Rapid Technology Injection for Crisis Assessment & Response

ONR Industry Partnership 08/14/02

One who says "it cannot be done" should not interrupt one who is doing… (anonymous)

John G. Blitch

Blitz Solutions Inc.

P.O. Box 270346, Littleton CO 80127

303.697.7607 office & fax, 703.431.0082 cell

jblitch@worldnet.att.net

AGENDA

- Introduction: Crisis Assessment Challenge
- CRASAR Evolution (video review)
  - SOFROB
  - KNOBSAR
  - SOMROV
  - DARPA TMR
  - Mars Flash-line Project
  - WTC
  - OEF
- Lessons Learned

Process => Fire Hose

Pythagorean theorem: 24 words.
The Lord's prayer: 66 words.
Archimedes' Principle: 67 words.
The 10 Commandments: 179 words.
The Gettysburg address: 286 words.
The Declaration of Independence: 1,300 words.
US Government regulations on the sale of cabbage: 26,911 words

MORAL OF THE STORY => USE VIDEO

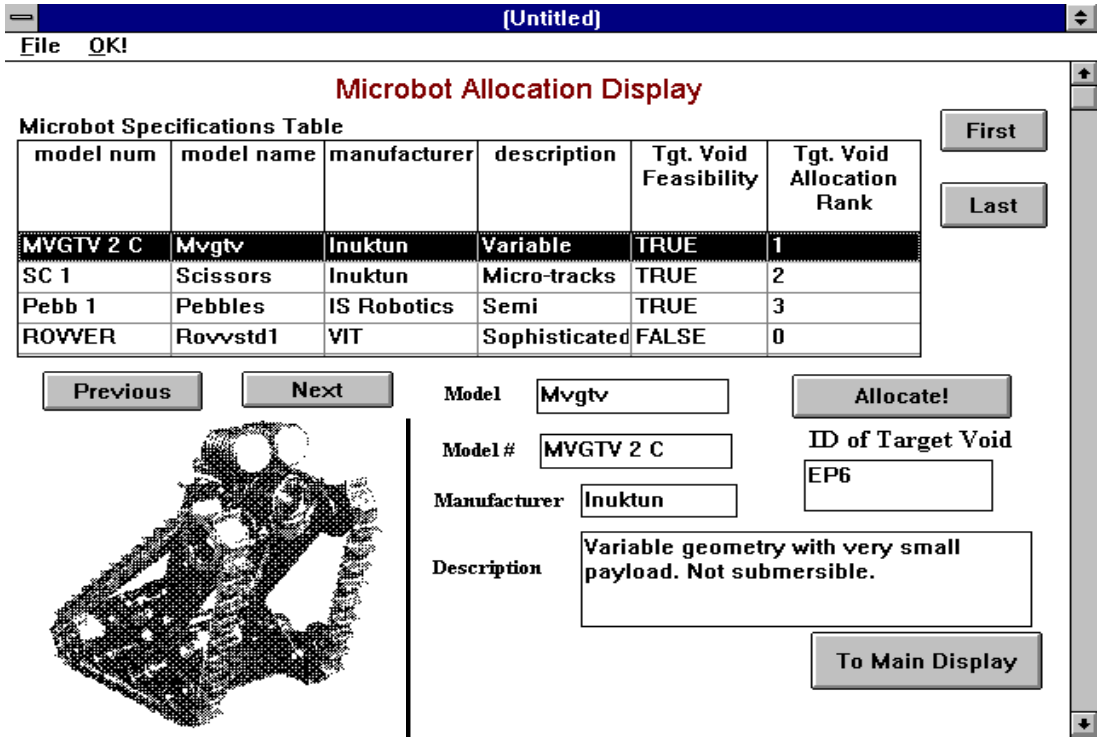
- **Military Bases / Training Areas**
- **Mars**
- **WTC**
- **Afghanistan**

Crisis Assessment Challenge

Disaster is usually a surprise – you never see it coming…

KNOBSAR Project

KNOwledge Base for Search And Rescue



Where have we been?
CRASAR Time Line

-06/94
-06/95
-07/95
-08/96

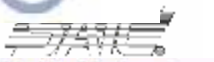
How do I pick right robot for the right entry?

