



United Technologies

UTC Wireless Sensor Applications Requiring Energy Harvesting

Presented April 13-14, 2000 at the
DARPA Energy Harvesting Program Review

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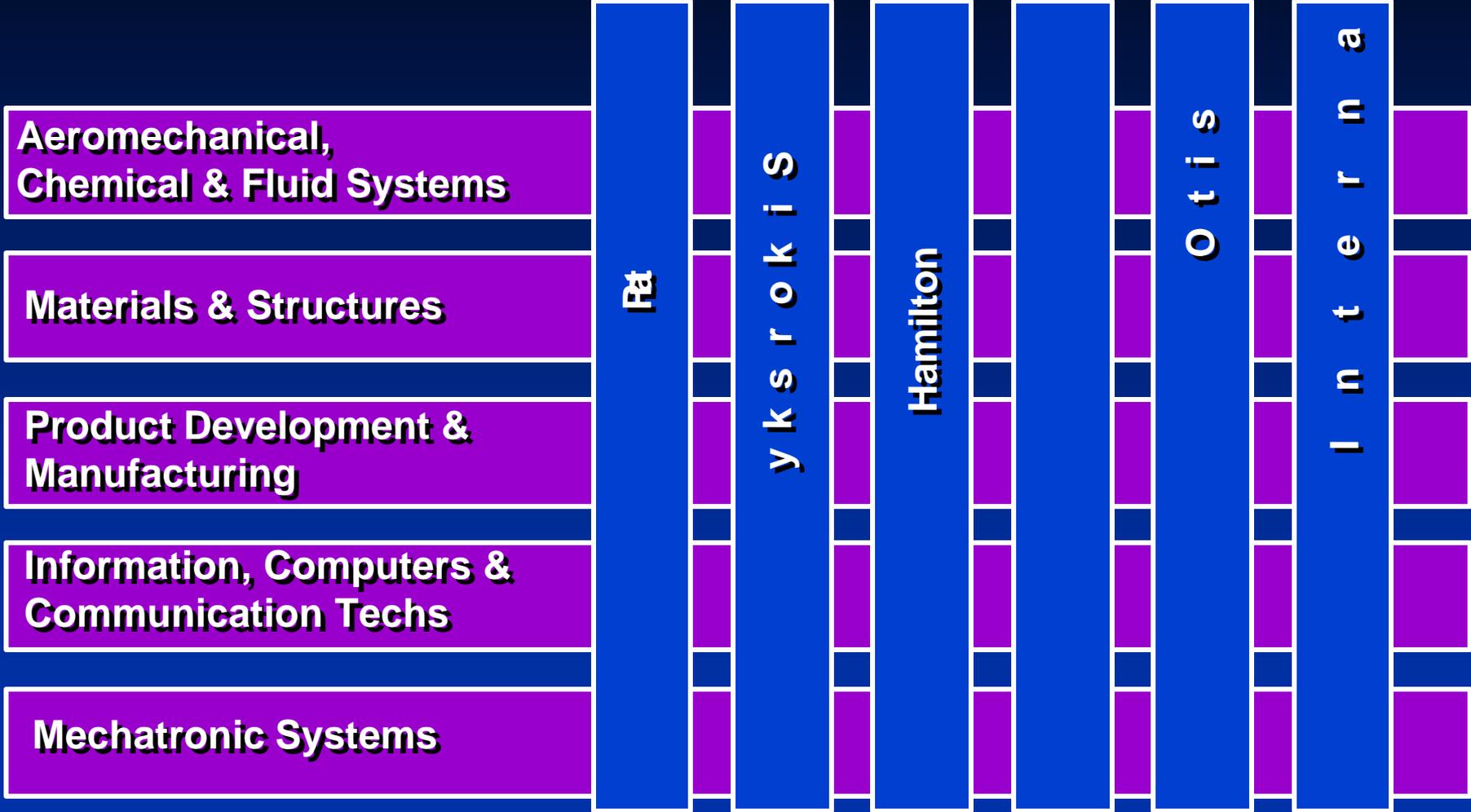
UTRC: WHAT WE DO

