

# Optimizing Hospital Layout:

## *Big Data Analysis of Staff Movement*

HCD  
HEALTHCARE DESIGN  
EXPO+CONFERENCE

Houston TX, USA  
November 13, 2016



# Let Us Introduce Ourselves

## Collaboration from USA, Denmark, and Japan



***Good Morning!***



**Joel Hill**  
Hitachi Consulting



***Godmorgen!***



**Claes Brylle Hallqvist**  
Bispebjerg Hospital



***Ohayou  
Gozaimasu!***



**Shigeyuki Tani**  
Hitachi Research

# Our Colleagues



**Hitachi Consulting**

We make it happen. Better.

Adrian Conduit  
Ludvig Marnell  
Mark Clewett  
Paul Watson

**HITACHI**  
Inspire the Next

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Toshimitsu Aritake  
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**Bispebjerg og Frederiksberg  
Hospital**

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Johan Reventlow



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**Bispebjerg og Frederiksberg  
Hospital**

**HITACHI**  
Inspire the Next

# Today's Presentation

Business Background for the Movement Study

The Approach for Conducting the Movement Study

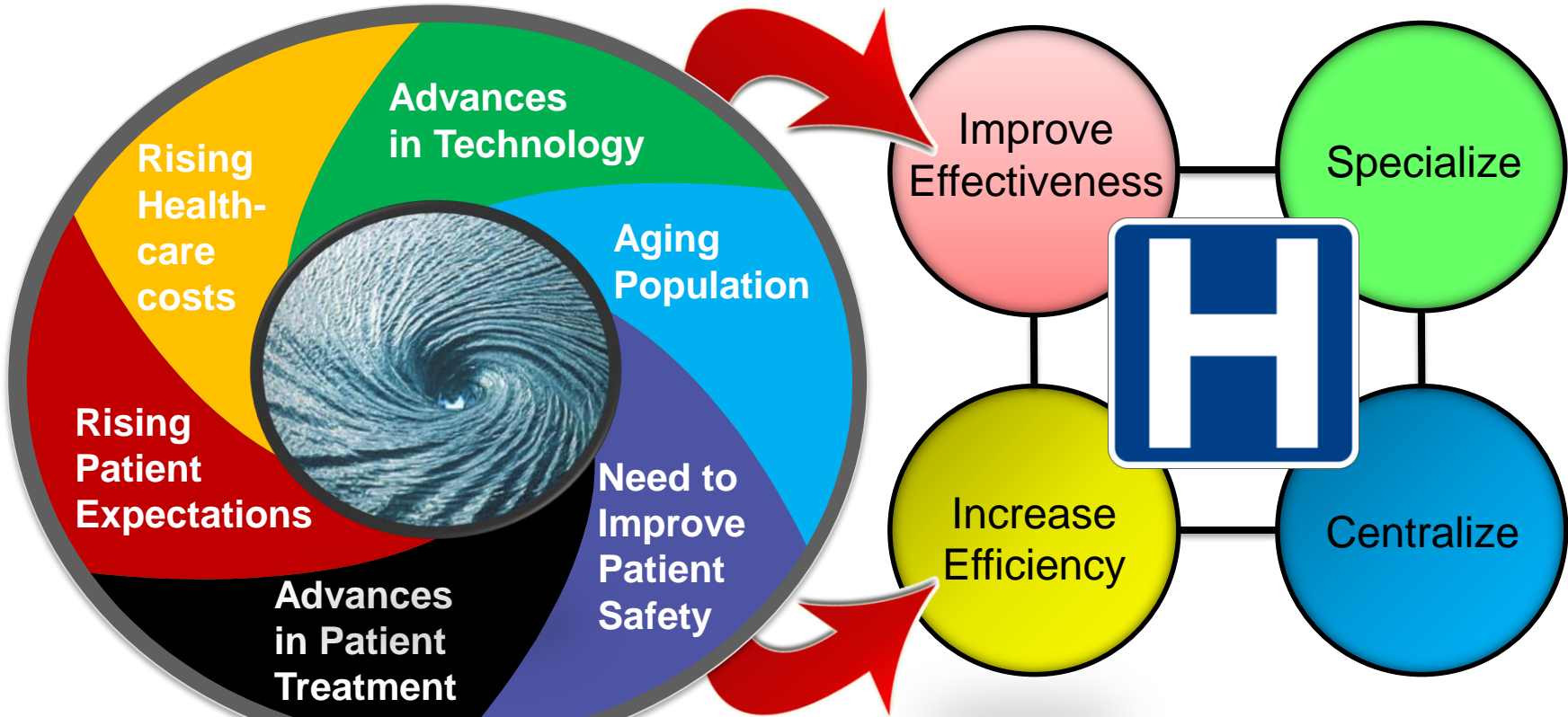
Collecting and Analyzing the Data

The Results of the Study

Q & A