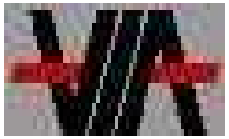
Show KNOBSAR Demo

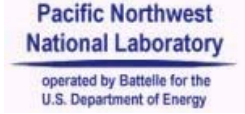
- IMPACT:
  - Captured NIUSR attention: “High Lonesome Award”
  - Inspired Defense interest & funding: SOFROB, JRP, DARPA TMR

DARPA TMR Talent

1997-2001 Academia + Industry + DOE <=> DoD







UGV /JPO

NIST

DARPA TMR Program

What is Available?

START VIDEO TOUR NOW

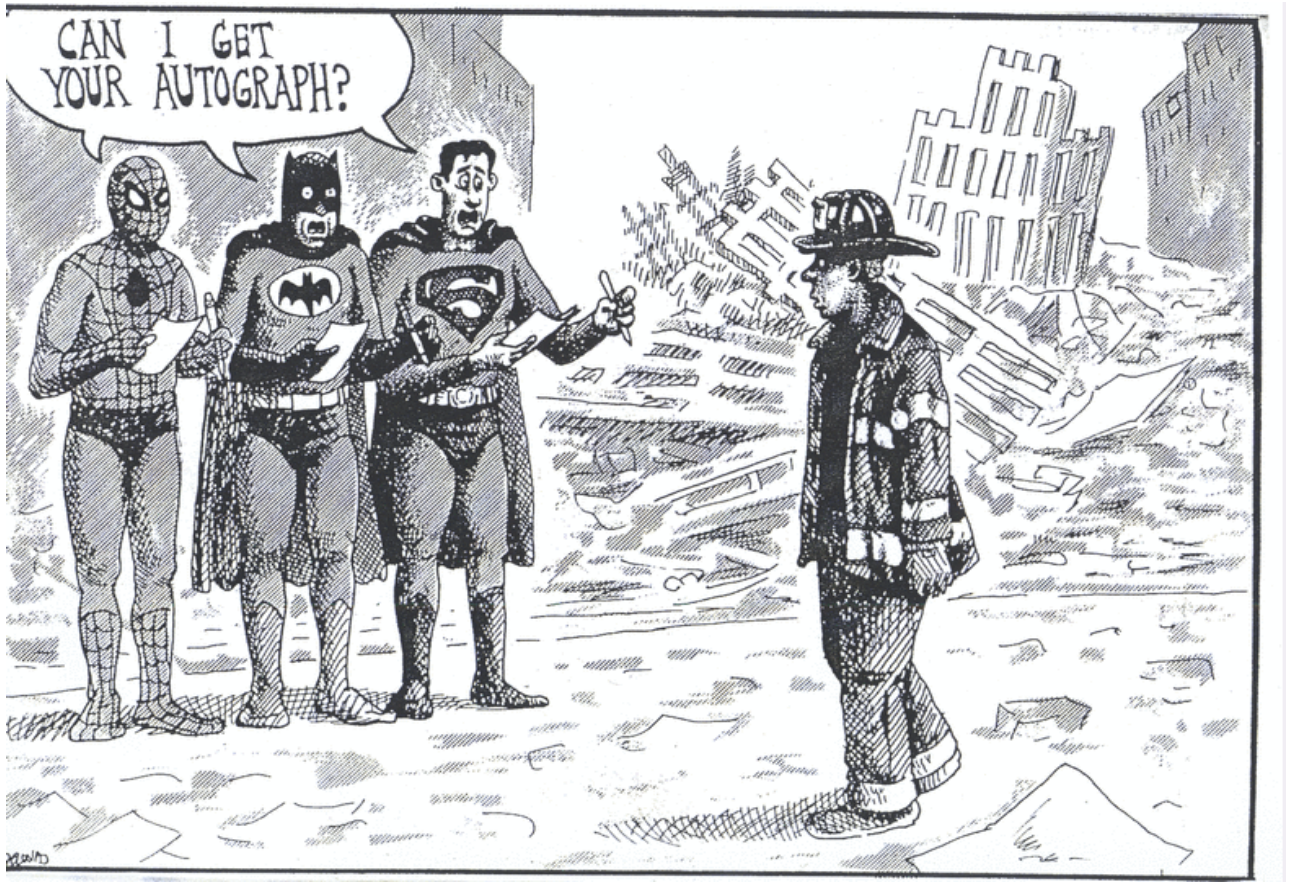
Tactical Robot Imperatives

Why do we need "smart" platforms?

