

A New R&D Initiative
Strategic Innovation Promotion Program
(SIP)

***"Infrastructure Maintenance, Renovation
and Management"***

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What is infrastructure?

Why does it matter to us?

→ Lifelines: Vital to our social activities



High Economic Growth from 1960s to 1980s



A lot of infrastructure in Japan was developed in a period of high-economic growth from 1960s to 1980s.

Year 1964 (last Tokyo Olympic)

Tokyo Metropolitan Expressway opened.

Operation of the high speed train, or Shinkansen, started also in 1964.



Society changes, but infrastructure remains old.



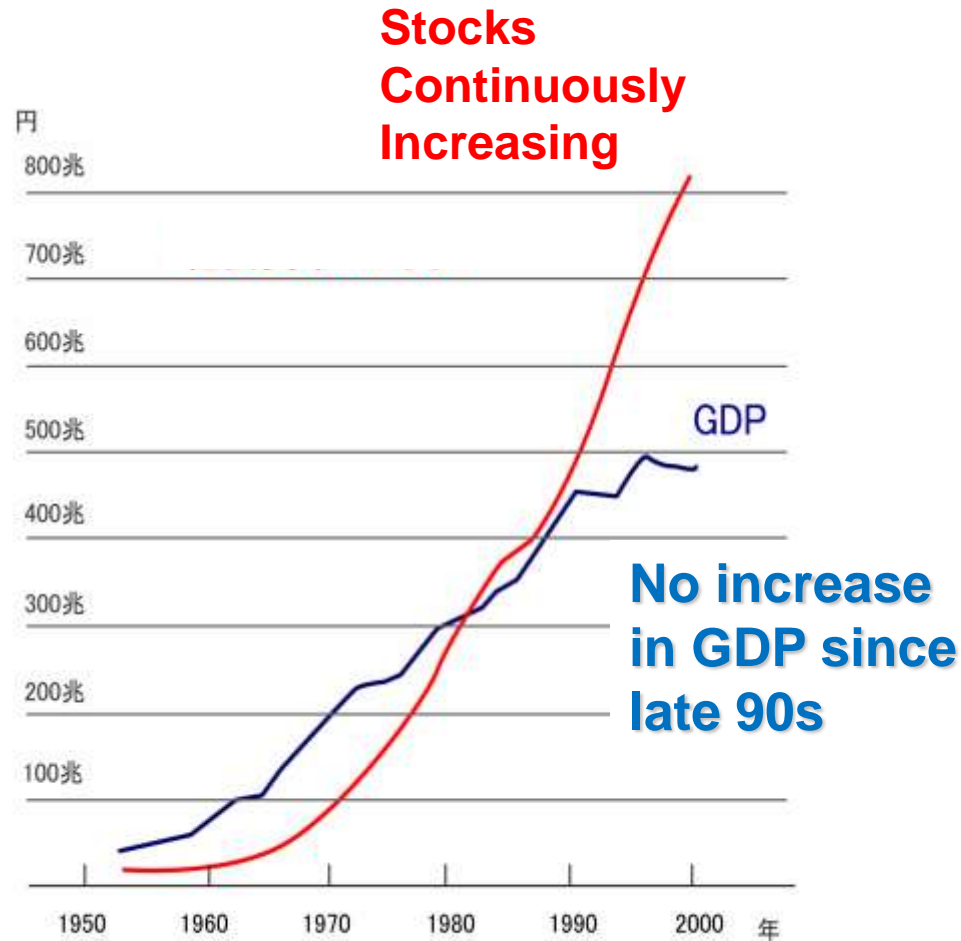
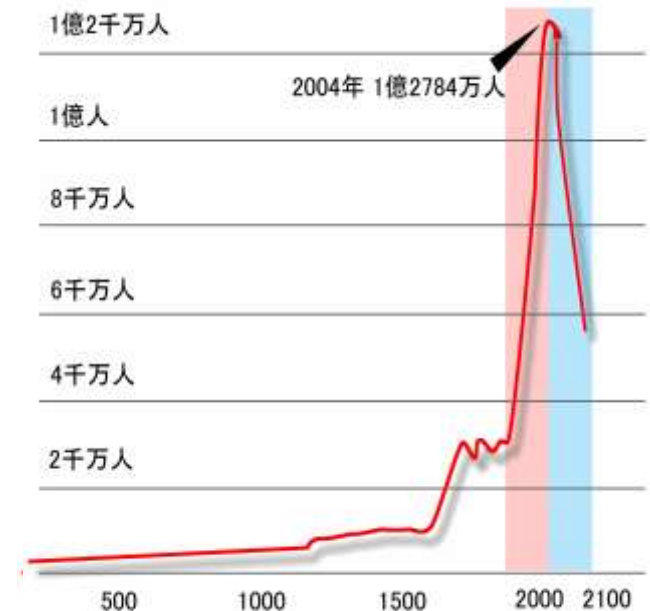
After 50 years, the number of vehicles increased drastically. But, the functional value decreases year by year.

