Fuel Cells For Robots

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Product Needs

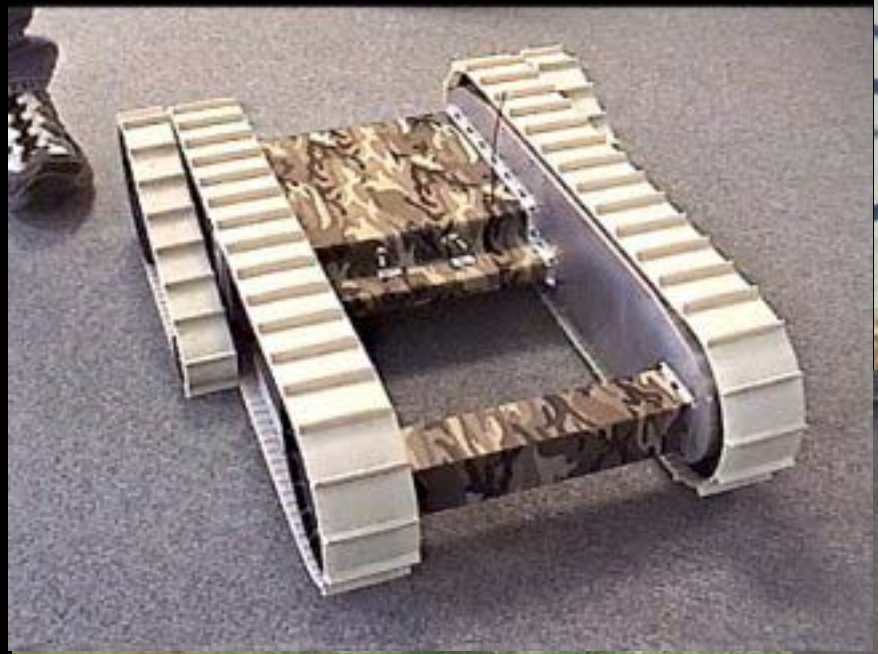
- Military/Police/Search and Rescue
  - **PackBot**
  - **Gladiator**
  - **ThrowBot/UGCV**
- Industrial and Oil
  - **CoWorker**
  - **MicroRig**