- ***Reliability*** **through Self Correction**
  - **1) Tumble Recovery** (Invertible, self righting, anti-snag, etc.)
  - **2) Lost Commz Behavior** (retro-traverse, seek-light, explore w/ delay, etc.)
  - **3) Anti-Handling/Anti-Tampering** (no interference from OPFOR, indig. personnel, wildlife, etc.)
  - **4) Self Location** (accuracy based on situational context, but tell me something!)
  - **5) Complex Obstacle Negotiation** (not avoid objects but climb/push/pull/penetrate stairs, rubble, bushes, etc.)
  - **6) Self Cleaning Sensor** ("wipe your face" to handle mud splash, dust, precipitation, etc.)
- **Autonomy Based** ***Enhancements***
  - **RF Signature Reduction**
  - **Operator Fatigue Avoidance**
  - **Conserve Power via behavior cueing**
  - **Manipulation efficiency for breaching, device emplacement, etc.**

Lessons (Re-) Learned

Humans WANT to take risk
Do NOT try to replace them



Technology Injection Lessons Learned

- Find a niche (unique, relevant, high bang for buck)
- Be Flexible (surprise / P.A.C.E)
- Accept Risk & EMBRACE Failure
- Manage Expectations (potential v. capability)
- Give others the credit
  - not just allow, but seek
  - Do as I say…
  - C squared

Where Next?

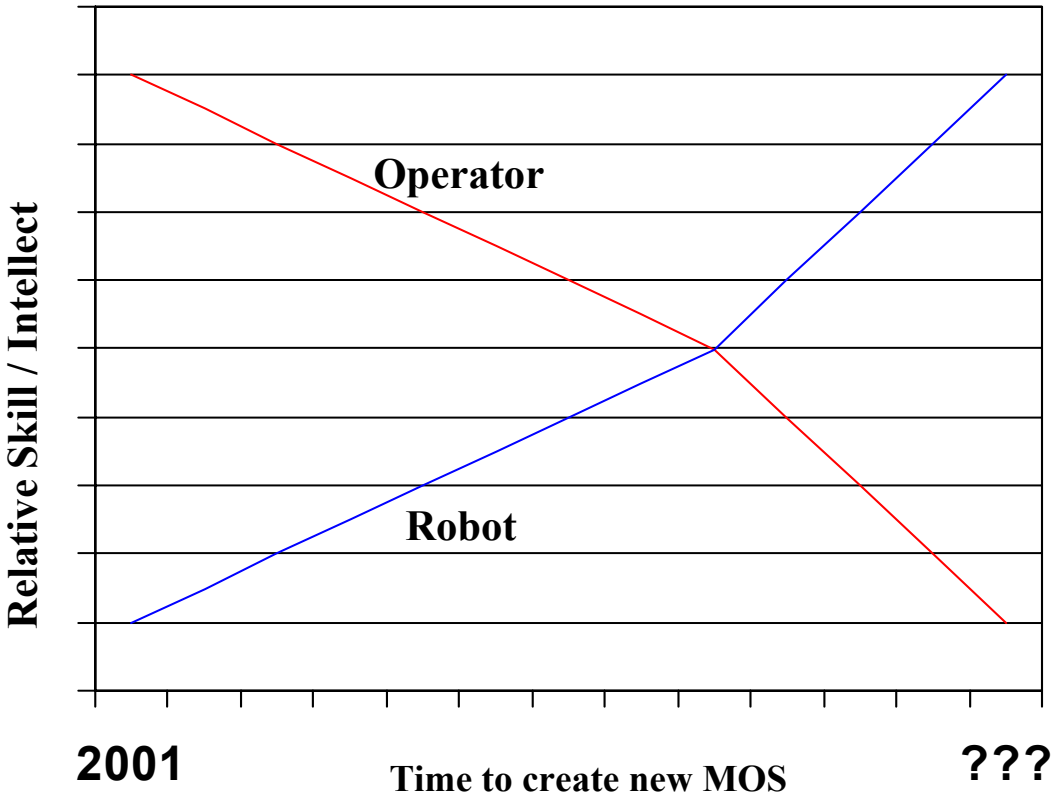
Future CRASAR Research Thrusts

- **Polymorphism: mobility, sensing, grasping**
- **Hyper redundancy: sensing,**
- **Adaptive multi-modal probing**
  - **Remote triage**
  - **Patient monitoring, med, water, air transport**
  - **“TREATMENT” – TOO COMPLEX FOR today’s ROBOTS – leave to humans for now**
- **Marsupials**
- **Adaptive shoring**