Traffic jam often occurs due to deck repairs. Expressway changes to a “world longest parking lot.”

Japan: Facing a Turning Point

Depopulation!

The peak:
128 million people in 2004
→ Now 125 mil.
→ less than 90 mil. in 2060

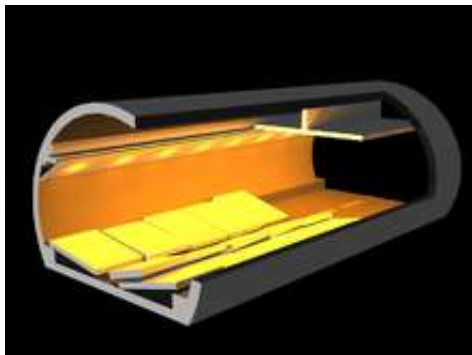


Infrastructure shall be managed under a very limited budget and with limited human resources.

40-year old Highway Tunnel Accident

The ceiling panels suddenly fell down. Several vehicles were crushed and there were 9 fatalities.

The first human-loss accident related to infrastructure maintenance in Japan.



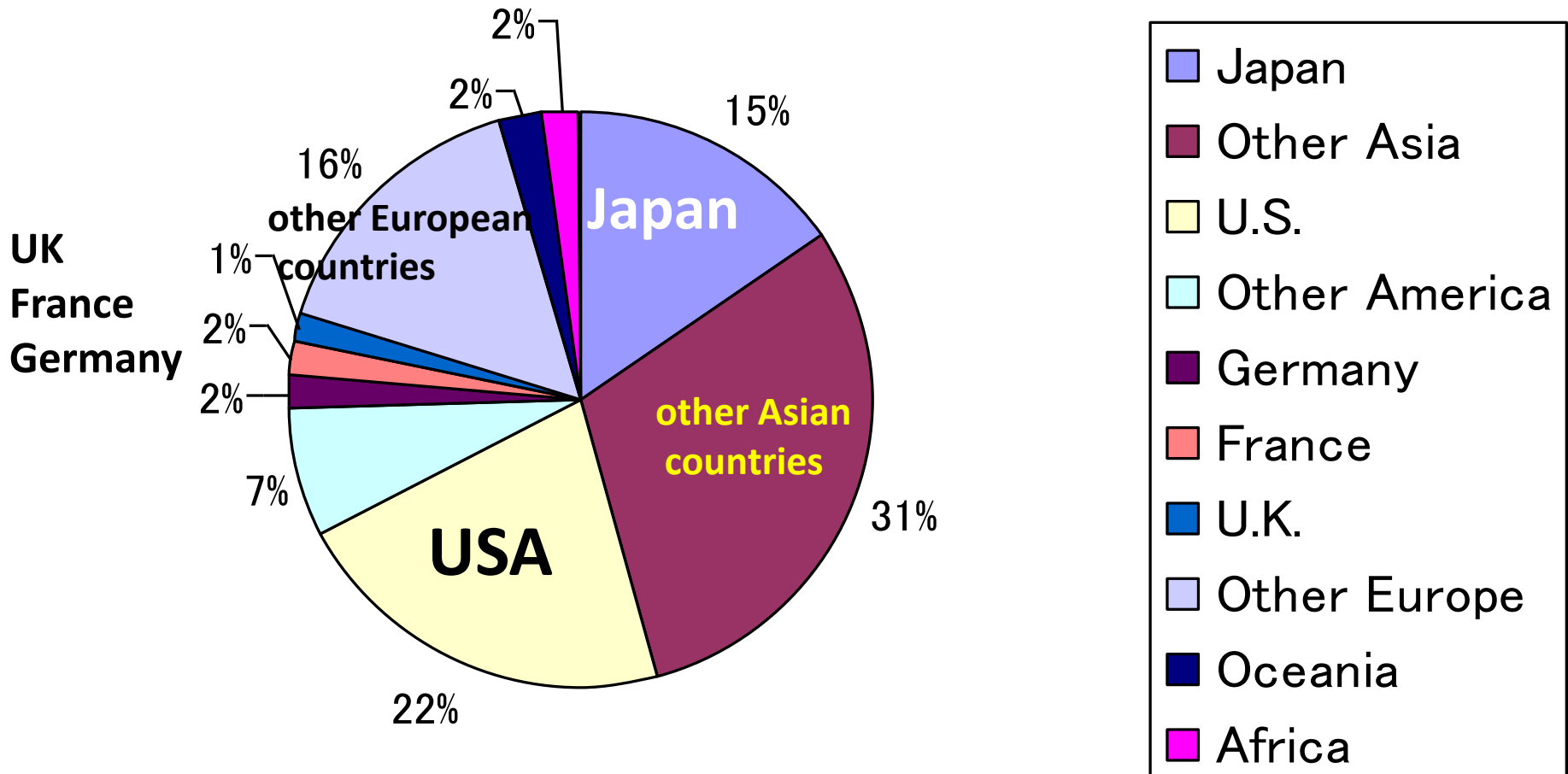
Hands-on visual inspection of infrastructure every 5 years has been compulsory since July 1, 2014

Japan: Living with Natural Disasters

Earthquakes, Tsunamis, Typhoons, Volcano eruptions, Floodings, etc.

Natural-disaster-related losses (from 1970 to 2004)