# Business Background for the Movement Study

# Rapid Changes are Challenging Denmark to Transform how Healthcare is Provided



# Super Hospital Program

€ 6,0 billion Healthcare Transformation Program

Government



€ 3,6 billion

€ 6 billion budget - 16 building projects



Regions



€ 2,4 billion

20 per cent of budget reserved  
for investments in ICT and  
medico-technical devices

## IMPROVED

- Patient flow
- Patient safety
- Efficiency
- Quality



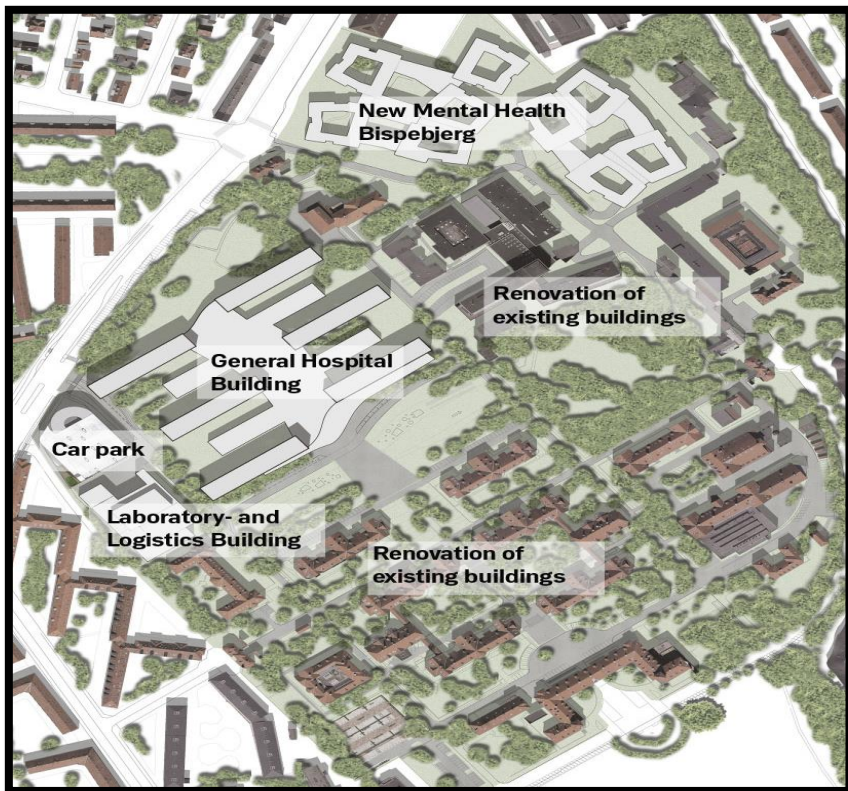
## Expected Improvements 2007-2020

- Reduce average bed days from 3.5 to 2.9
- Reduce number of beds 20%
- 50% increase in outpatient treatment

Source: The Danish Ministry of Health



# The Future Bispebjerg Hospital and Mental Health Center



## Total Square Meters Upon Completion in 2025

**General Hospital Total:** **98,000 Sq m**  
Construction 66,000 Sq m  
Renovation 32,000 Sq m

**Mental Health Total:** **49,000 Sq m**  
Construction 24,000 Sq m  
Renovation 25,000 Sq m

**Grand Total:** **147,000 Sq m**  
Construction 90,000 Sq m  
Renovation 57,000 Sq m

**Garage Parking:** 975 cars



# Bispebjerg “City of Tomorrow” Health District

## Patient & Families

- Continuous contact
- Patient confidence
- Informed patient
- Patient involvement and self-reliance

## Campus & Buildings

- Healing architecture
- Green & climate friendly
- New + Preserved
- Integrated with City