TMR HRI Paradox

Specialized Skill v. Robot Autonomy

- **Now:**
  - "Dumb" robots need "Smart" humans to compensate for complex situational management
- **Future:**
  - "Smart" robots will require much less supervision
- **Paradox:**
  - **Need in human control skills or robot autonomy?**
  - **How much to each?**



RASCIT Experiment No. 1

Initial Results

RASCT Confined Space Inspection Experiment No. 1						
Mars Society Flashline & NASA Hughton Mars Projects						
Name	**Elapsed Time**	**Number Faults Correct**	**No. Faults Missed**	**Spat-A Score**	**Perf. Rank in crew**	**Spat-A Rank in Crew**
first only	*min:sec*			*percent*	*lower time is better*	*higher better*
Task 1: Confined Space Inspection: Hab Damage						
base case	**08:47.2**	**6**	**0**			
	CREW 3 on 07.28.01 overcast, wet, temp ~ 48 Deg F					
crew 3-1	19:14.8	6	0	73.42	3	2
crew 3-2	29:54.8	6	0	45.24	5	5
crew 3-3	24:52.2	6	0	60.71	4	4
crew 3-4	19:01.2	6	0	66.2	2	3
crew 3-5	14:07.3	6	0	77.38	1	1
	CREW 4 on 08.01.01 raining, temp ~ 35 Deg F					
crew 4-1	33:06.6	6	0	78.6	1	1
crew 4-2	54:54.4	6	0	42.9	3	3
crew 4-3	35:21.1	6	0	76.2	2	2
Task 1a: Confined Space Inspection: Hab Damage w/ two robot perspective						
Task 2: Confined Space Inspection: Rover Damage						
Task 2a: Confined Space Inspection: Rover Damage w/ two robot perspective						
Task 3: Cluttered Area Sample Collection: Marsupial Collection						
Task 3a: Cluttered Area Sample Collection: Marsupial Collection w/ two robot p						
Task 4: Confined Space Sample Collection: Glacial Fissure, Ice Cave, Lava Tub						
Task 4: Confined Space Sample Collection w/ two robot perspective						
Task 5a: Confined Space Inspection: Hab Damage w/ three robot perspective						
Task 5b: Confined Space Inspection: Rover Damage w/ three robot perspective						
Task 5c: Cluttered Area Sample Collection: Marsupial Collection w/ three robot						
Task 5d: Confined Space Sample Collection w/ three robot perspective						