total=1.1trillion Euro <http://www.cred.be/>

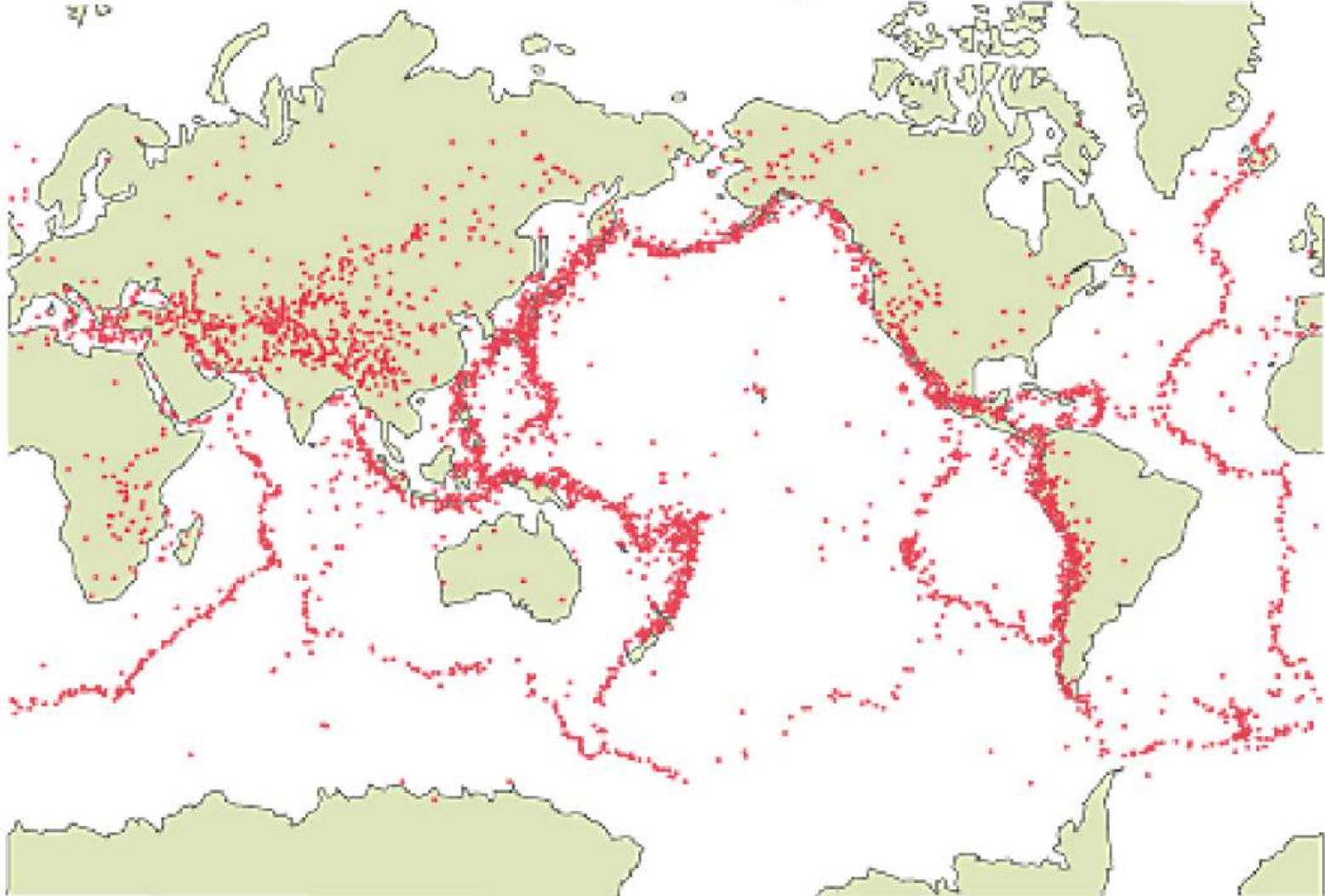


Japan+other Asian countries+USA=70% vs. European countries=20%

Example: Earthquakes

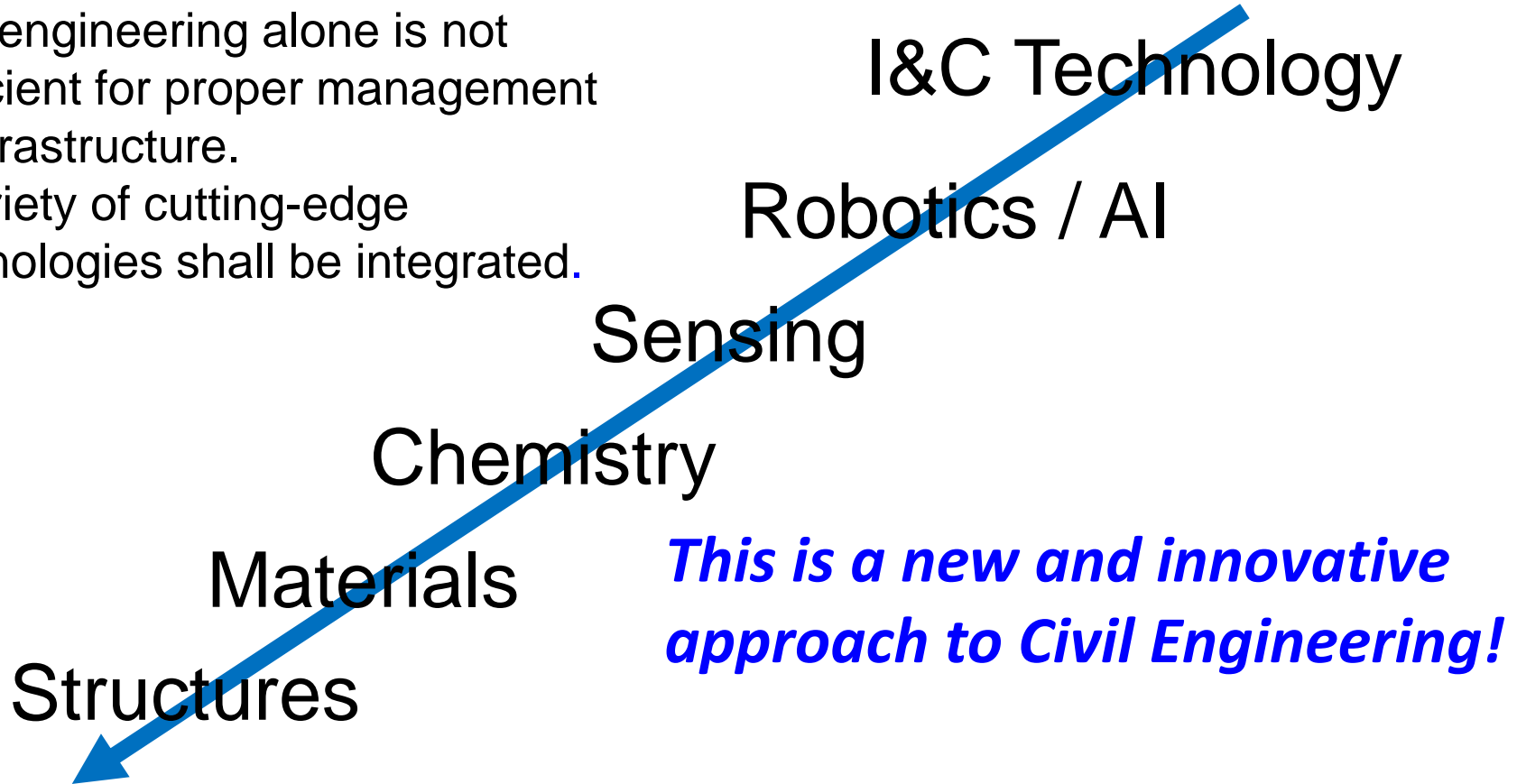
Distribution of Epicenters

Red dots show location of epicenters located along the Pacific rim. Cannot see Japan.



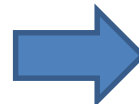
Civil engineering alone is not sufficient for proper management of infrastructure.

A variety of cutting-edge technologies shall be integrated.

