Robots and Innovation

Joe Dyer
Chief Operating Officer
iRobot Corp.

jdyer@irobot.com

iRobot Product Line (<u>not</u> to scale)

HRD Robots

G&I Robots

LANdroids	210 Negotiator®	310 SUGV	320 SUGV	510 FasTac™	510 PackBot®	710 Warrior®	1KA Seaglider™

Transphibian   15A Ranger™

iRobot®

Disruptive Technologies Timeline

Fire — 60000BC
Wheel — 4500BC
Alphabet — 2300BC
Printing Press — 1400AD
Electricity — 1700AD
Oil — 1800AD
Automobile — 1900AD
Television — 1940AD
Computers — 1980AD
Internet — 1980AD
Biotech — 2000AD
2004AD
Robotics — 2014AD
NanoTech — 2024AD
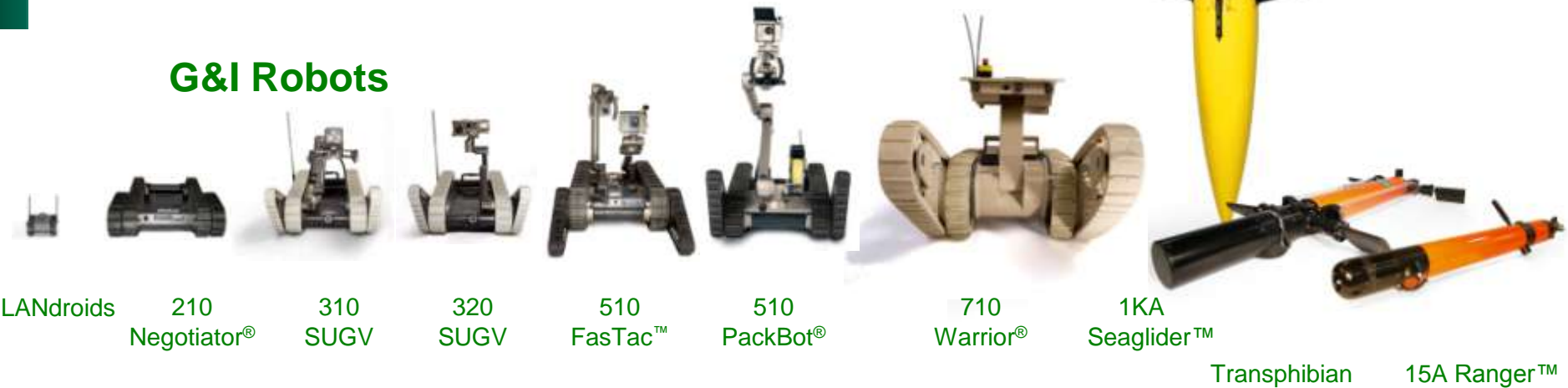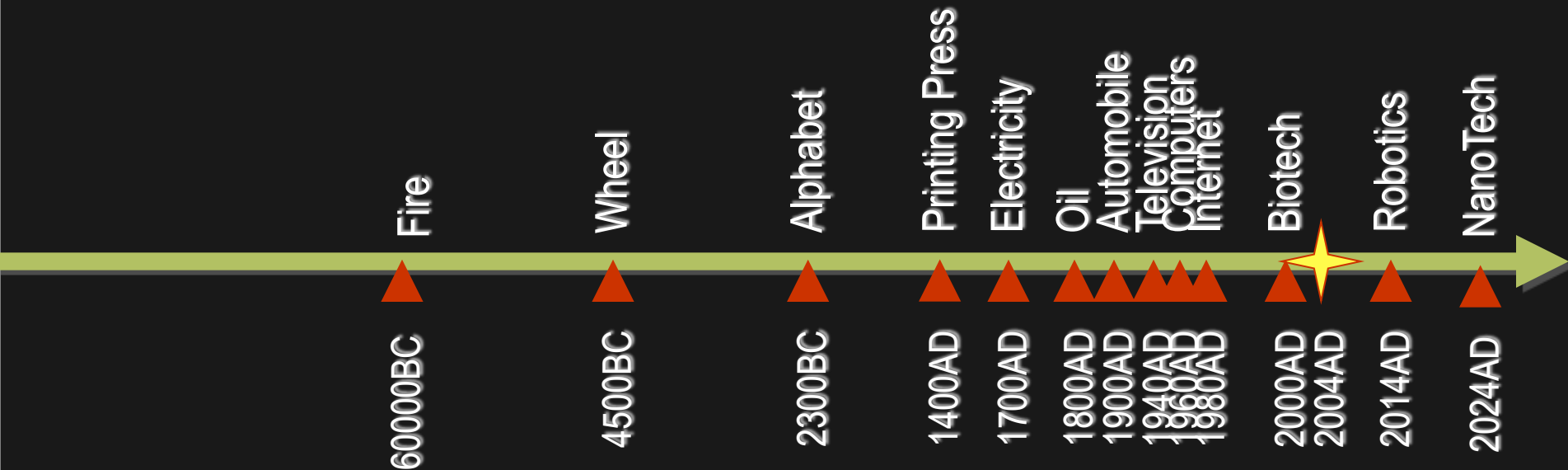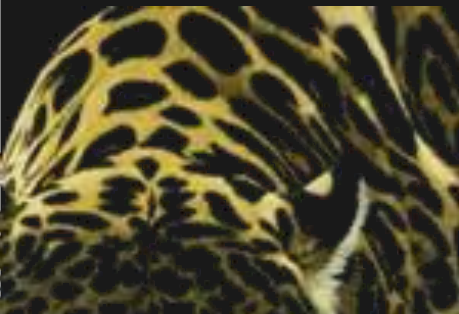
Massive disturbances occur with the introduction of disruptive technology.
Life before and after a disruptive technology is fundamentally different.