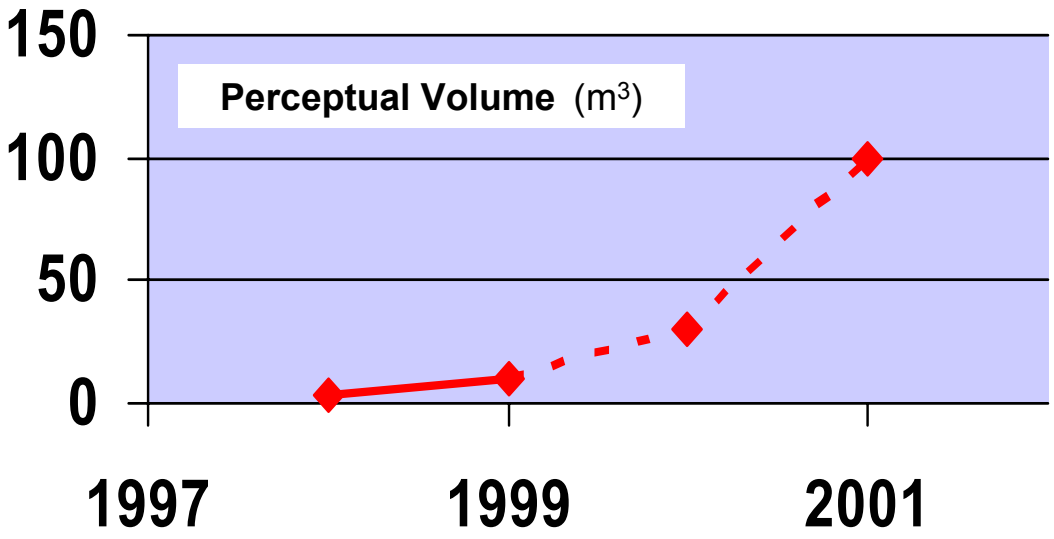
Perceptual Metrics

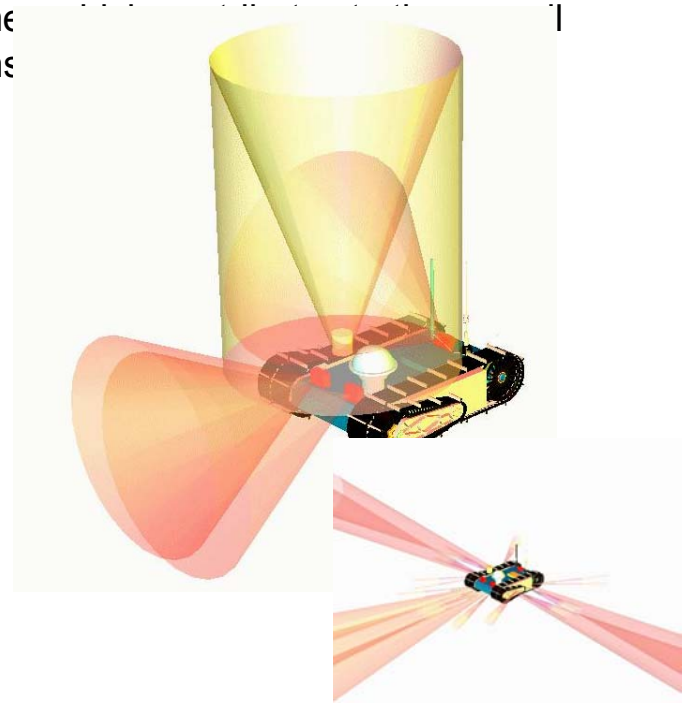
Polymorphic Sensing Support

Minimum Useful Resolution (MUR) is defined as the minimum resolution needed to have a reasonable chance of accomplishing a useful task (such as a 90% probability of visual identification of a human at a given range, localization of the sound of a rifle bolt closing, etc.).

Effective Performance Span (EPS) is defined as the volume of coverage (in cubic meters) from an organic TMR sensor, outside of which its resolution falls below the **MUR** threshold.

Perceptual Volume (PV_t) is defined as the sum of EPS volume[illegible] awareness of a TMR's external environment across all available sens[illegible]





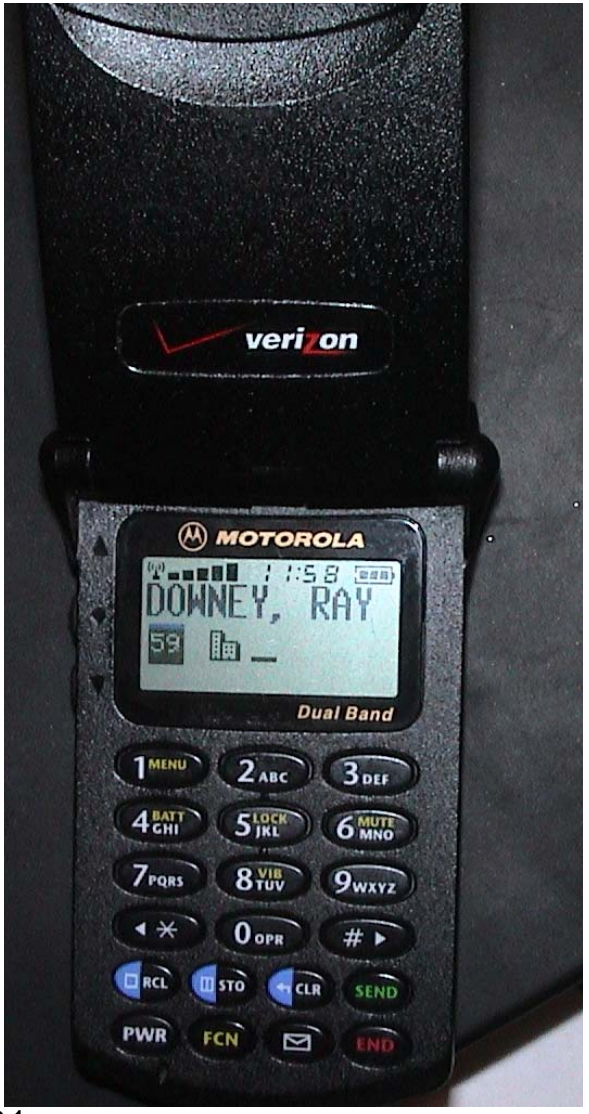
Organizational Vision

CRASAR Structure

- **Operations Committee**
  - **Chaired by Dep.Dir. Ops/Training**
  - **Comprised of experienced SSAR reps**
  - **Establishes prioritized needs (pull)**
- **Research Committee**
  - **Chaired by Dep.Dir. R&D**
  - **Comprised of salient roboticists**
  - **Establishes / tech baseline (push)**
- **Headquarters**
  - **Matches ops priorities w/ tech baseline**
  - **Allocates resources**

CRASAR Response

- **Decision Challenge**
  - WTC or Pentagon?
  - What's our status?
  - Where are the robots?
- **Co-ordination Chaos**
  - Co-ordinate with… who?
  - Who knows about us?
  - Where is Ray?