## STRATEGIC THEMES

## Hospital Employees

- Work environment
- Well-being
- Satisfaction

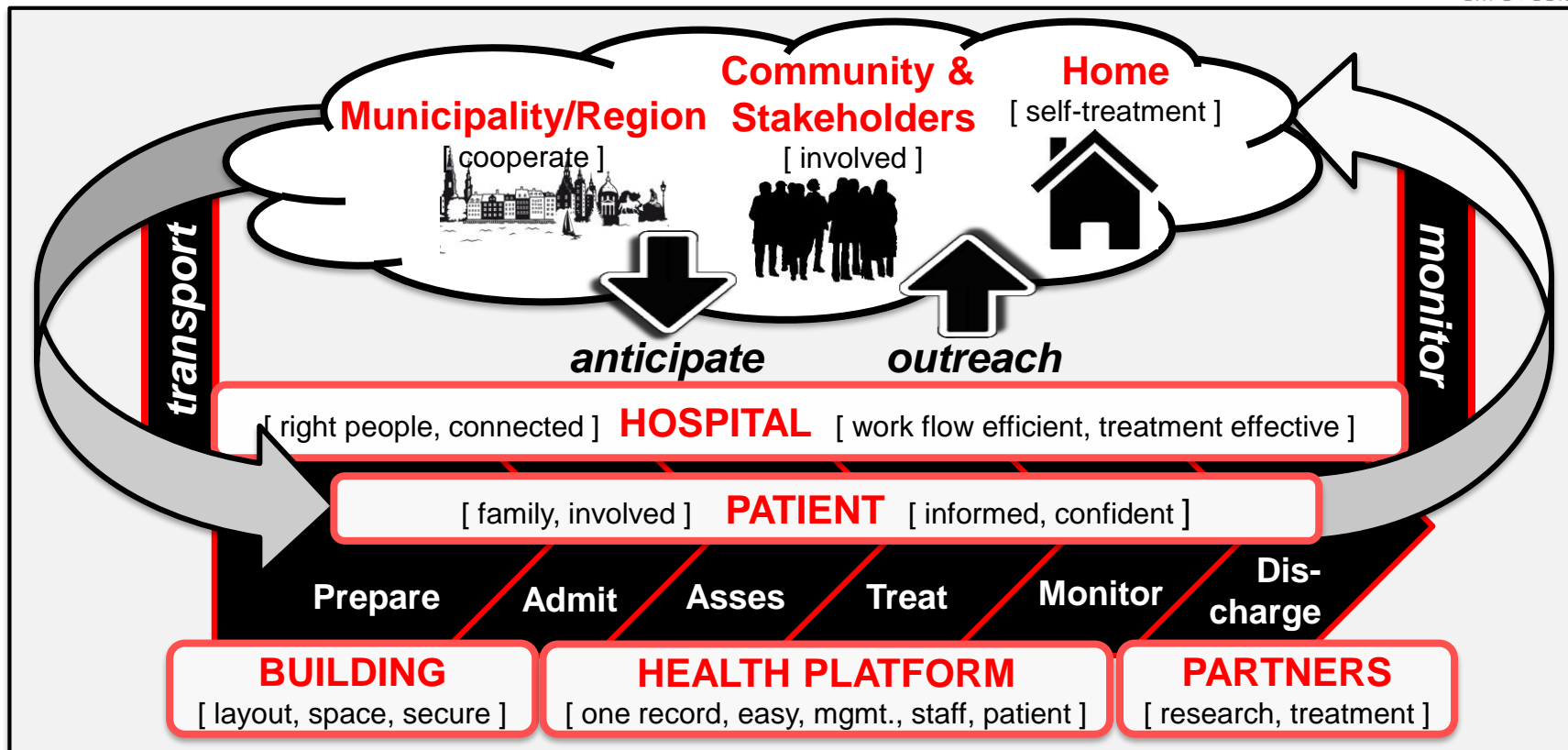
## Community

- Stakeholders
- Research partners
- Business opportunities
- Citizens

## Continuous Improvement

- Focus & simplify
- Process effectiveness
- Treatment effectiveness
- Data-driven management

# Movement Tracking & Analysis is Critical



# Hitachi & Bispebjerg Hospital

## Joint Development Agreement – November, 2014



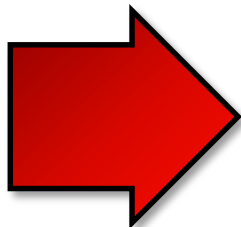
# The Approach for Conducting the Movement Study

# Movement Analysis Study Mission

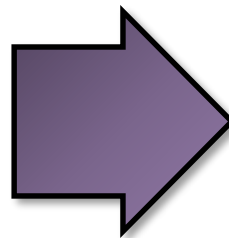
Building Grant for New Hospital Required 7% Efficiency Improvement