Help the business units



Provide advanced technologies for UTC

UTRC: MAXIMIZING R&D IMPACT



Sundstra

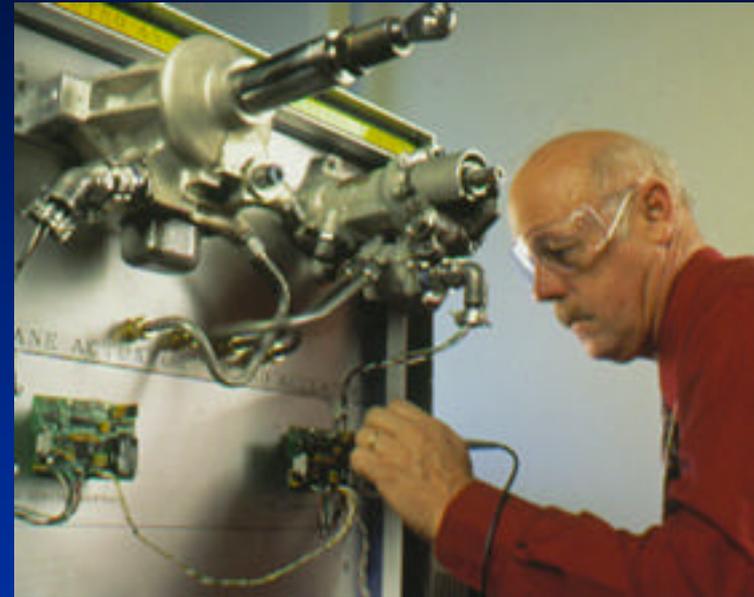
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I n t e r n a t i o

UTRC CORE CAPABILITIES

Mechatronic Systems Department

- Dynamic Modeling & Analysis
- Feedback Control
- Sensing and Actuation Systems
- Power Electronics and Magnetics
- Harsh Environment Electronics, Packaging and Reliability
- Embedded Computation
- Embedded Communications



