Healthcare for Organizations Using Wearable Sensors and Feedback System to Energize Workers

# Koji ARA Advanced Research Laboratory Hitachi, Ltd.

# Outline

#### Background

- Business Microscope
  - Technology
  - Data analysis : Science of human nature
  - Integrating in business process
- Next challenges

# "1cc Computers": Impact on Our Daily Life

- Miniaturization: x 1/100 every 10 years ... Wearable
- Long battery life: low power, self-charging ... Continuous sensing 24 hours/365 days



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# Problems organizations have

Difficulties in communication
 1) Delayed project status reports
 2) Inaccurate information
 3) Limited information
 4) No standard to judge communication sufficiency

#### Problems

- a) Delays in attaining consensus
- b) Misunderstood specifications
- c) Failure in knowledge transfer
- d) Cognitive stress



# Similar problems repeatedly occur due to lack of technology. © Hitachi, Ltd. 2011. All rights reserved.

# Business Microscope (R)

Visualize "real" communication in organization
 Solve problems by combining technology, science of human nature, and knowledge of business process.



## Business Microscope "Hi-badge"



Sensor	Data
Infra-red	Interaction (3 m, 180 degree)
Acceleration	Motion rhythm

#### Usage

(1) Morning: take badge from battery charger and wear it

(2) Evening: recharge battery

Data becomes available next day through public-display and website.

# **Communication network**



# **Communication network**



### Feedback at individual level

#### Amount of communication with colleagues and time usage



### Visualizing effect of management

- •Two groups were combined for improved productivity.
- •Several workshops were conducted for improving number of steps in network.



# **Communications in Organization**

Coverage of face-to-face detection determined on basis of typical communication postures



Device should capture communication within 60 degrees in 3 m.

# **Placement of IR-modules**

- Equipping 1 IR-module not enough to detect 60 degrees.
- Power consumption increases by installing 4 IR (battery life: 5 hours)









# Synchronization of sensor nodes

- Each node adjusts timestamp under 10ms accuracy by using internal counter during synchronization process.
- Working time of IR-module minimized without losing detection rates of other badges.



# **Power consumption**

#### Original version



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# **Power consumption**

#### Synchronized version (Beam Scan Node)



# **Power consumption**



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Science of human nature and organizational behavior

Why are software projects always delayed?

Why do functional silos exist?

Why does mental illness occur?

Why does bankruptcy occurs?

Researchers have began to investigate these questions with real behavioral data.

# Database of organizational behavior

### Data collected from various organizations.

Accumulated data



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### •Type of organization

Target organization/job function	# Of
	subjects
Think tank/research	75
Bank/planning	23
IT developer/sales support	37
Hospital/nurse	32
IT developer/development	60
Design/researcher	170
IT developer/customer support	30
IT development/HR management	40
Research laboratory/research	70
Social infrastructure/planning	30
University/student class study	160
University/leadership training	60
Office equipment/sales and development	83
IT developer/software development	30
Research laboratory/HR management	29
IT developer/software development	30
IT developer/software development	125
IT developer/software development	416
Research laboratory/research	500
IT developer/software development	1500
IT developer/software development	430

# Analysis of mental stress within organization

Stress level, potential risk of depression, in software firm



Communication network

Difference in personality with "network neighbors" the most significant predictor of stress level.

- 2<sup>nd</sup> predictor: personality (neuroticism)
- 3<sup>rd</sup> predictor: number of working hours © Hitachi, Ltd. 2011. All rights reserved.

# Using behavioral data in real organization

- Experiment was conducted in software development firm to evaluate behavior-sensing and feedback (65 workers, 10 weeks)
- ■Key questions
  - (1) Relationship between performance and behavior
  - "Does more communication really improve performance?"
    - (a) Performance of manager: employee evaluation
    - (b) Performance of developer: quality of development
  - (2) Effective project management process with sensor data

# Data analysis

#### •Performance parameters

#	Parameter	Detail
1	Employee	Top managers rated all
	evaluation	workers on scale from
		one to five on basis of
		their capabilities.
2	Quality of	Quality of individual
	developm	worker's product, i.e.
	ent	number of bug reports

### Personality features

#	Category	Feature
1	Big five	Extraversion,
	traits	agreeableness,
		conscientiousness,
		emotional stability, and
		openness

#### •Behavioral features

#	Category	Feature
1	Network	Degree
2		Cohesion
3		Distance
4	Commun	Amount of communication
5	ication	Active communication
6		Non-active communication
7		Communication ratio
8		Active communication ratio
9	Activity	Amount of work
10		Amount of solo work
11		Amount of concentration
12		Amount of non-concentration
13	Neighbor	1-step average
14		1-step deviation
15		2-step average
16		2-step deviation

### Analysis of manager's behavior

- (a) Amount of communication weakly correlates with performance (r=0.41, p<0.05). Throughout interview with managers, managers assumed to often visit customers and communicate a lot outside office.
- (b) Communication ratio (i.e., time spent in communication  $\div$  working hours in one's office ) strongest predictor of high-performance managers (r=0.67, p<0.01).



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### Analysis of manager's behavior

- (a) Communication richness (communicating a lot with many workers)
- (b) Amount of work outside office (visiting customers and other stakeholders).



### **Behavior monitoring**

Behavior data fluctuate under problematic unplanned events (changing specification) and regular planned events (project reviews).



### Behavior-based project management

Practical process was developed using knowledge of project.



### Behavior-based project management

■Sensor helps to accelerate current management cycle from monthly to weekly- or daily-basis.



Target organization determined to increase number of subjects for better productivity.

# Summary

- Business Microscope is developed to capture behaviors within organization and accelerate business process.
- Integrating technology, science of human nature, and business process is key to successfully creating practical technology.

# **Next Challenges**

 Measuring social behavior to learn about society
 MIT is deploying hundreds of phones to analyze peoples' behavior. Companies are sponsoring to improve their service.
 (1) Behaviors in office, home, and on transportation.
 (2) Physical and on-line behavior.

### System for large amount of wearers (\*)

\* If data keep increasing (3 times / year), 50 M reached by 2015.
(1) Compression and degeneracy of network & movement data
(2) Error detection, re-programmability