80%

of hospital expense



Walkin



Reduce



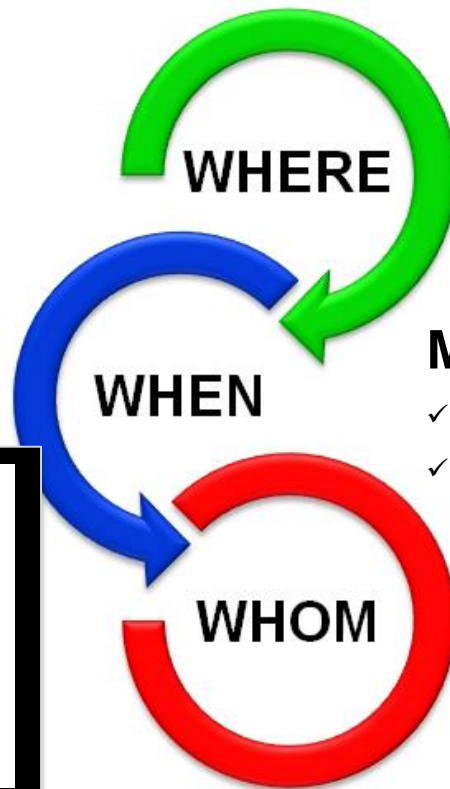
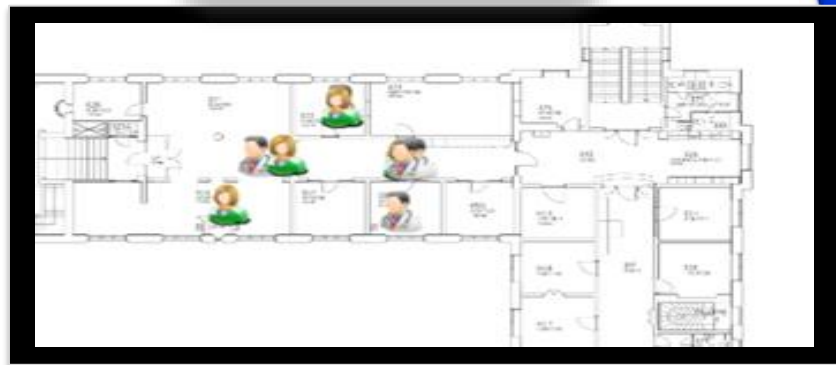
20 fewer steps per staff member  
per day = DKK 1,000,000 per  
year savings\*

Benefits



\* Source: "Bispebjerg Hospital: Data Driven Building Layout"  
– Capital Region of Denmark

# Where, When, & Whom to Track



## Four Departments

- ✓ Emergency Department,
- ✓ Intensive Care Unit
- ✓ Bed Ward
- ✓ Radiology Department

## Monday-Friday



- ✓ 8:30 AM-3:00 PM
- ✓ for an average of four weeks

## Hospital Staff

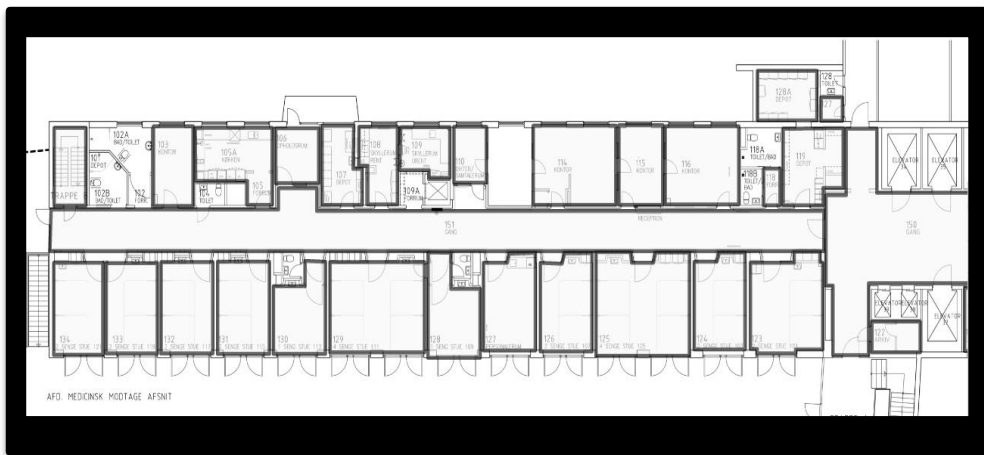
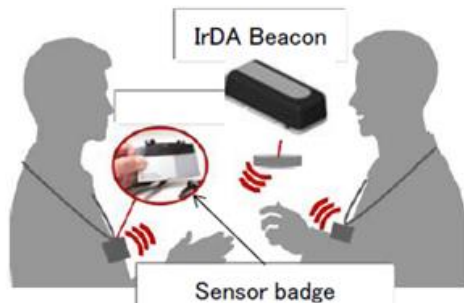
- ✓ Doctors, nurses
- ✓ Assistants, porters
- ✓ Secretaries