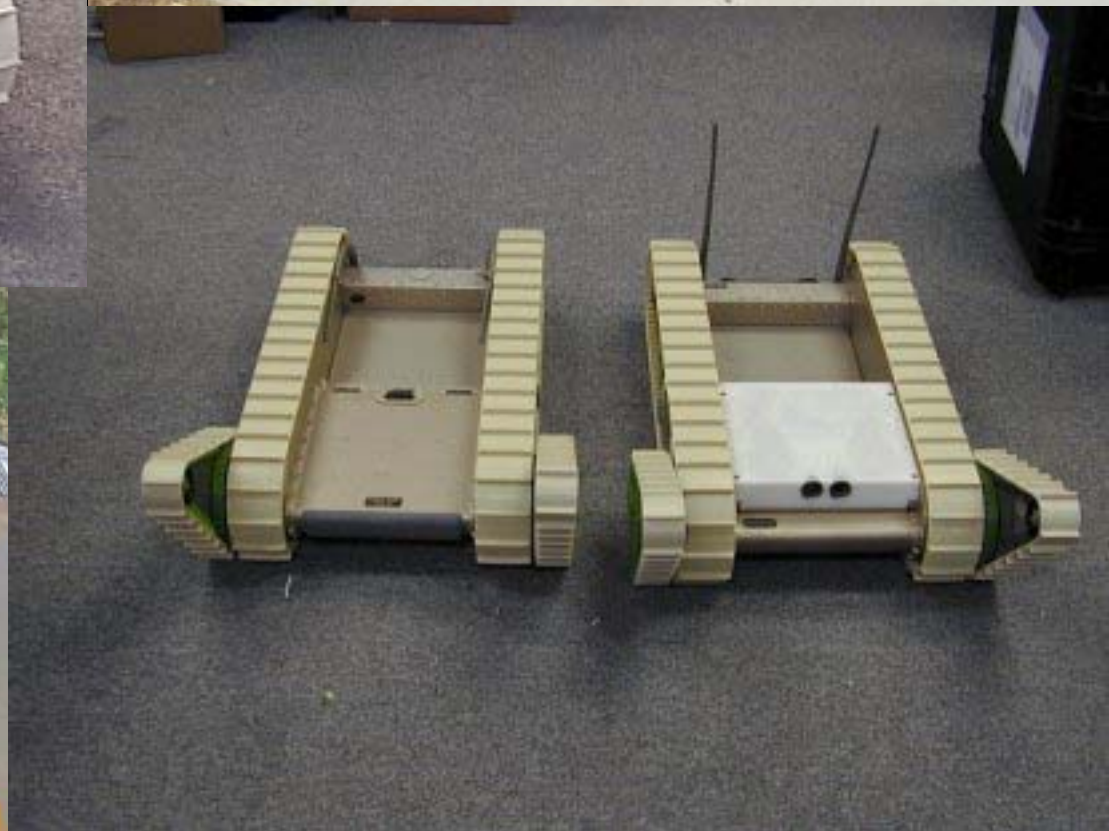
PackBot

- Mission capable robots
- Rugged, portable tools for minimal casualty engagements
- Assisting behaviors
- Small size and weight

System Concept

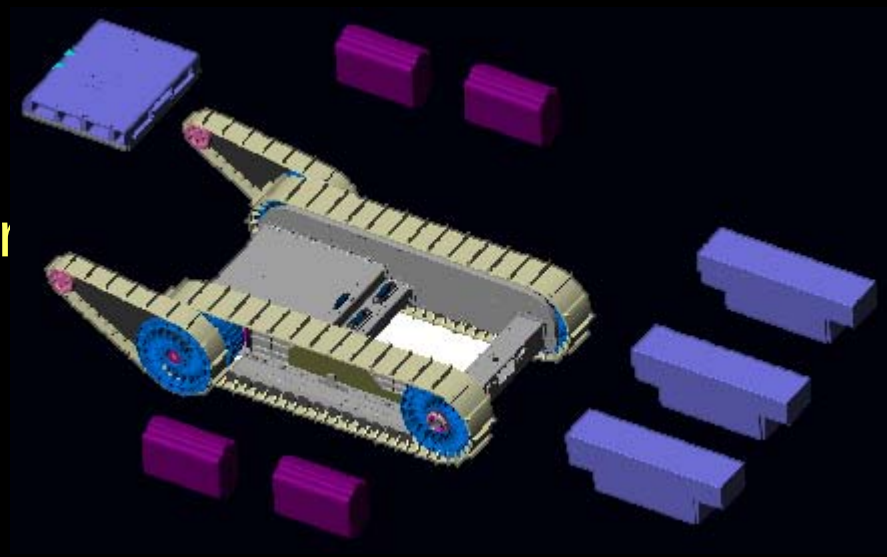
System Concept





System Concept Continued

- Modular payload bays
  - **3 primary**
  - **1 head**
  - **4 side pods**
- Each payload socket suppor
  - **Ethernet**
  - **2 Analog video inputs**
  - **USB**
  - **2 serial ports**
  - **Raw power input/output**
  - **FARnet (low latency motor/sensor bus)**
- Mission Specific Sensors/Effectors



System Concept Continued

- On-board functionality
  - **Full Pentium III system**
  - **Accelerometers**
  - **GPS**
  - **Compass/Inclinometers**
  - **Health (temperature, current, etc)**
  - **Radio**
  - **Active power routing**
  - **Active power conservation**
    - **User or system specified conservation measures**
  - **Intelligent payload management**

Packbot Capabilities

- Climbing/scrambling
- Rugged (survives drops of 3m)
- Expandable (payloads)
- Low profile (thermal, visible)
- Watertight to 3m
- Quiet
- Fast (4+ m/s)

