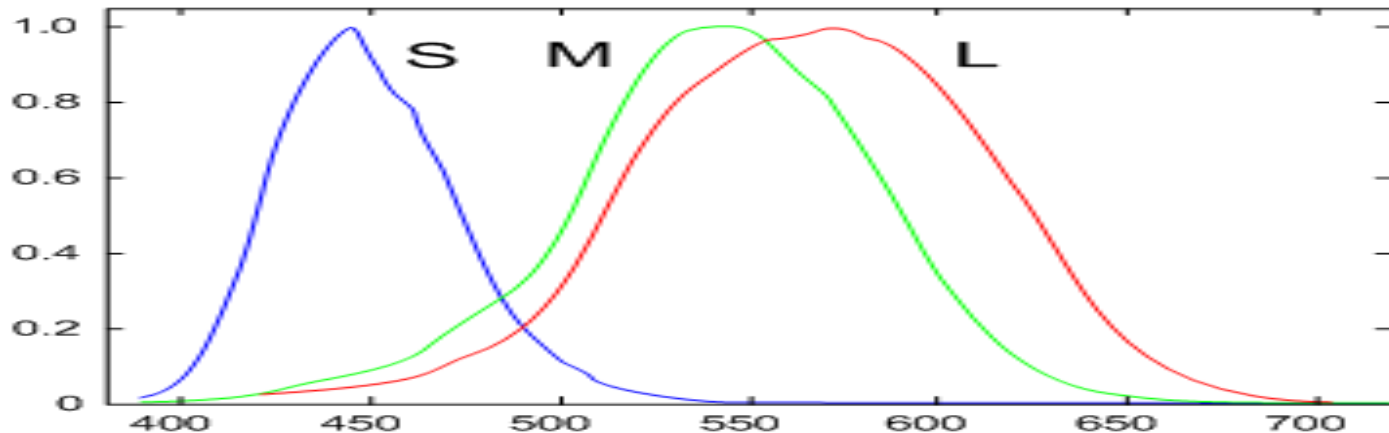
Key to an Optimal CoO Target Factory is Robo-hound

What does the Physics Say?

(mimic the dog)

- Nuclear Magnetic Resonance (NMR) is the essence of a simultaneous signature with a minimal number of peaks.
- Ditto - Chromatography
- Spectrometry and the like have been the mainstay for understanding what sort of “target” is present for decades. Hyper-spectral imagery has only been limited due to focal plane electronics shortcomings which are no longer present.

Cones in the human eyes operate with simultaneity of 3 basis functions



Key to an Optimal CoO “Target Factory” a Systematic Signature

What does the Business Case Say?

(mimic the dog)

- **Capital Equipment Markets are Driven by CoO**
- **The Military Capital Equipment Market Involves lives with respect to the CoO calculation, more than most; even if lives are only measured in wages, minimizing use of people is by far the dominant factor with respect to cost and safety for the military**
- **What is valuable for the military market is valuable for the civilian aviation market as well**
- **Robo-hounds are a key means to provide useful information**

Minimize CoO

Think TOI-factory (TOI = Target of Interest)