# Different Set Up Required for Two Real Time Location Systems (RTLS)

	<div>1</div> <div><b>Hitachi Business Microscope</b></div> <div><i>WEARABLE SENSOR</i></div> <div></div>	<div>2</div> <div><b>Wi-Fi Network Device</b></div> <div><i>WRISTBAND DEVICE</i></div> <div></div>
PROS	<ul style="list-style-type: none"><li>• Easy to set up for smaller areas e.g., a ward or department.</li><li>• Measures intergroup communication (person-to-person contact)</li></ul>	<ul style="list-style-type: none"><li>• Full coverage of the entire site.</li><li>• Can track anything with a Wi-Fi transmitter (e.g., tag, cell phone, medical equipment).</li><li>• On line system (continuous upload of data)</li></ul>
ALSO	<ul style="list-style-type: none"><li>• Staff needs to wear a special badge.</li><li>• Off line system (batch upload of data).</li><li>• Need to deploy beacons.</li></ul>	<ul style="list-style-type: none"><li>• Special SW required for Wi-Fi controller.</li><li>• Expensive license structure.</li><li>• Calibration of every building at the site.</li></ul>

# Building Divided into Smaller Zones



Face to  
Face  
interaction



Who met?  
When? How  
long?

Body  
Movement



Active / Non-  
Active

Location



Room, within  
room, duration

# Collecting and Analyzing the Data

# The Data Tracked by Each RTLS

1

## Hitachi Business Microscope

### *WEARABLE SENSOR*



- Who, where and when (X:Y coordinates of the beacon)
- Speaking, and with whom.
- Position calculated from combination of beacons & other Business Microscope badges.

2

## Wi-Fi Network Device


### *WRISTBAND DEVICE*



- Who, where and when (X:Y coordinates)
- Position calculated from Wi-Fi base stations.

# Human Business Microscope Data Analysis

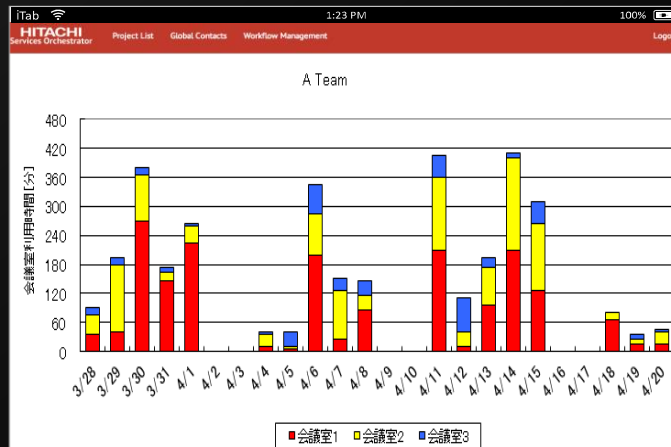
## People Interaction



対面マトリクス【キーパーソン間】

	部長	岡田	森本	伊藤	鈴木	高橋	柴田	佐藤	竹原	合計
	01	02	02	03	03	04	04	05	05	分
部長	01	0	120	60	50	20	13	90	150	703
岡田	02	120	0	88	0	8	50	31	140	454
森本	02	60	88	0	8	3	321	66	44	848
伊藤	03	50	0	8	0	15	0	12	1	88
鈴木	03	20	8	3	15	0	3	14	1	79
高橋	04	13	50	321	0	3	0	232	13	712
柴田	04	90	31	66	12	14	232	0	77	660
佐藤	05	150	140	44	1	1	13	77	0	756
竹原	05	200	17	258	2	15	80	138	330	1040