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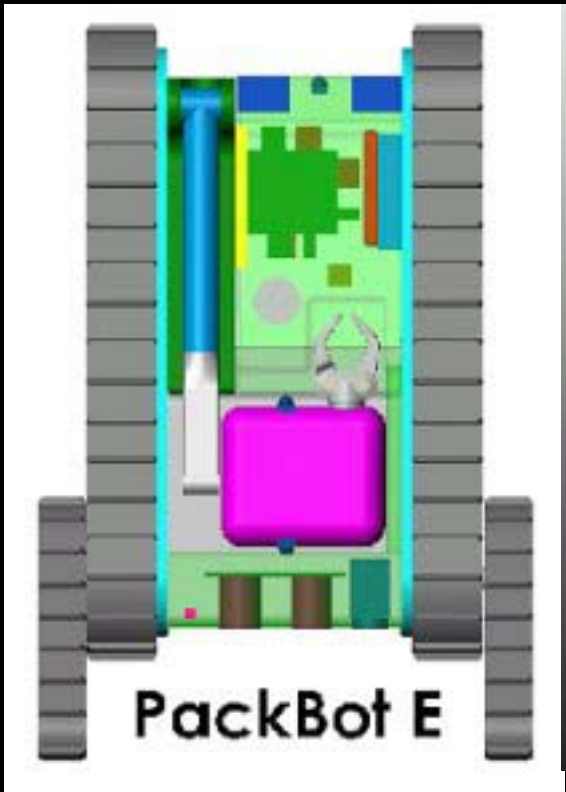
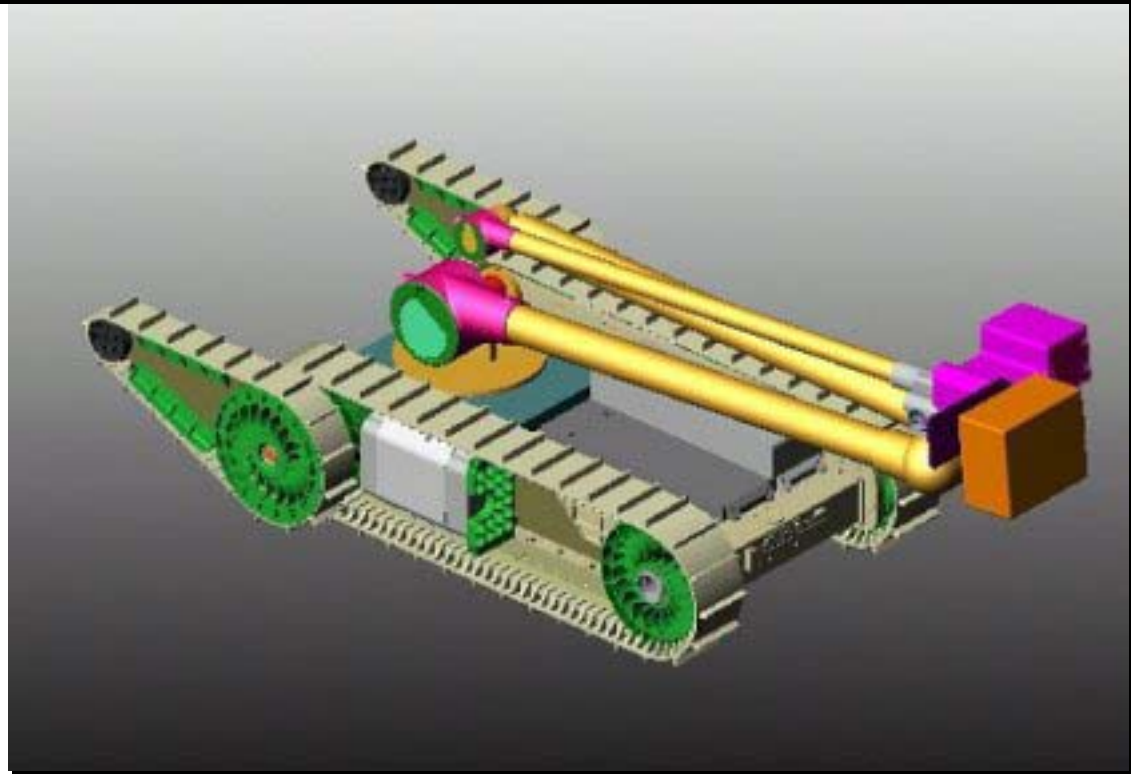
Mission Sensors/Prototype Payloads





Power & Duration

- 230 Watt-Hours Capacity (2 NiCad packs)
- 3x with LiIon secondary, 5x Lithium primary (est)
- 16-30 Volts (24 nominal), 30amp fuse
- Payload Power Supplies Supported
  - **Lithium**
  - **Fuel Cells**
  - **Hybrid power**
- Using NiCad Packs
  - **2+ hours at 2.2 m/s (on-road)**
  - **2+ hours at 1.5 m/s (off-road)**
  - **12+ hours (sentry/monitoring duty)**
- Each NiCad Pack about 6lbs.