What We Brought

Portable Semi-Autonomous Robots

Tethered

Inuktun microTrac
video, 2 way audio

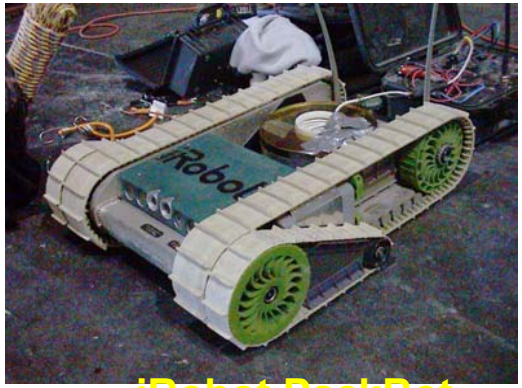
Inuktun microVGTV,
Inuktun pipe crawler
video, 2 way audio

Wireless

FM Solem
video, striper, audio

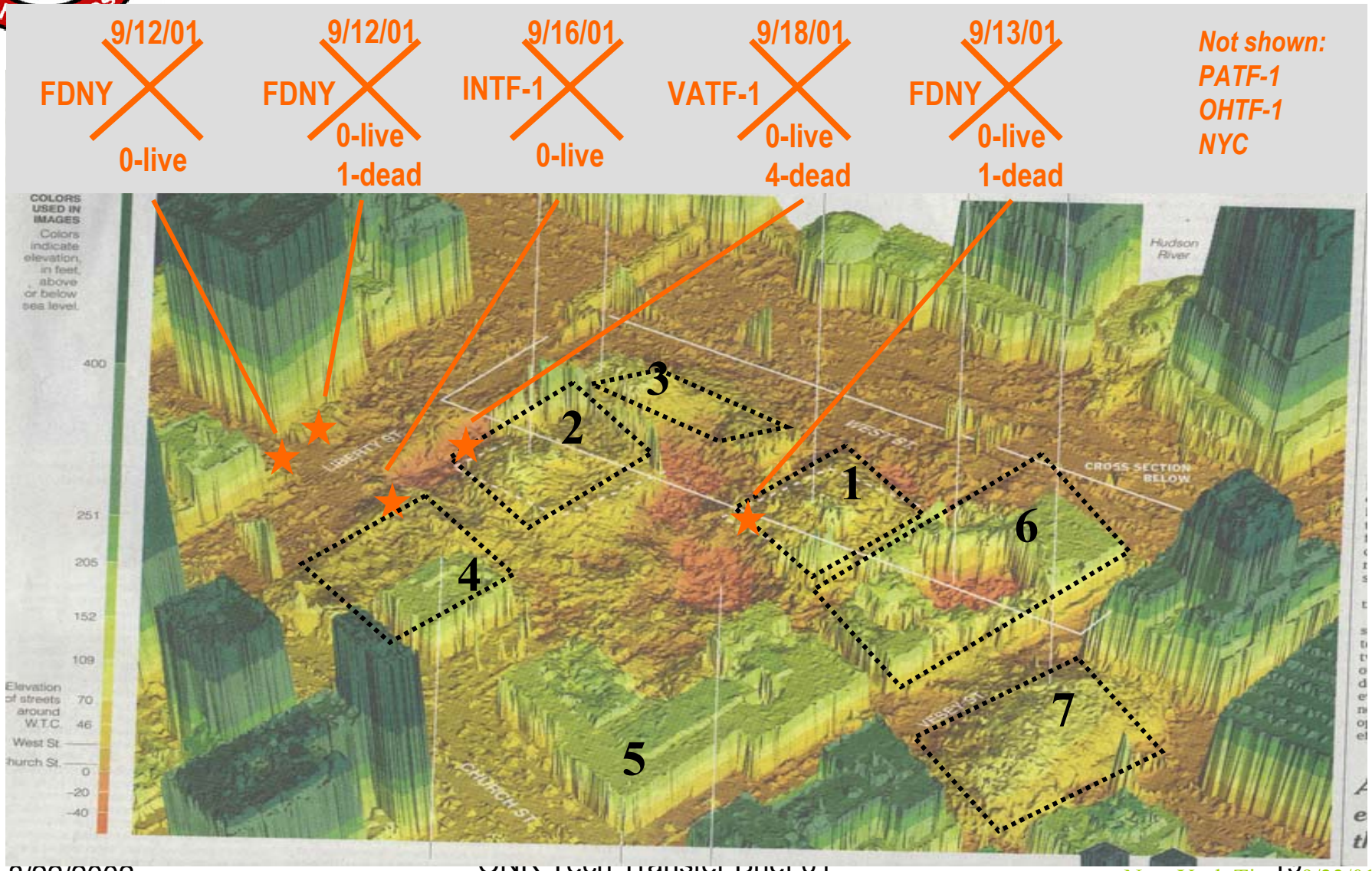
FM/SPAWAR
Urbot: Invertible cam, FLIR

FM Talon
video, arm + gripper



iRobot PackBot
video, FLIR, 2 way audio

Where The Robots Were



New York Times 9/23/01

CRASAR in Action

SHOW VIDEO

Lessons (Re-) Learned

Robot Chassis Design / Mobility

- **Smooth Exterior w/ recession**