## Room Analysis



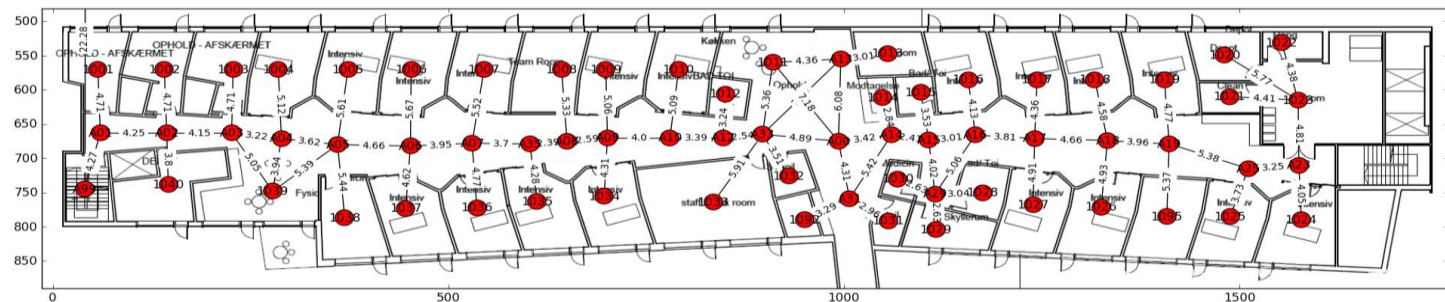
# Modeling the Hospital Ward

## Sample Assumptions and Constraints

- The optimisation is for one "wing" on one floor of the new building.
- Distance between two rooms is shortest distance in the network shown below.
- Distance between two adjacent points is calculated using Euclidean distances

- AGV and relatives toilet have fixed location.
- Reception must be located in one of four rooms closest to the entrance for security reasons.
- There are no constraints on bed room location.
- Wash rooms do not need to be adjacent.

### Distance Between Rooms



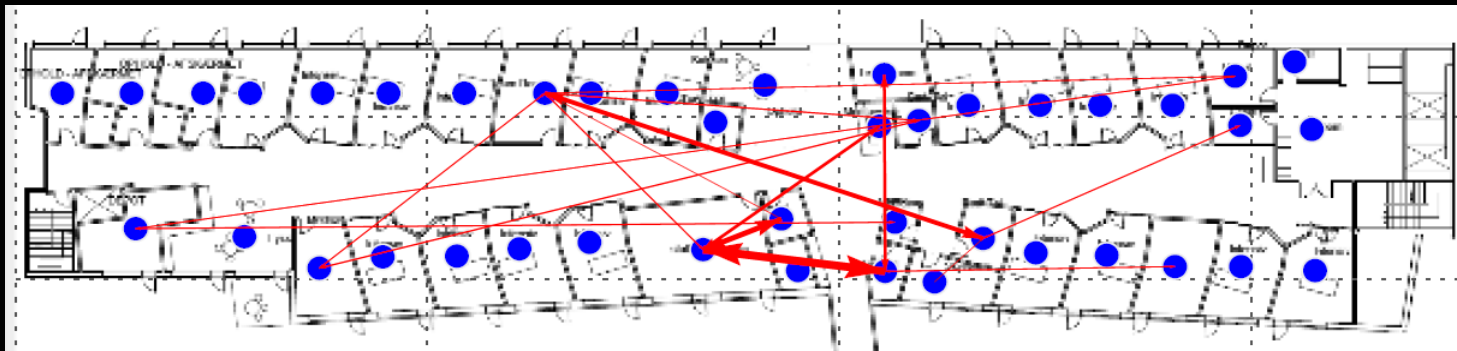


# Modeling Staff Movement

## Sample Assumptions

- The ratio of staff is the same in the new hospital as in the data collected for ICU.
- Corridor is only used for transit.
- Movement to and from other departments is disregarded.
- There is no distinction between different rooms with same functional assignment.
- The three depots retain their individual characteristics.