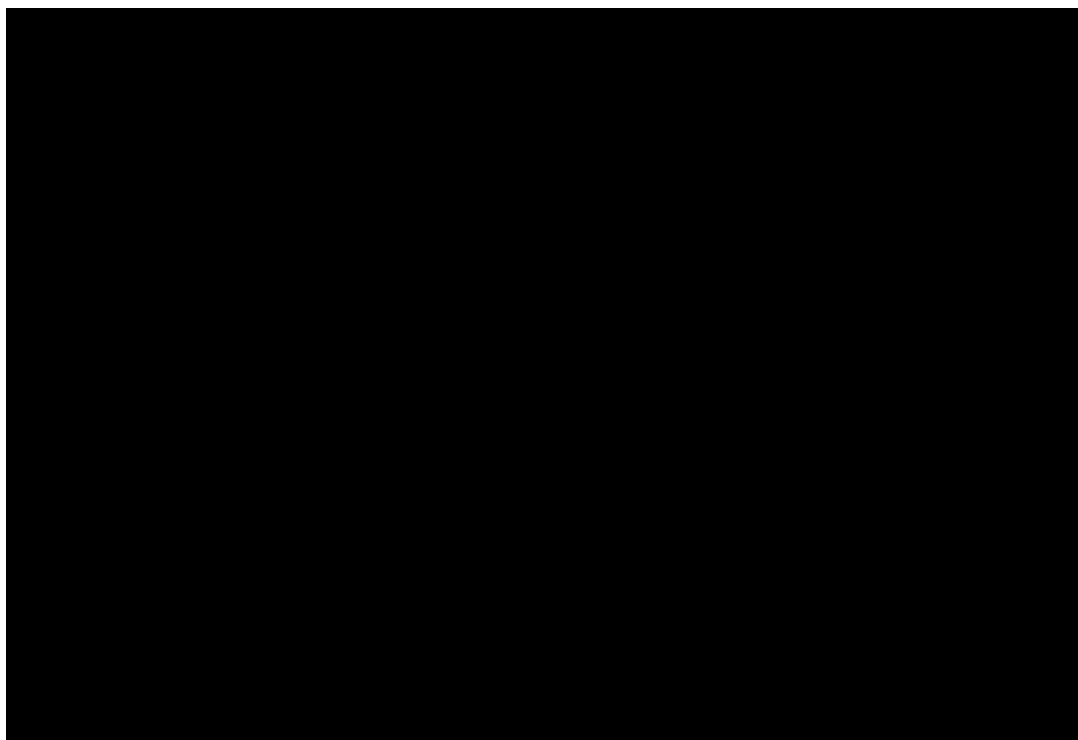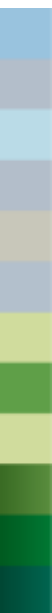# Disruptive Technologies Timeline
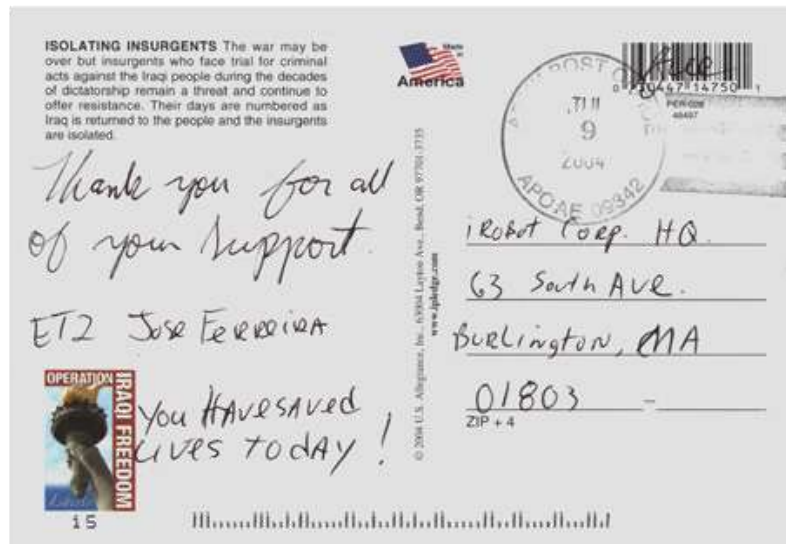
Fire

60000BC

Lead position – brand and installed base

- **Well over 5 million home robots sold**

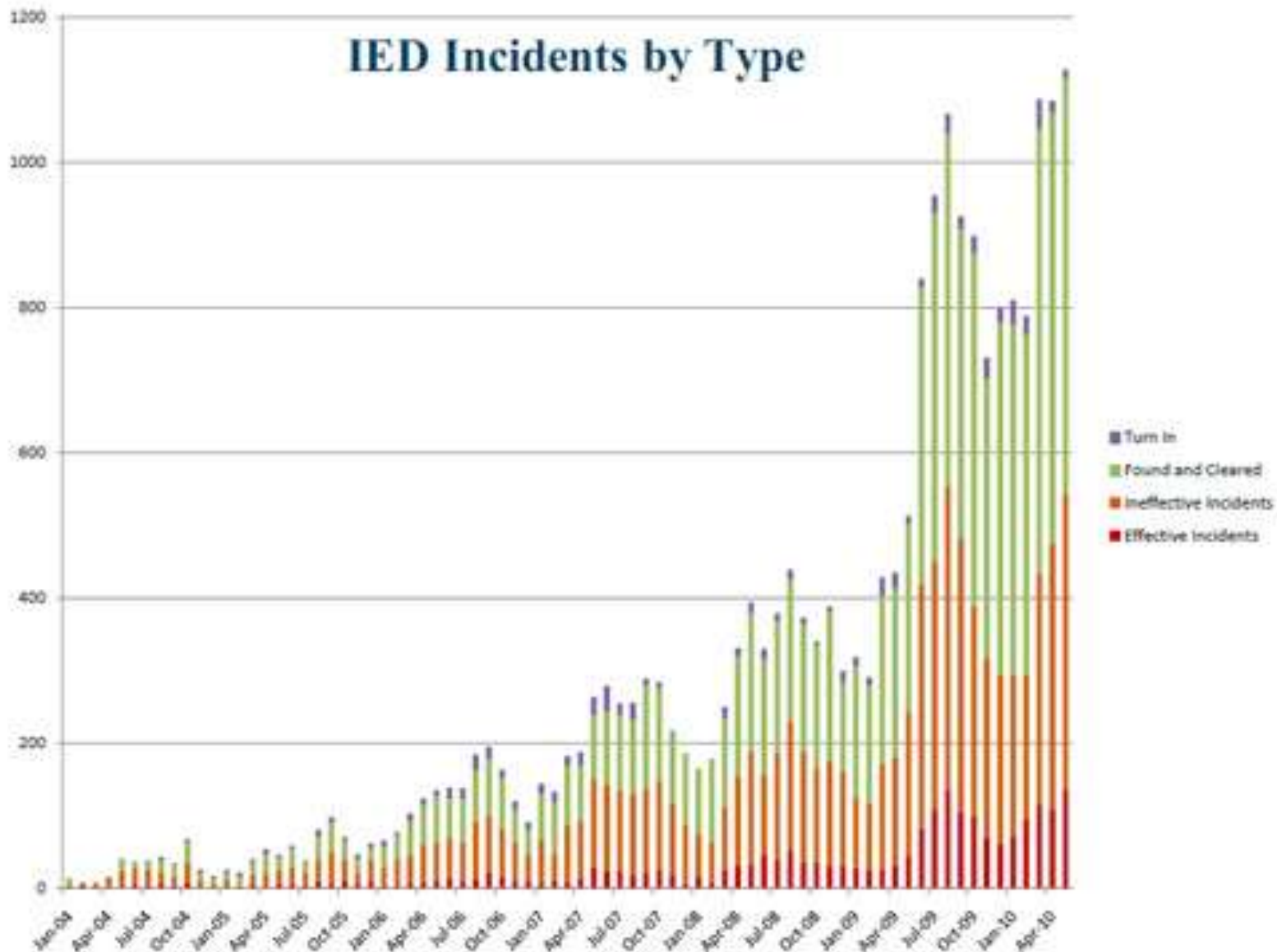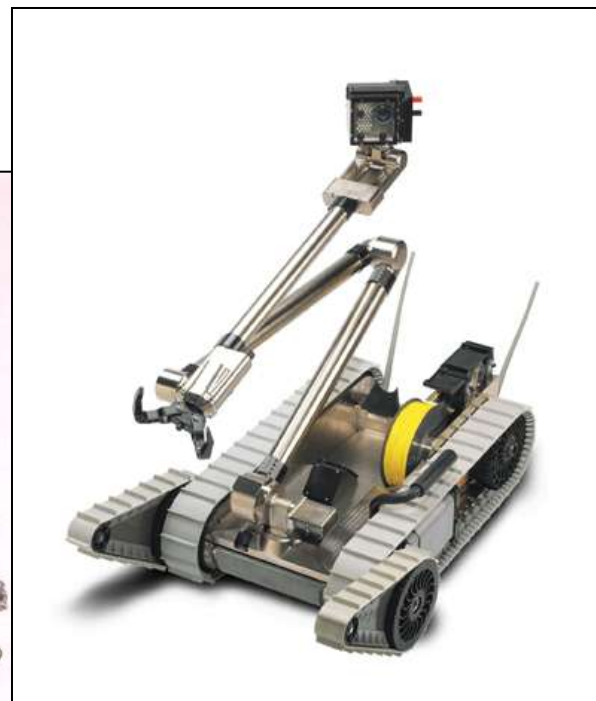- **Currently sold in over 45 countries around the world and expanding**