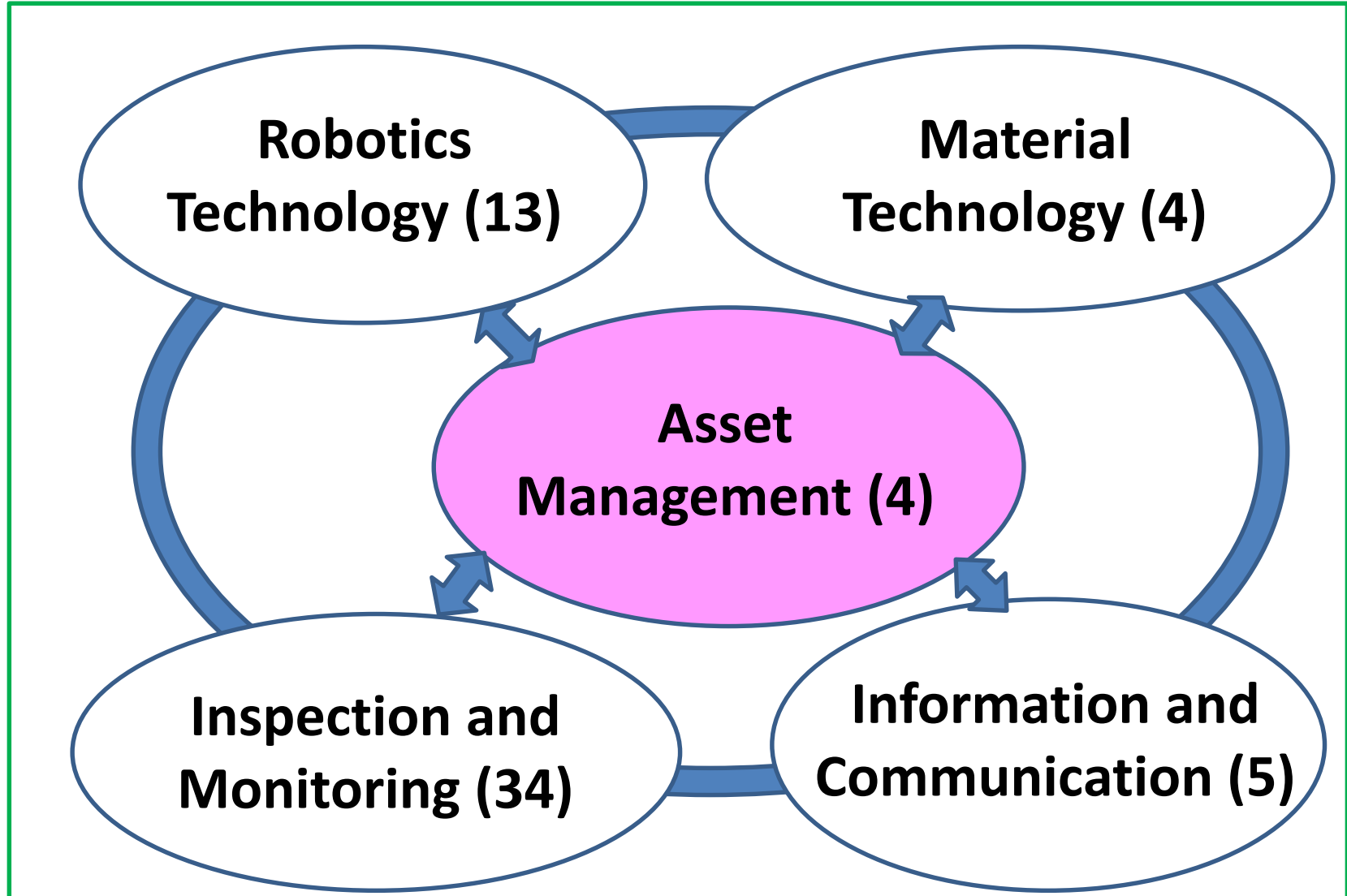


This is a new and innovative approach to Civil Engineering!

Infrastructure Management System



- * Risk Management under abnormal conditions
- * Daily Asset Management under normal conditions



**More than 1,500 researchers & engineers are involved.
Universities, Governmental Institute, Public institute and Industries.**