### 30 Strongest Connections



# Minimization of Staff Walking Distance

$\square \square \square \ddot{\square} \square \square \square \square$

## Where

- $\square$  is the number of transitions between facility  $\square$  and  $\square$
- $\square$  is the distance between room  $\square$  and  $\square$
- $\square = \square$  if facility  $\square$  is assigned to room  $\square$ , otherwise 0



# The Results of the Study

# Significant Benefits Uncovered

Walking Distance Reductions	% Reduction
Intensive Care Unit	12
Bed Ward	12
Emergency Department	5
Radiology	12



**20 fewer steps per  
staff member per  
day = DKK  
1,000,000 per year  
savings\***

\* Source: “Bispebjerg Hospital: Data Driven Building Layout”  
– Capital Region of Denmark

# Updated Blueprints of the Bed Wards

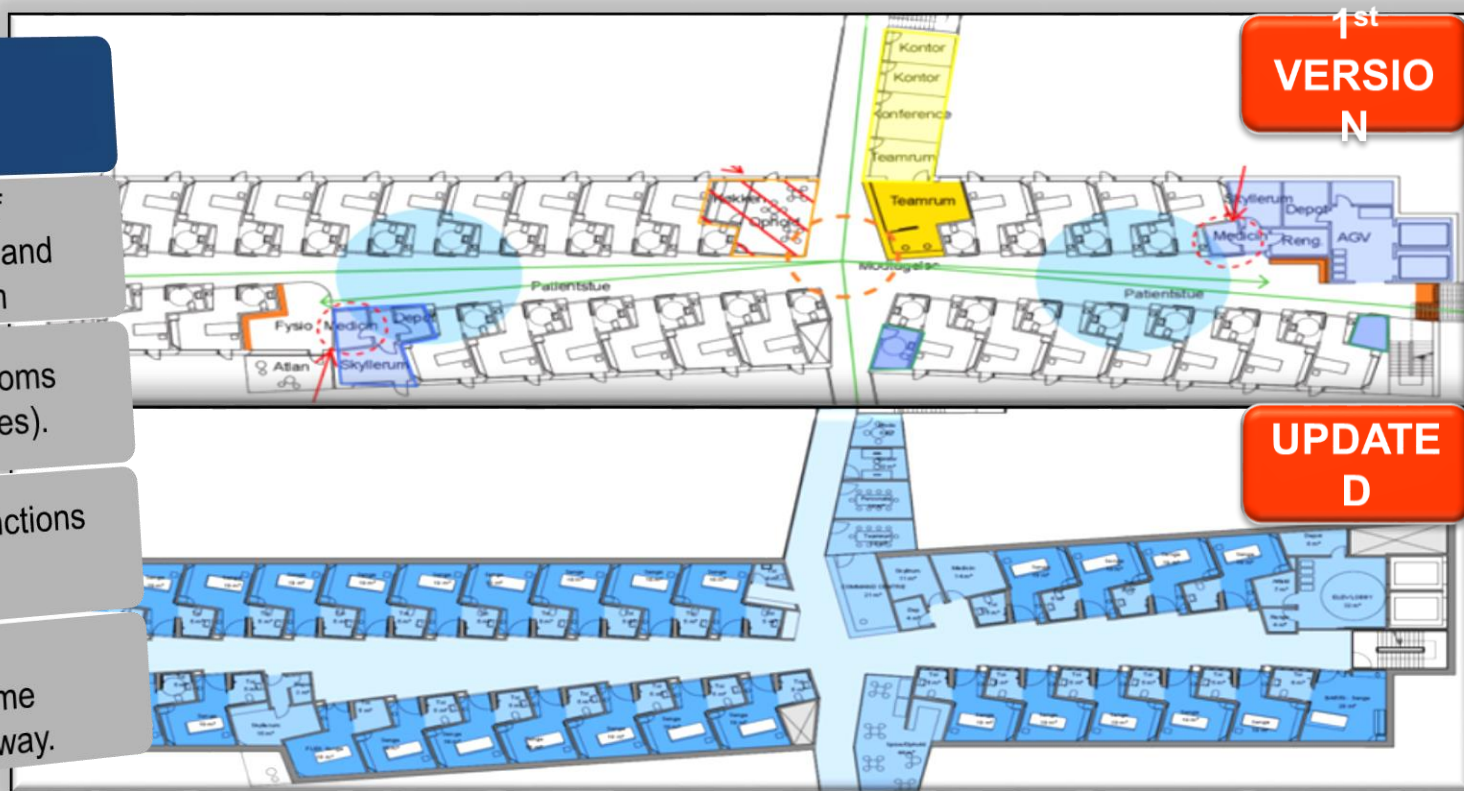
## New Insights

Placement of staff  
toilets, staff room and  
coordination room

Case on wash rooms  
(disposable utilities).

Focus on the functions  
in rooms.

Adjacent/linked  
functions on same  
side of the hall way.



# Optimized IC Unit

New  
Insights

Coordination room  
placed centrally

Central functions  
like offices and  
kitchen placed  
around  
coordination room.