- **Over 3,500 PackBot and SUGV robots sold**

- **Customer base: Army, Navy, USMC and USAF…plus > 15 allied countries worldwide**

iRobot

ISOLATING INSURGENTS The war may be over but insurgents who face trial for criminal acts against the Iraqi people during the decades of dictatorship remain a threat and continue to offer resistance. Their days are numbered as Iraq is returned to the people and the insurgents are isolated.

Thank you for all of your support.

ET2 Jose Ferreira

You HAVE SAVED Lives TODAY!

iRobot Corp. HQ
63 South Ave.
Burlington, MA
01803 -

iRobot

IED Incidents by Type

Legend:
- Turn In
- Found and Cleared
- Ineffective Incidents
- Effective Incidents

iRobot

PackBot #129

**Killed In Action
Iraq**
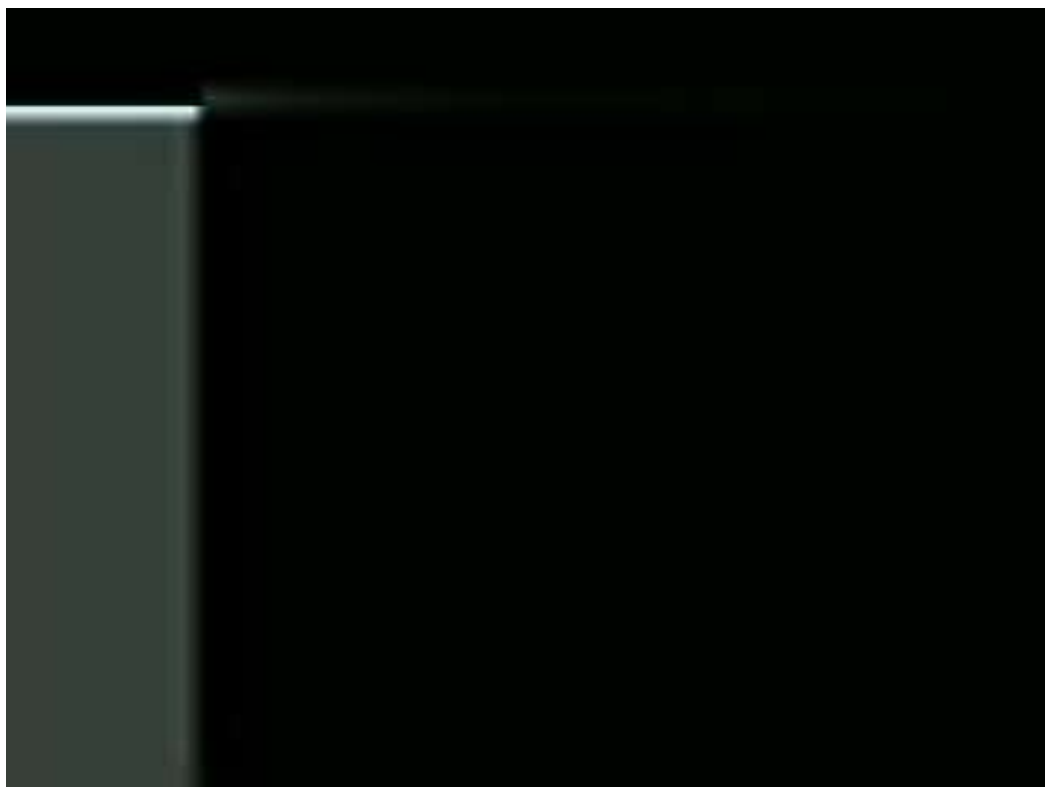
iRobot

Today's Robots Make a Difference

Key Benefits

Non-Line of sight Exchange ratio, *Percent*

15 X

38.5

2.6

W/O SUGV   With SUGV

- **Increased Mission Success**
  - Greater ability to engage NLOS

- **Improved Survivability**
  - Reduces friendly casualties by >50%
  - Significantly reduces IED casualties

- **Increased Lethality**
  - Increases enemy kill rate by 50%

- **Reduced Collateral Damage**

Friendly Losses, # per engagement

2.3

-57%

1.0

W/O SUGV   With SUGV

**Robots provide increased SA
& ability to engage NLOS,
increasing mission success**

Enemy Losses, # per engagement

+50%

3.0

2.0

W/O SUGV   With SUGV
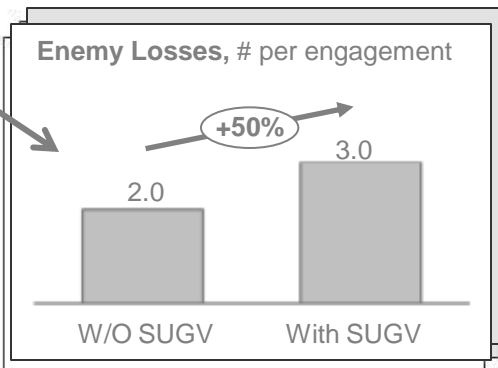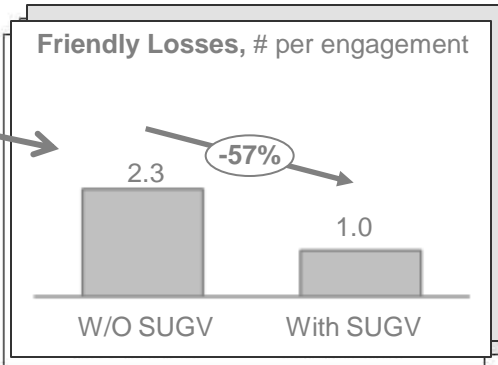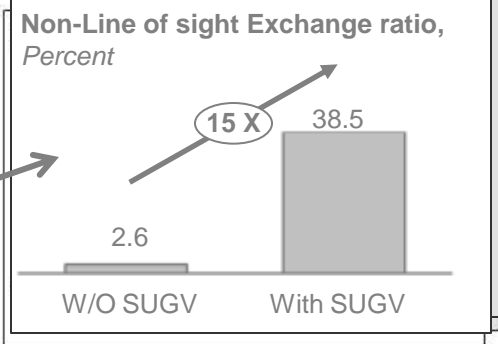
iRobot