UNITED TECHNOLOGIES PRODUCTS



Pratt & Whitney



Otis



Carrier



Sikorsky



Hamilton Sundstrand



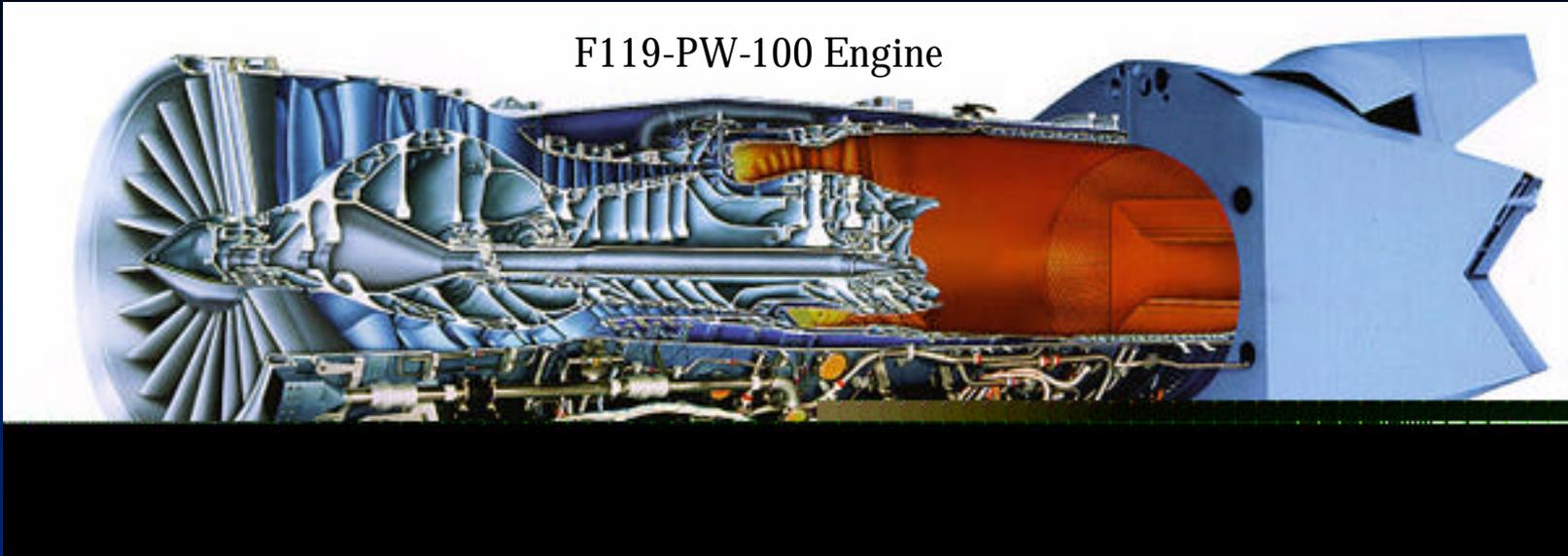
International Fuel Cells

Pratt & Whitney



Pratt & Whitney: Wireless Sensor Opportunities

F119-PW-100 Engine



Sensor Opportunities

Temperature Pressure Vibration Strain

Environmental Constraints can be Significant!

Depending on Sensor Location:

- Temperatures from near ambient to >1000 °C
- G-Loading from 10's of G's to 10k's of G's
- Small Size ($<2\text{cm}^3$ preferred) & Weight are Critical