Smart Factory Flow

Total Time

Operations Time

Manufacturing Time

Uptime

Productive

Engineering

Standby

Non-Scheduled
Time

Unscheduled
Downtime

Scheduled
Downtime

Smart Military CONOPS

Total Time

Operations Time

ISR Time

Pixels on
Target

Flight
Controller
Directed

NO Pixels
on Target

Non-Scheduled
Time

Unscheduled
Downtime

Scheduled
Downtime



Overview of Cost of Ownership

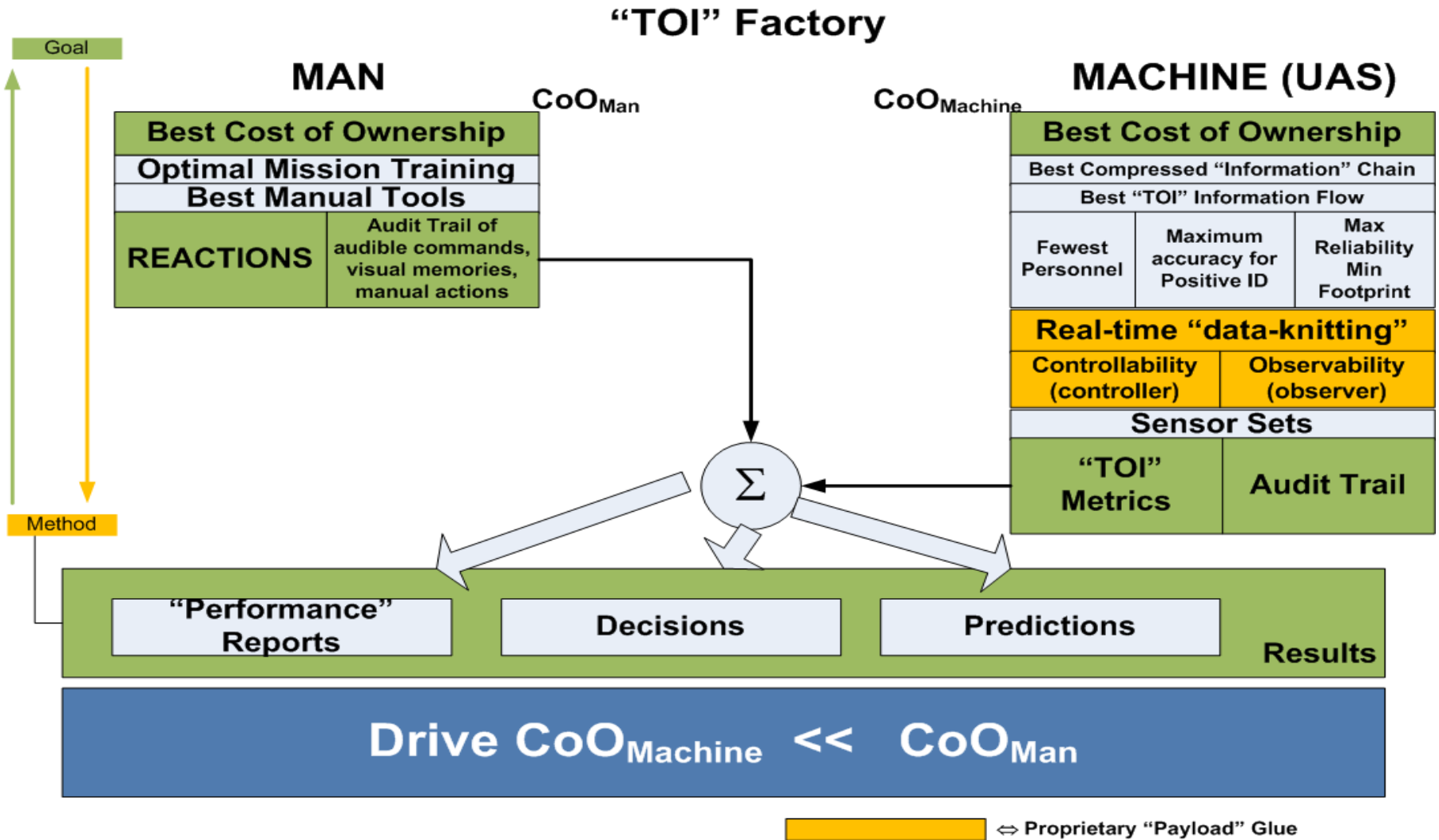
$$\text{CoO} = \frac{CF + CV + CY}{TPT * Y * U}$$

Where:

- **CF** is fixed cost
- **CV** is variable cost
- **CY** is yield loss cost
- **TPT** is throughput
- **Y** is composite yield
- **U** is utilization