BEFORE



AFTER



## Legend

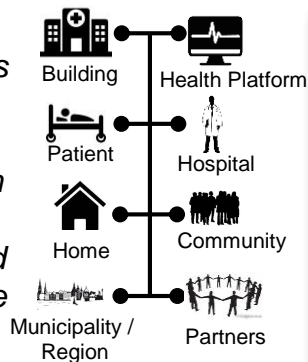
Shielded staying room
Bedroom
Sitting area/ Staff room / Kitchen
Offices
Wash rooms
Command Centre / Reception
Depot / Medicine room
Physiotherapy / AGV
Toilets / Copy room



# NEXT: IoT + Big Data combined to collect and analyse data to improve operational outcomes and efficiencies

IoT

Sensors and cloud platforms providing low-cost data gathering from diverse healthcare and non-healthcare environments.



Big Data

Advanced data management and analytics applied to discover enhanced insights that can be acted upon



APPLIED

## CAPITAL REGION MISSION & OBJECTIVES FOR HEALTHCARE



### MANAGE PEOPLE

- Patient Pathways
- Wearable Devices
- Diagnostic/imaging



### MANAGE BUILDINGS

- Building Energy Mgt.
- Capacity management
- Safety and security



### MANAGE ASSETS

- Location intelligence
- Medical devices
- Pharmacology

### MANAGE HEALTHCARE

- Care quality outcomes
- Energy & infrastructure
- Mobility & efficiency



RESEARCH

EDUCATION

INNOVATION

GROWTH

***Thank you!***

***Tak!***

***Arigatou  
gozaimasu!***



 **Hitachi Consulting**  
We make it happen. Better.



 **Bispebjerg og Frederiksberg  
Hospital**



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# Contact Information and Additional Reading



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## Bispebjerg Hospital

- <https://www.bispebjerghospital.dk/nythospital/nyt-og-presse/nyheder/2016/Sider/Sporing-af-medarbejdere-giver-smartere-indretning.aspx>

## Analysis of Hospital Staff Movement

- Email Shigeyuki Tani for articles

## Hitachi Business Microscope

- <http://www.hitachi.com/New/cnews/month/2015/02/150209.html>

# Continuing Education Information

## Architects - 23 Credit Hours available

Have your conference badge scanned by the room monitor at the start of each session you attend.

Complete the AIA verification form (be sure to check off the sessions you attend) and retain it for your records. CE credits will be uploaded to the AIA transcript system within 6-8 weeks of the close of the conference.

## Interior Designers - 23 Credit Hours available

- Have your IDCEC verification form STAMPED by the room monitor at the start of each session you attend. This is the ONLY proof of attendance that will be accepted.
- You will self-submit your credits to the IDCEC system at the conclusion of the conference.
- If you have questions about reporting your credits, contact the interior design association that is responsible for monitoring mandatory continuing education to fulfill membership requirements.

## EDAC - 20 Credit Hours available

EDAC – Certified Sessions include: K01, K02, D01, D02, D03, W01, E01, E04, E05, E06, E09, E11, E12, E13, E14, E15, E18, E19, E21, E25, E26, E28, E30, E31, E32, E33, E35, E36, E41, E42, E45, E46, E47, E48, E49, E51, E53, E56, E57, E58, E59, E61, E66, E67, E69, E70, E71, E75, E77, E78, E81, E83, E84, E86, E87, E91, E92, E93, E94, E95, E96, E98, E99, E101, E103, E107, E108, E109, I01, I03, I05, I06, I08, I10, I13, I16, I23, I25

Complete the EDAC verification form and retain it for your records

You will self-submit your CE credits to Castle Worldwide at the time of your EDAC renewal. Renewal notices with login instructions will be sent from Castle Worldwide six months and three months prior to the candidate's renewal date.

The verification form is your proof of attendance in case of an audit.

# Provide Us With Your Feedback!

## Session Evaluation – HCD Mobile App

All session evaluations will be done through the new HCD Mobile App. If you have not done so already please download the app through your device's app store. If you have any questions or need assistance please visit the help desk.

## Individual Session Evaluation Instructions -

1. On the top navigation bar, click the small screen icon
2. Find the session you are attending – they are listed by day, track or type
3. After clicking on an individual session a navigation bar will appear on the left. Click the clipboard icon and evaluation/survey will begin.

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2. **or a comment on Facebook**  
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3. **Tell us something** you've learned or a unique product you've seen at this year's Healthcare Design Expo & Conference.