Advancements Will be an Evolutionary Process

Autonomous Robotic Organizations

Semi-Autonomous Robotic Teammates

Tele-operated Robotic Tools

10+

5+
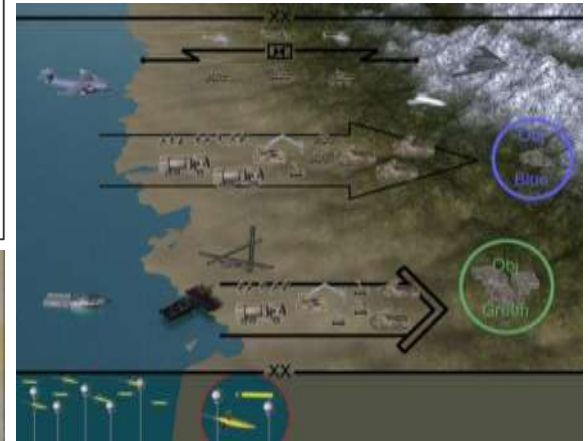
Today

iRobot

Today Robotic Tools Perform Important But Limited Tasks

- Established CIED, ISR, and tunnel exploitation missions.

- Emerging capability in MOUT.

- One to one controller/robot relationship.

UAV ISR, Targeting, and Engagement

Tunnel Clearing/ Exploitation

Operations in Urban Terrain

IED Detection and Defeat

iRobot

Network Infrastructure & Information Sharing Capabilities

- Today's two-node (operator:robot) network.

- Multiple-node networks currently in test, but not required for robots to deliver capability today.

- Operator gets raw data from robot, e.g., speed, orientation.

- Robots require constant and detailed control from operators.

- While this works, occasionally comms limitations, e.g., bandwidth, reduce number of robots that can be simultaneously tele-operated in same area.
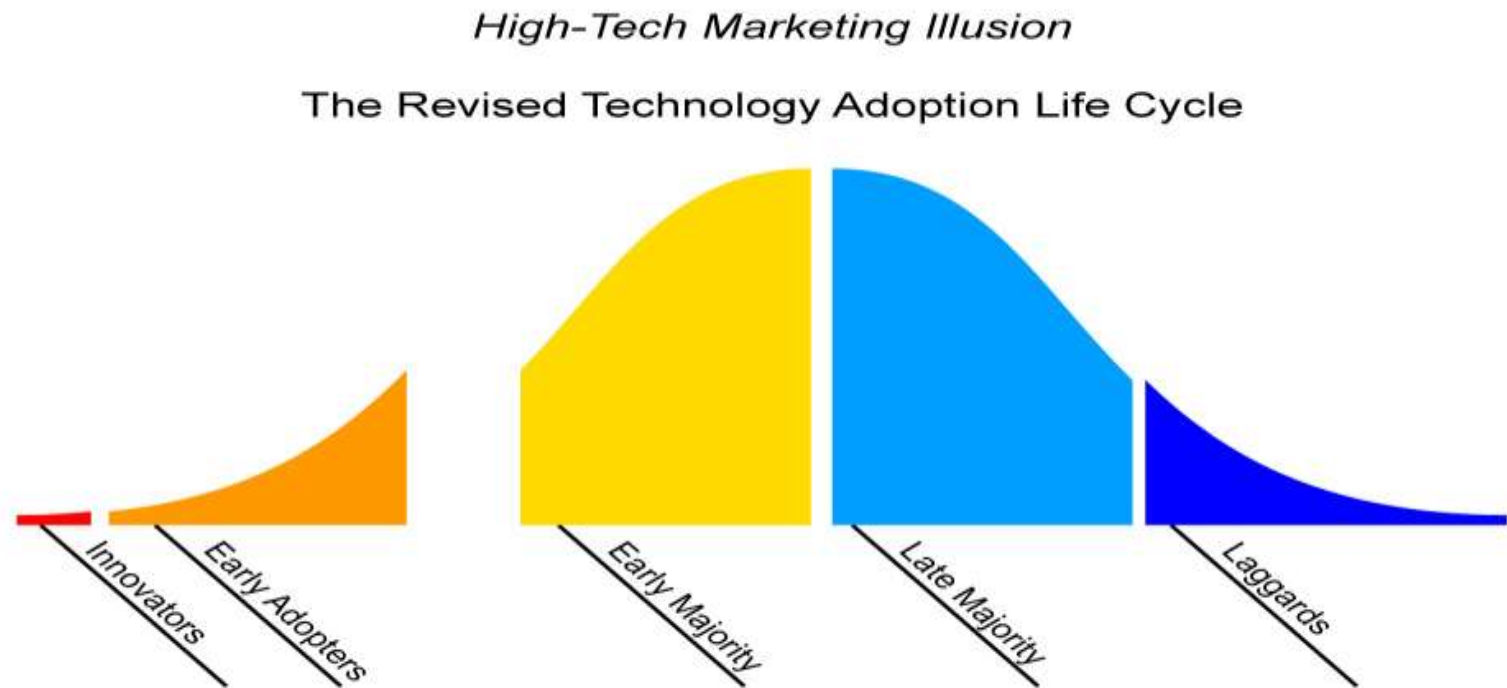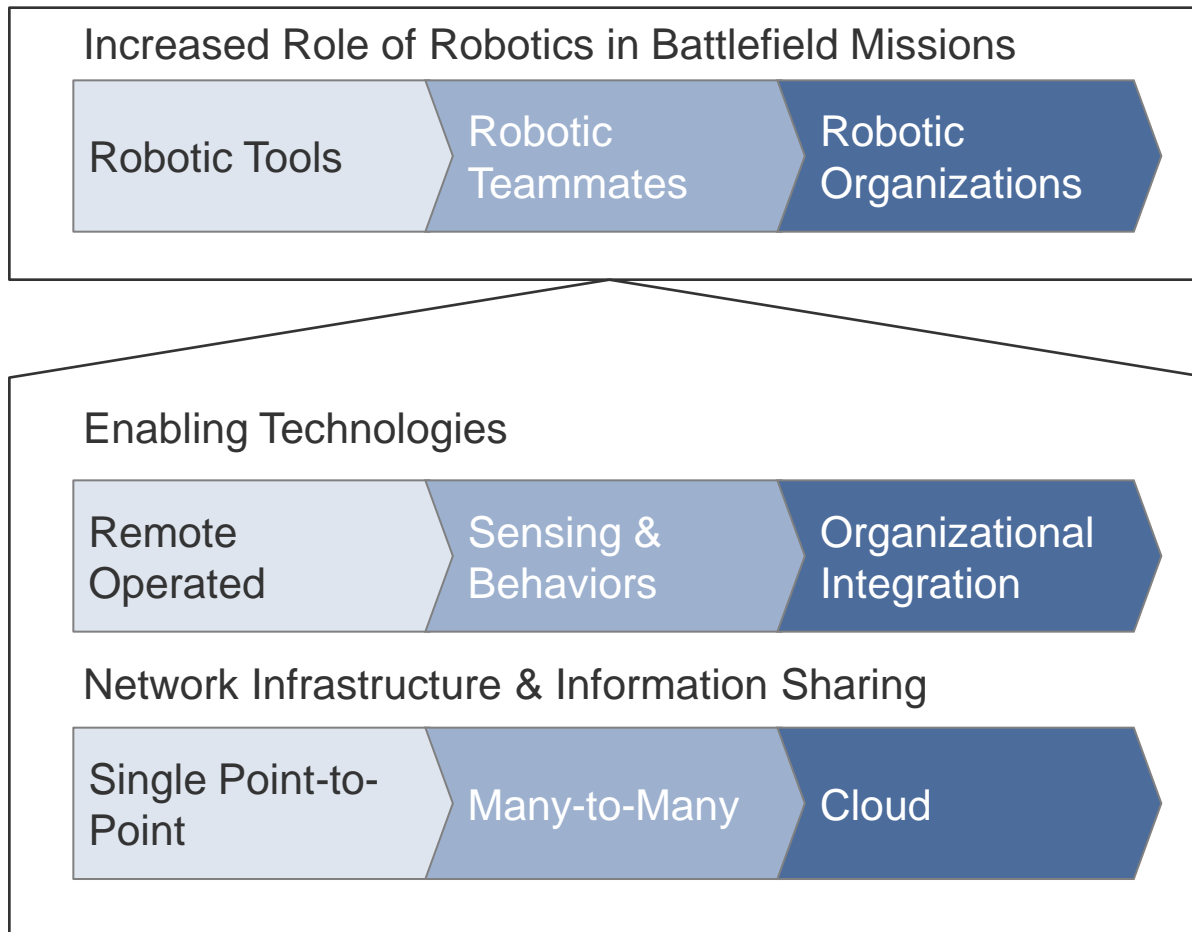