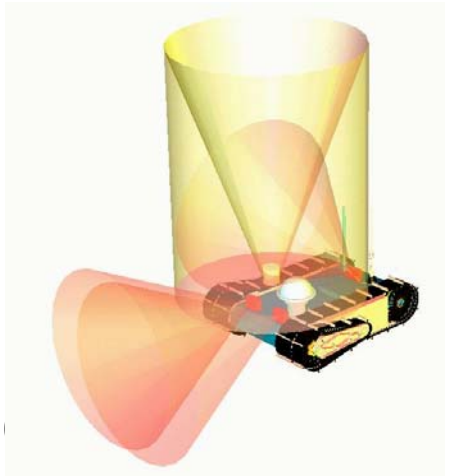
- **High Traction**

- **Invertible Hybrids**

Lessons (Re-) Learned

Sensing

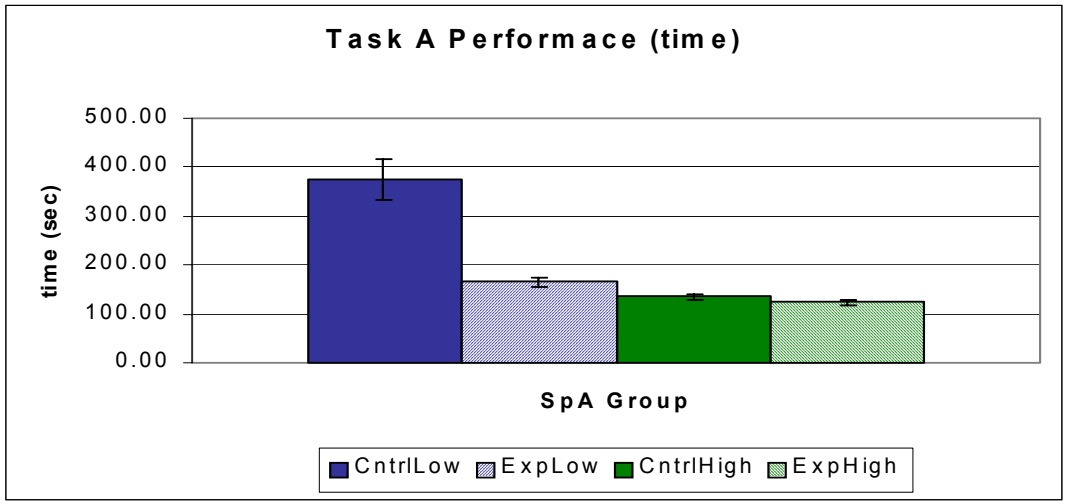
- **Organic Sensing Minimums**
  - **Audio/Visual**
  - **IR**
- **Penetrating / 3D**
  - **Impulse Radars**
  - **Seismic, etc..**
- **Recording Format**
  - **NO laptops**
  - **NTSC distribution**



Lessons (Re-) Learned

Human Robot Interface

- **Recording Format**
  - **Portable / Rugged OCU**
  - **No Laptop**
  - **NTSC distribution**
- **Wearable Systems**
- **Specialized Skill Set?**