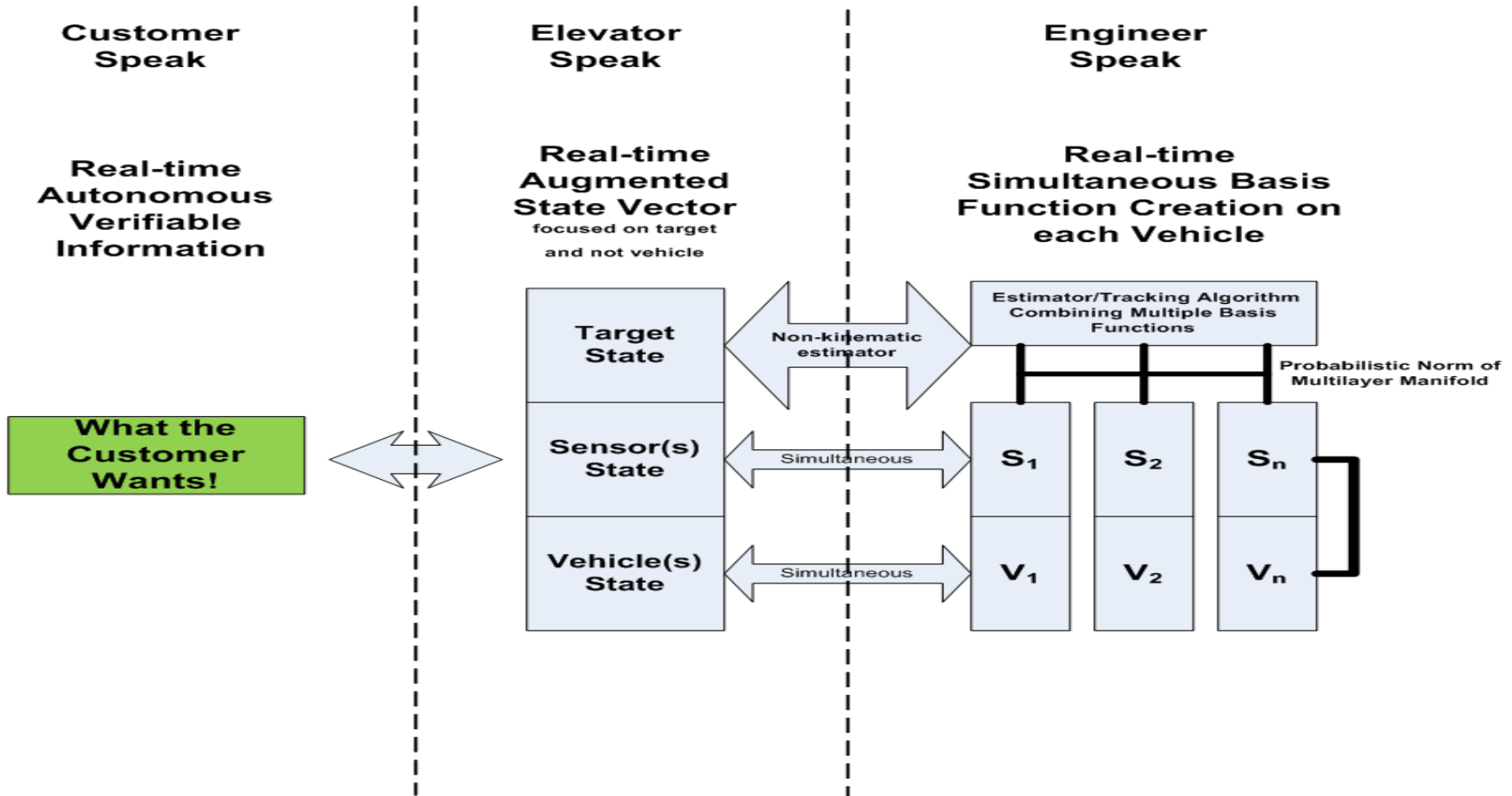
Note: The CoO units are on a yearly basis! It is all about successfully finding PIK's, for ISR operations.

What does a "PIK" Factory Look Like



Achieving Customer Satisfaction

(multiple well-trained “talking” dogs sniffing continuously – universal nose)



Conclusions

- Use Autonomy to drive $CoO_{Machine}$ as low as possible to maximize warfighter (or commercial equivalent) effectiveness.
- Optimizing CoO assures a win-win strategy for both warfighter and taxpayer in a competitive environment.



References

- [1] G.L. Viviani, “The Stochastic Process of Optimal Dynamic Signature Detection.” (in progress)
- [2] G.L. Viviani, “On Devices with Periodic Flows and the Topological Nature of Optimal Encoders,” submitted to IEEE.
- [3] Economist - [Flight of the Drones](#)