Today's controller and OCU.

iRobot

- Autonomy
- 80 : 20
- 20 : 80
- EOD → Infantry

iRobot

High-Tech Marketing Illusion

The Revised Technology Adoption Life Cycle

Innovators · Early Adopters · Early Majority · Late Majority · Laggards

"Crossing the Chasm" by G. Moore, Harper Business Essentials

iRobot

Technology Advances Will Grow Role Of Robots

Increased Role of Robotics in Battlefield Missions

| Robotic Tools | Robotic Teammates | Robotic Organizations |

Enabling Technologies

| Remote Operated | Sensing & Behaviors | Organizational Integration |

Network Infrastructure & Information Sharing

| Single Point-to-Point | Many-to-Many | Cloud |

- Today
- Next Horizon (5+ years).
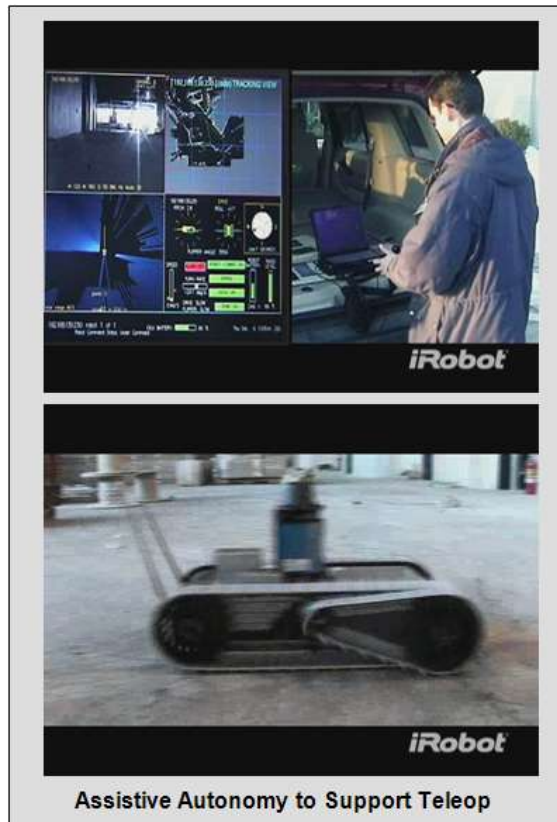- Horizon After Next (10+ years).

iRobot

Next Time Horizon – Robotic Teammates

- 5+ years.
- Limited scope autonomy or semi-autonomous operations.
- Move away from dedicated operators.

Limited Scope Autonomy Makes Robots Force Multipliers

iRobot

Progression and Enabling Technologies

Mapping, Localization, Navigation

Assistive Autonomy to Support Teleop

Person Following and Gesture Understanding

- Localization, mapping, navigation.
- Assistive autonomy.
- Natural language, gesture, and speech.
- Information sharing between humans and robots.
- Advanced power and power management.
- Encoding of basic TTPs.
- Basic team behaviors.

Fuel Cell Powered PackBot

iRobot FasTac - Camera Follows Gripper Autonomously

Enabling Technologies, Networks, Information Sharing

- Everything and everyone connected to the network.

- Real time sharing of information at many levels of abstraction – data, decisions, conclusions, hypothesis, etc. Human C&C will also have evolved.

- On the robots -- mission-level autonomy – not just encoding TTPs but equipping robots with ability to plan to achieve goals.

- Sophisticated perception and understanding algorithms enable robots to understand much of the world around them.

- Collective learning so robot performance improves with experience and learning is shared between robots via network.

- Long duration power sources plus power scavenging and generation.