Machine-assisted Inspection of Bridges



Manual inspection using a movable inspection gondola

Analogue to Digital
Manual to Automatic

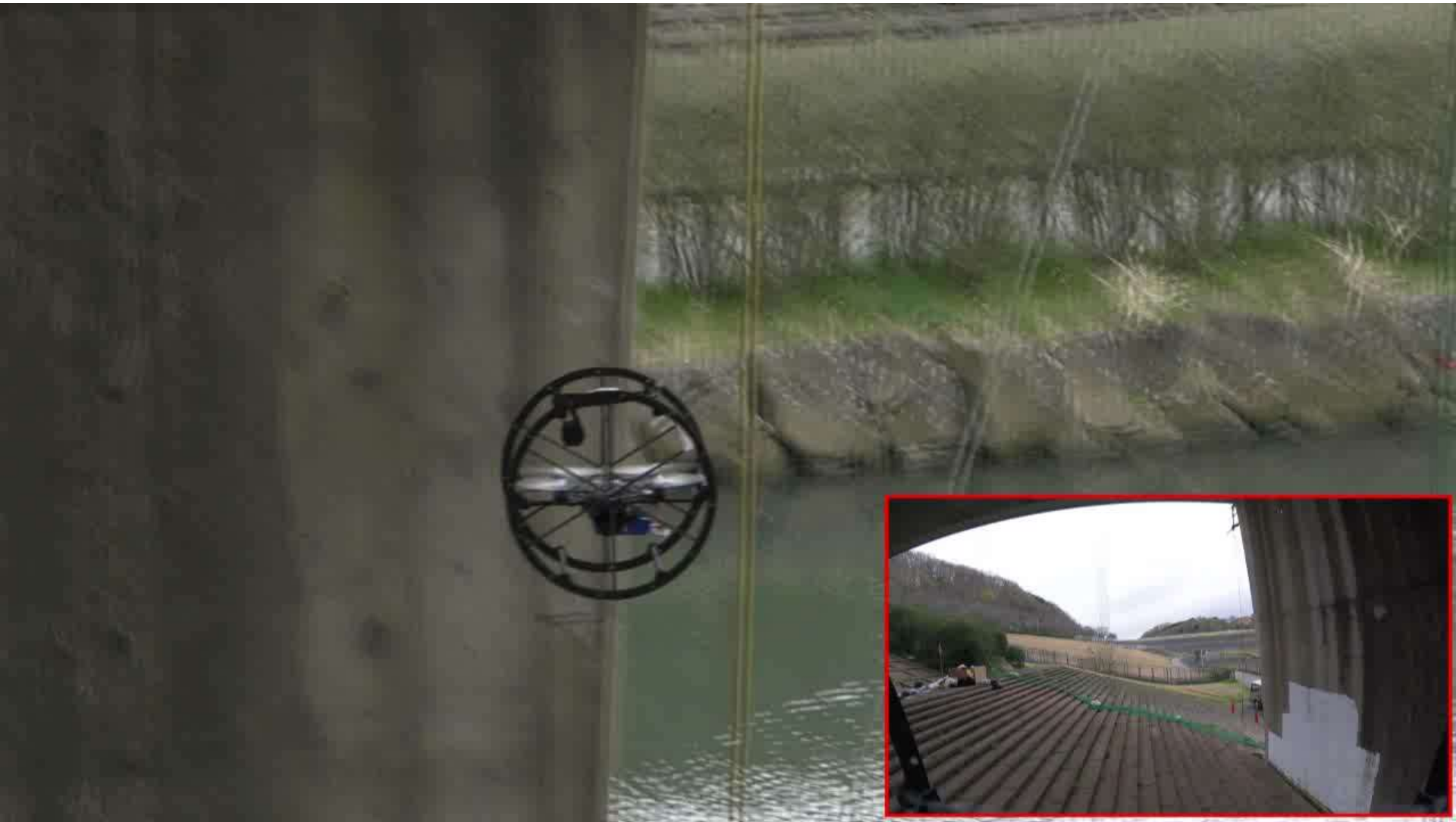
Flying robot. Drone, UAV, ROV

Hands-on inspection relies on human senses.

- eyes
- ears
- hands



2輪車を使った橋脚点検ロボット(富士通+北大+東大)