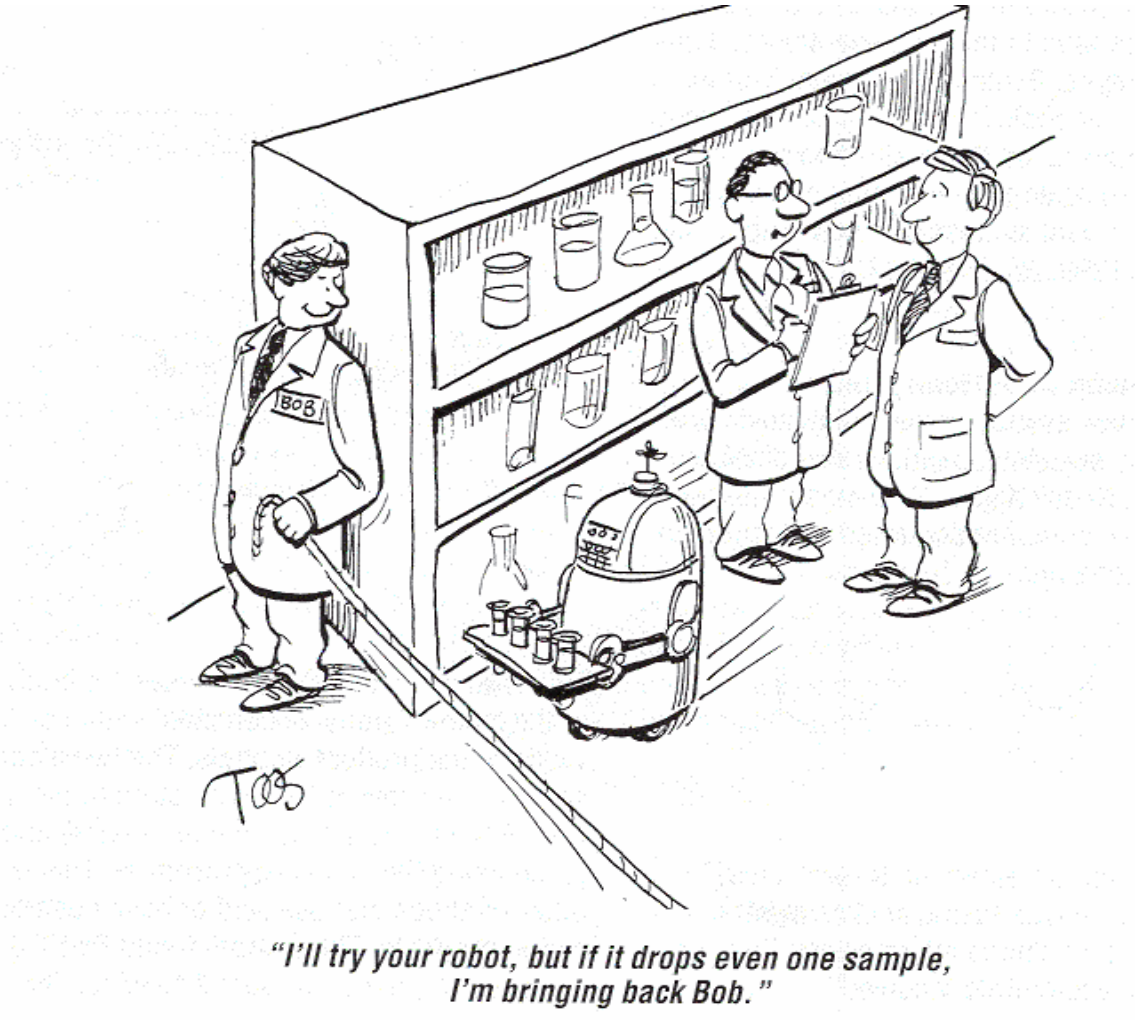
Lessons (Re-) Learned

Motivations for Robot Autonomy

- ***Reliability*** **via self recovery behavior**
  - **Tumbles & Tangles**
  - **Lost Communications**
  - **Non-GPS Position Estimation**
  - **Complex Obstacle Negotiation**
  - **Self Cleaning**
- ***Efficiency*** **via complexity reduction**
  - **Fatigue Mitigation**
  - **Cognitive Overload**
  - **Power Conservation**
  - **Manipulation Effectiveness**

Summary

Always beware the Luddite…



"I'll try your robot, but if it drops even one sample, I'm bringing back Bob."