Other MilSys

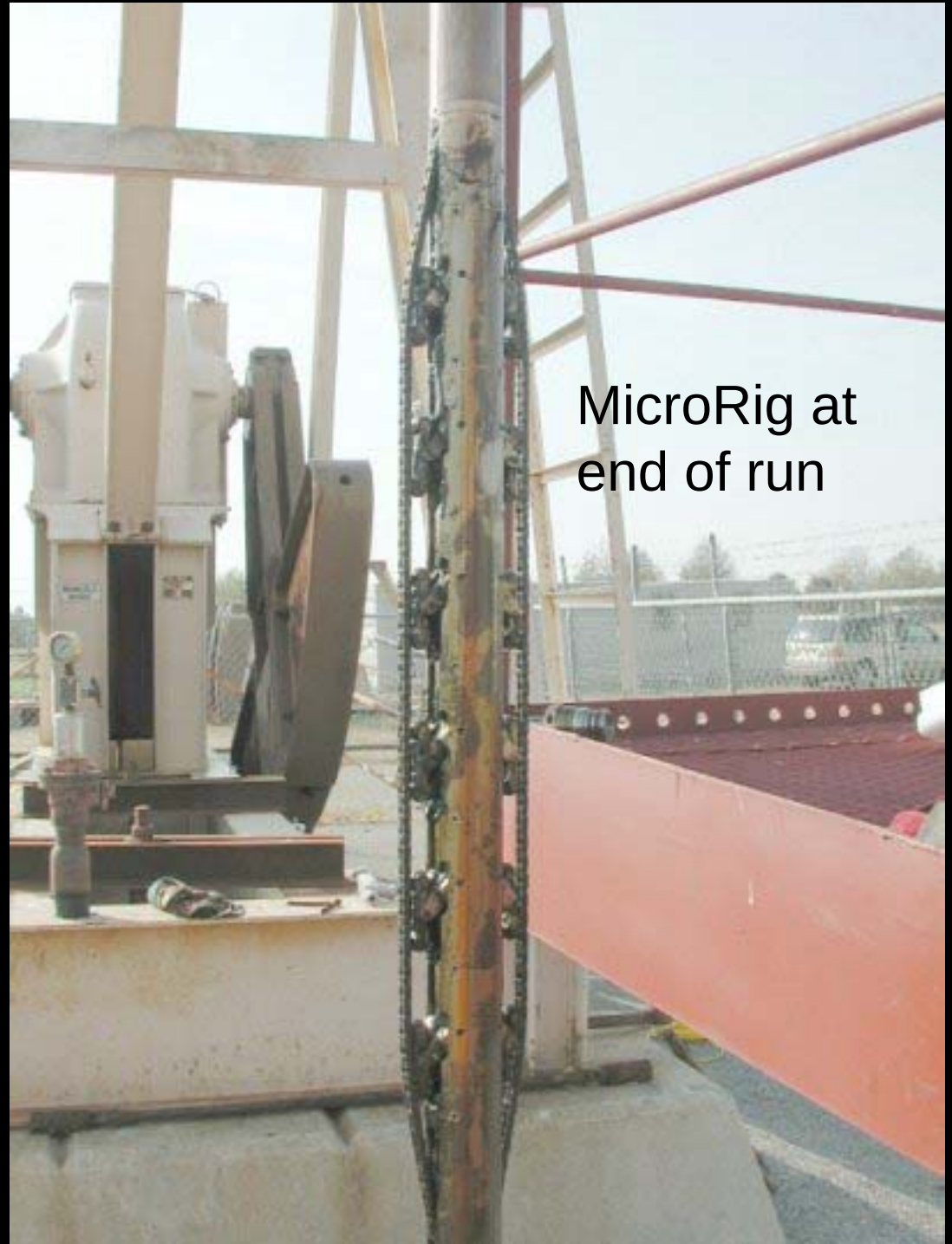
- ThrowBot: pocket sized, 1kg
  - **9-12V, 1-2A, 25WHr**
- Gladiator: 800lb class
  - **2 kW continuous @48 Volts,**
    - **5 kW peaks**
  - **total: 30 kWh over 24 hrs**
  - **One dimension <12"**
- Military front end:
  - **strip hydrogen out of diesel**