Sikorsky



Sikorsky

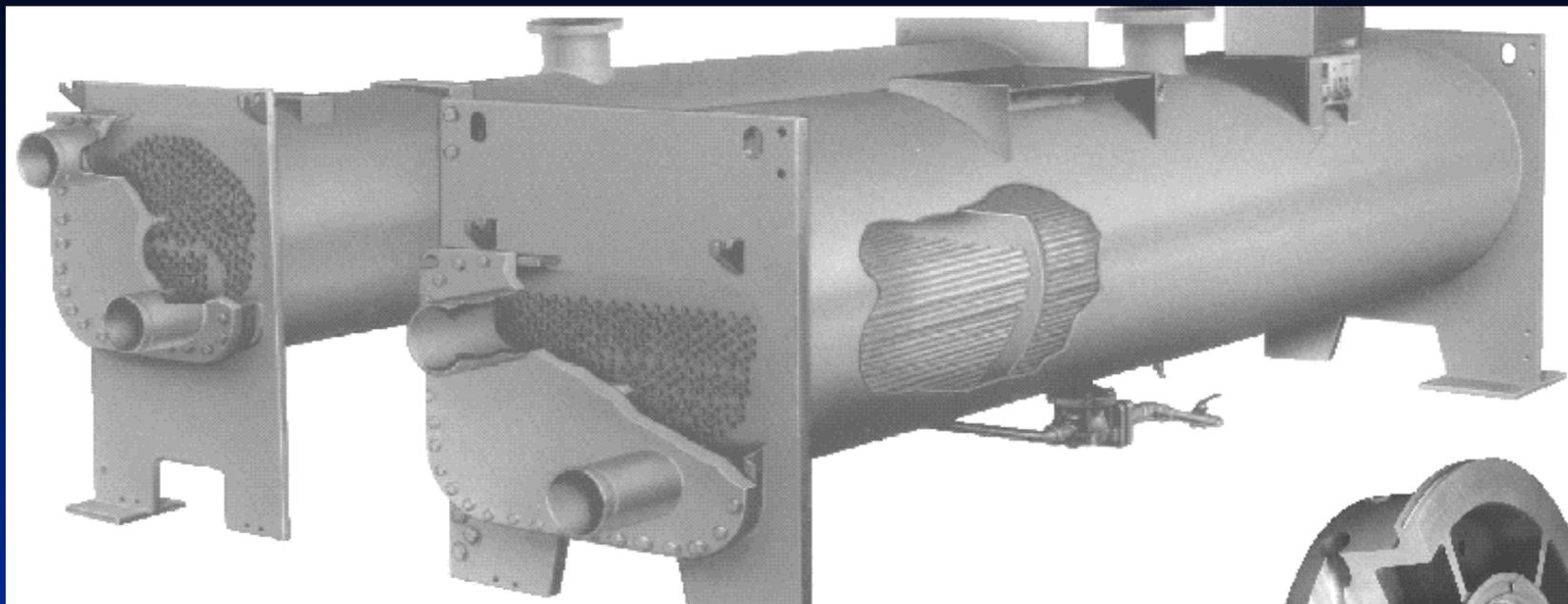


Sensor Opportunities (primarily on rotor)

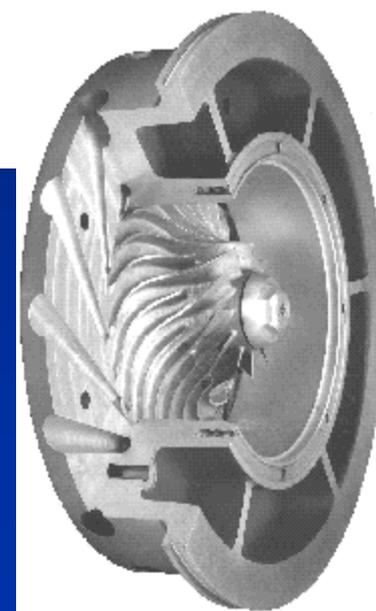
Environmental Constraints

Depending on Sensor Location:

- Temperatures generally close to atmospheric ambient
- G-Loading from 0 to 100's of G's (Small Size & Weight!)
- Rain / Sand / Possible Corrosives etc.



19XL HERMETIC CENTRIFUGAL LIQUID CHILLER



**HERMETIC SINGLE
STAGE HIGH EFFICIENCY
COMPRESSOR**

19XL HERMETIC CENTRIFUGAL LIQUID CHILLER

HERMETIC SINGLE STAGE HIGH EFFICIENCY COMPRESSOR

Sensor Opportunities

Temperature

Oil Contaminants

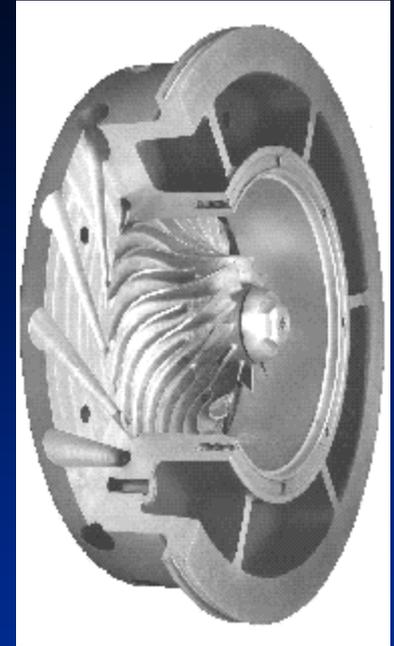
Pressure

Bearing Health

Environmental Constraints

Depending on Sensor Location:

- High Static Pressures
- Temperatures from near ambient to ?
- G-Loading from 10's of G's to 100's of G's
- Small Size & Weight
- Exposure to Oil, Water, Refrigerants



Wireless Sensor Circuit	Operating Power Required (mW)			Required Operational Duty Cycle (%)
	Present	Low Power Optimized	Extremely Low Power / MEMS	
Dynamic Strain	650	100	20	100
XX Channel Temperature	600	60	6	1
Acceleration	200	20	2	100

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United Technologies Research Center

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