- Combining intelligence on the robot with intelligence that is "in the network."
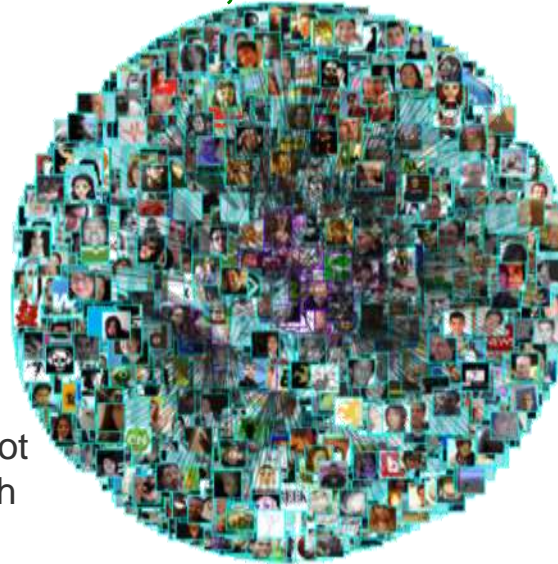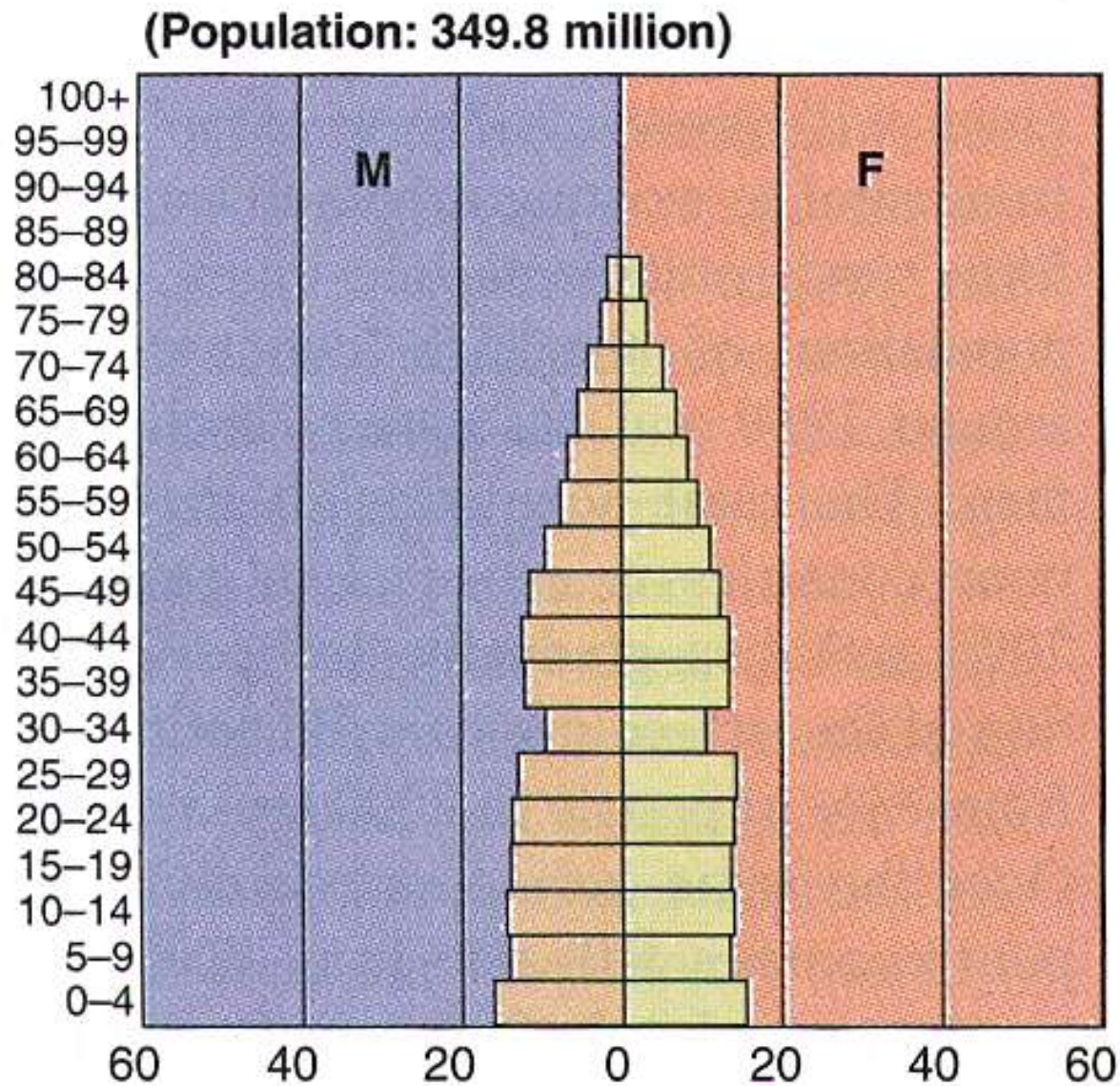

Sharing information at many levels of abstraction.

Everything networked.

Smarter and more immersive C&C tools.

Robotic power scavenging.

The Robot Industry

Mowing

Mop

Security

Vac

Home

UUV

UGV

Military

UAV

Industrial cleaning

Wet

Dry

Toys

Robots

Farming

Hospital

Long term care

Health

Home care

Energy & Utility

Mining

Oil & Gas

Construction

iRobot®

Europe - 1950

(Population: 349.8 million)

Europe - 2000

(Population: 451.4 million)