MicroRig Overview

- MicroRig is a fully autonomous downhole robotic vehicle.
- Its purpose is to carry oil field sensors to the bottom of oil wells to take data critical for reservoir management.
- This information is very valuable to the oil companies in that if the reservoir is properly managed, more oil may be recovered at less cost.
- Currently sensors are carried down on ends of long cables or pushed down on the end of long flexible tubes.

Successful Return from 7000 ft.

Chain and Idler Close-up



MicroRig at end of run

Competitive Advantage Against Coiled Tube

- The MicroRig has the most competitive advantage in the newer non-vertical (highly deviated) wells. These wells have sections that are greater than 50 degrees from vertical.
- In these wells, gravity alone will not get the sensors to the bottom, so the old technology requires them to be pushed down on the ends of flexible coiled tube.
- These wells are 15 to 25 k ft deep. As a result, the spool of coiled tube is huge, not to mention the handling equipment to push the tube and the control van. For offshore wells, a coiled tube unit requires a barge for transportation.

MicroRig being lowered into well

No Need for Tube or Cable

- The MicroRig is fully Autonomous, so there is no need for connection to the surface.
- The MicroRig ships in two 7 ft long shipping cases that may be flown to the sight on a helicopter.
- The MicroRig uses behavioral software to carry out the mission as well as health monitoring such as remaining battery capacity.
- The MicroRig currently used 32 D-D lithium primary cells as its fuel source.

MicroRig Operation in Pressurized Well

Project Backing

- The MicroRig project currently receives fund from:
  - **BP**
  - **Halliburton**
  - **Marathon Oil**
  - **Stat Oil**

MicroRig Power

- Small Vehicle Specs:
  - Max Environmental Temperature: 125 deg C
  - Average Power: 200 watts
  - Peak Power: 300 watts
  - Voltage: 105 to 120V (200 V max)
  - Mission duration: 24 hrs ave (longer is better only draws 200 watts returning)
  - Min Capacity: 10 Mega Joule ($10 * 10^6$)
  - Max OD for Cell Packaging: 1.687"
  - Length: < 20 ft.

MicroRig Power

- Large vehicle Specs:
  - Max Environmental Temperature: 125 deg C
  - Average Power: 700 watts
  - Peak Power: 900 watts
  - Voltage: 150 to 200 V or higher
  - Mission duration: 24 hrs average
  - Min Capacity: 50 Mega Joule ($50*10^6$)
  - Max OD for Cell Packaging: 3.25"
  - Length: < 20 ft.

CoWorker

Coworker is:

- An internet connected remote presence robot.
- A revolutionary new form of worker to worker communication.
- A more cost effective way to closely link multiple worksites.
- A way to enable your best workers to be in two or more places at once.
- A new way to work…

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CoWorker

- Digitally controlled pan/tilt/zoom camera -- Allows you to see the office from a whole new angle.
- High quality speaker and microphone -- Audio quality lets you carry on a conversation.
- Rugged platform that turns on a dime -- Highly maneuverable & easy to drive. Makes getting around the office easy.
- Ethernet 802.11 LAN radios -- Robust wireless communication.

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CoWorker

- Bus Voltage 18 to 30V, 24 nominal
- 15AHr lead acid batteries
- 2.5A active non-driving current
- Max 10A continuous driving
  - **fuzed**

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Review

- Military/Police/Search and Rescue
  - **PackBot (scooter class)**
  - **Gladiator (bicycle class)**
  - **ThrowBot (cell phone class)**
- Industrial and Oil
  - **CoWorker (bicycle)**
  - **MicroRig (high temp, cyl form factor)**