iRobot

Europe - 2050

(Population: 401 million)
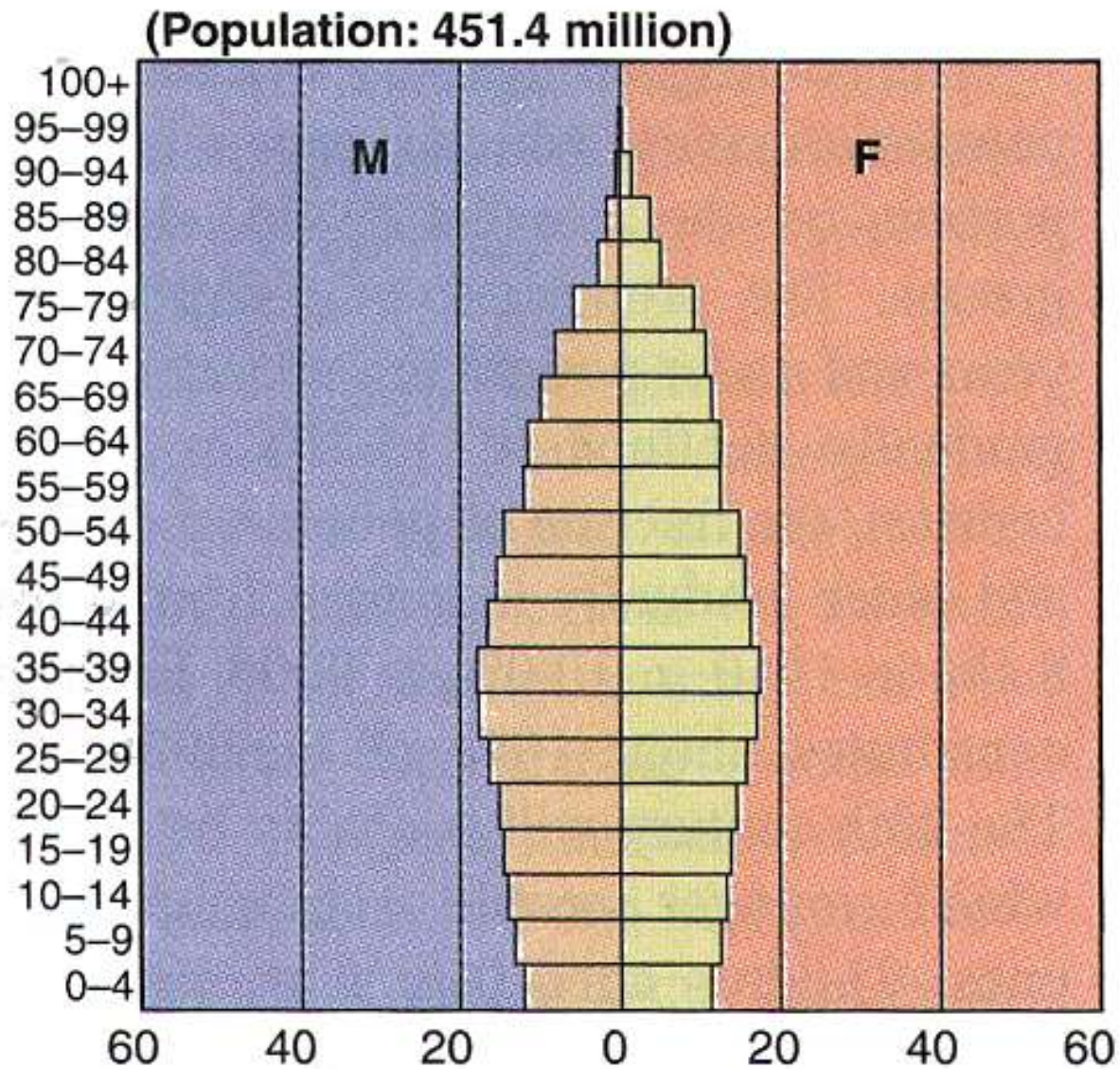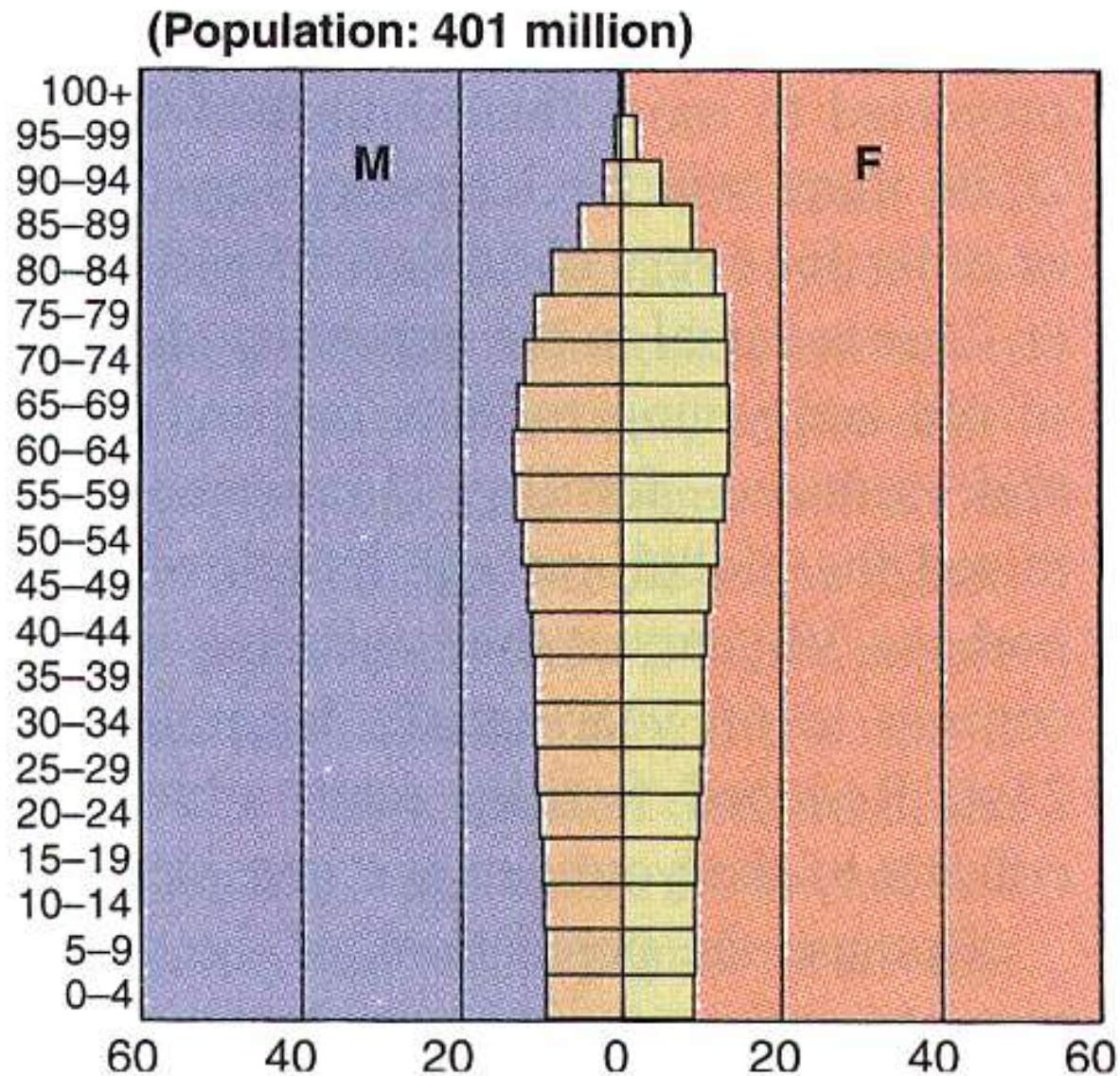
Our Healthcare Robots Scope Statement

Add a million years of
 independent healthy
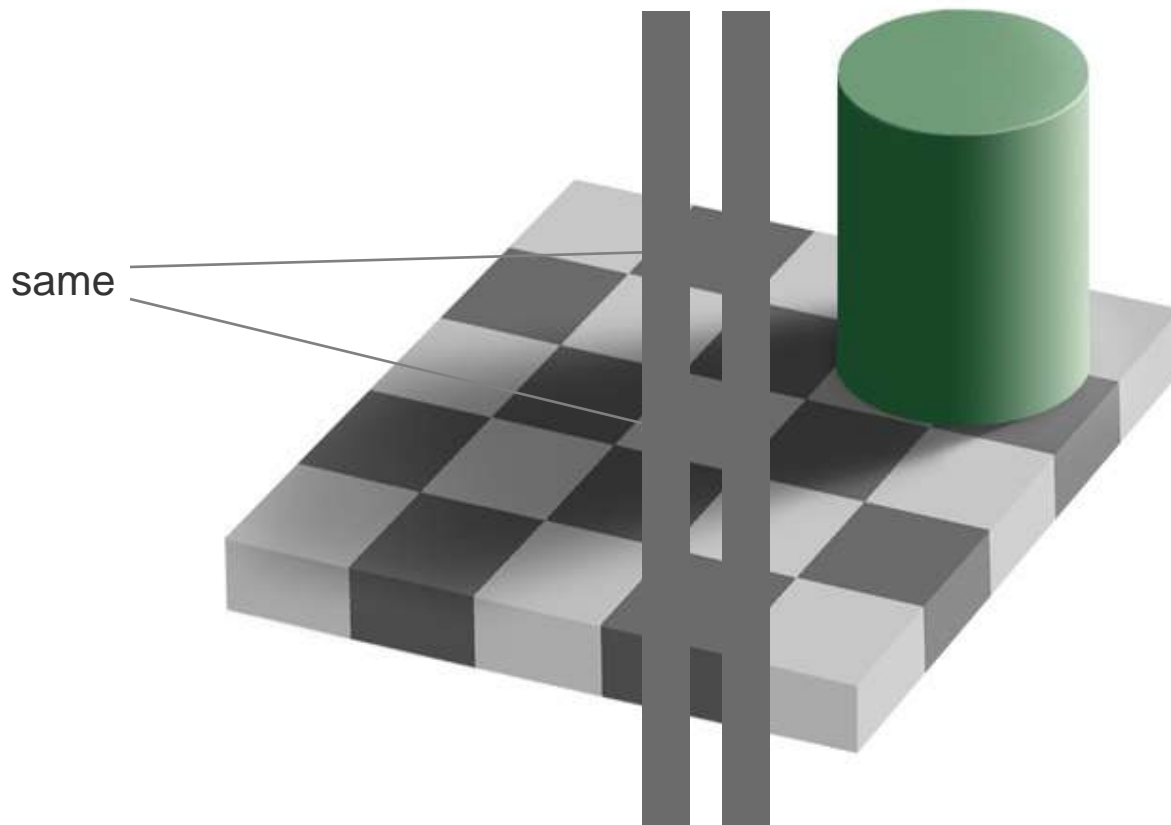 living for our customers.

iRobot

"Robot Enabled" Care

- Enablers
  - Robots
  - The Network
  - Cloud-based applications
- Pros
  - Access to most specifically qualified Doctors and tools
  - Leverages Dr's time
  - Easier to monitor quality of care
  - Leverages Patient's home and caregivers
  - Patient can usually stay put
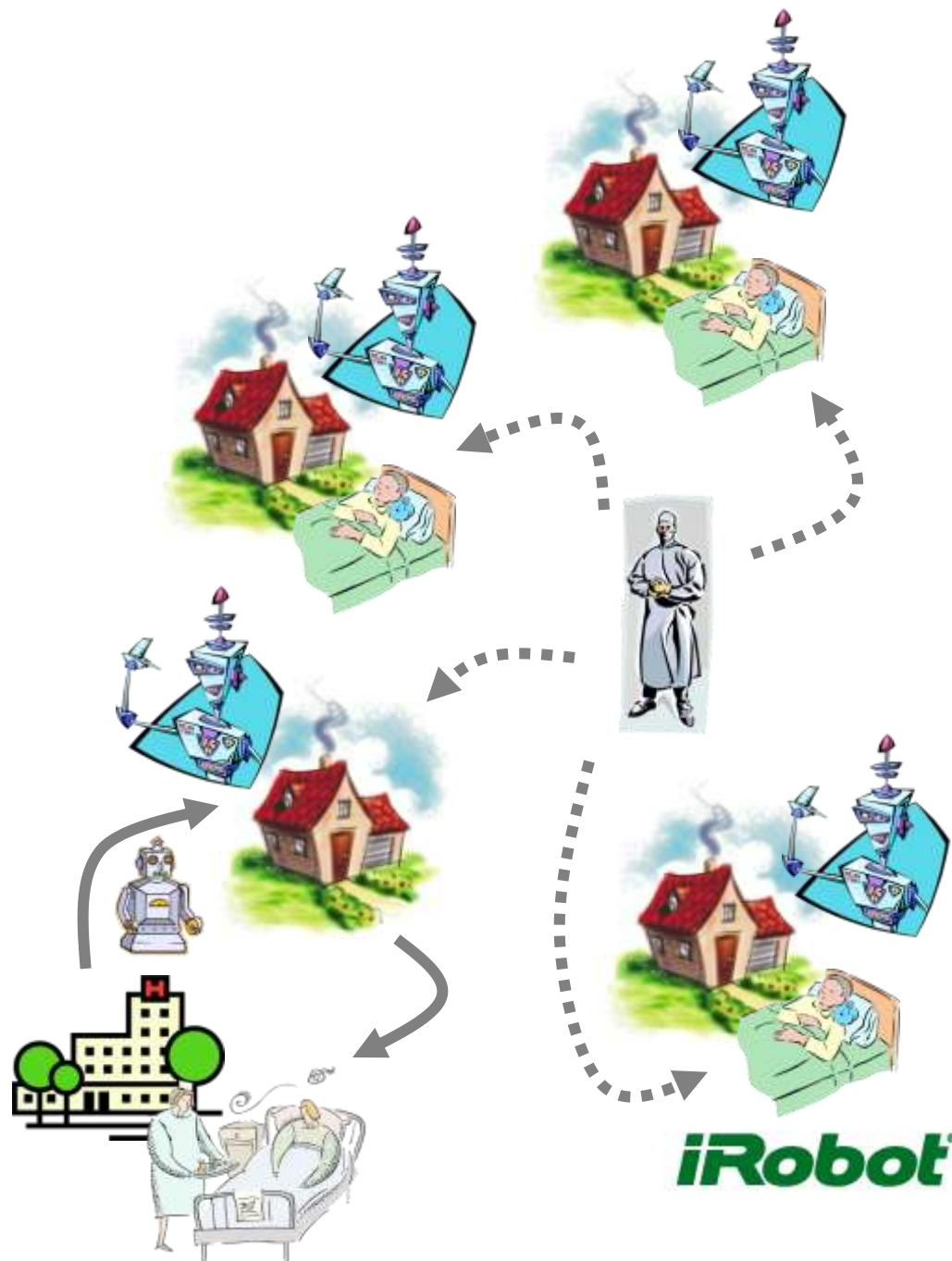
iRobot

The Checkerboard Illusion

same

Here, the human visual system infers the color of the checks in the world, not the gray value in the image.

The illusion reflects the successful design of the visual system, not a quirky failure.

iRobot

Thank You

jdyer@irobot.com

Cell: 410-610-2935

iRobot®