Bridge-Deck Damage Detection using Radar

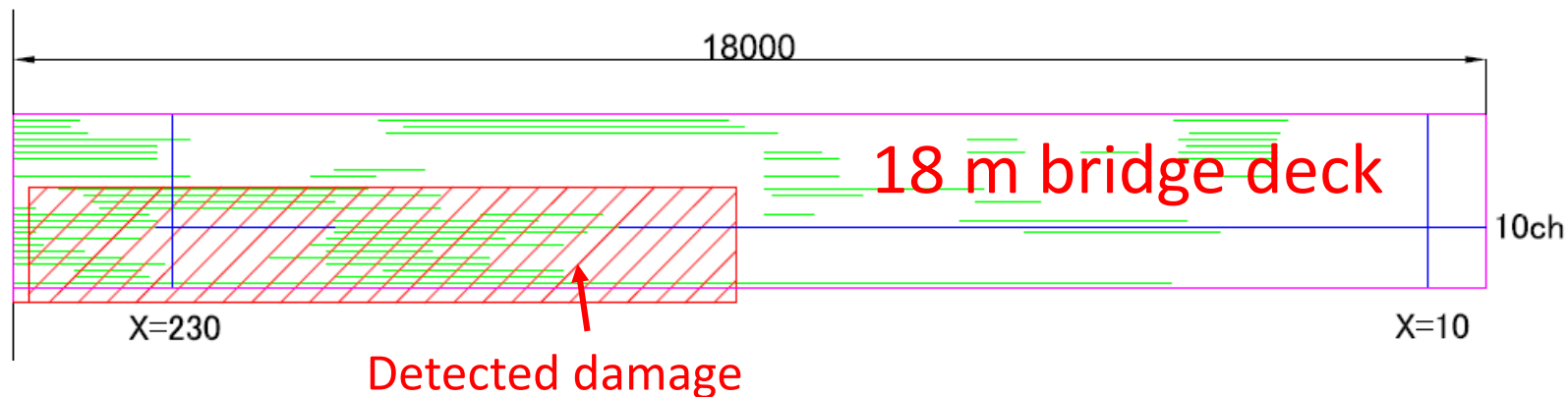
(By Asst. Prof. Mizutani and Prof. Fujino)



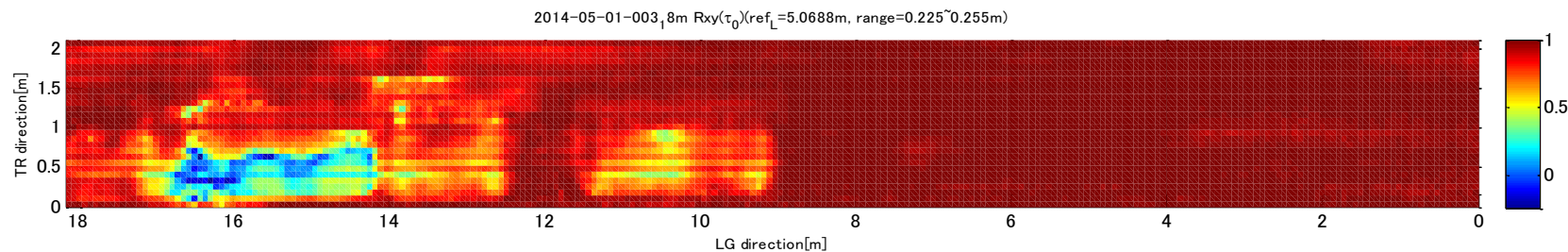
80km/hour

Radar

(Fast Scanning and Non-contact detection)



A Result of Signal Processing (Processing Time: Around 1 min.)



Geotagging technology

Estimate camera's pose using sequential Omni-directional images to add geographical data to proximity images.

Proximity image



Omni-directional image



Pose estimator

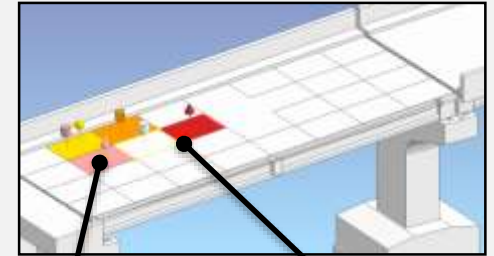
Geotagged proximity image



Inspection data management using 3D-CAD model

Inspection data

3D-CAD



Geotagged images



3D-CAD model generation technology

Semi-automated generation of 3D-CAD model from 3D point cloud.

Automatic registration



Automatic principal plane detection



Application software example

A bridge inspector can refer past inspection data on 3D-CAD model using tablet PC.

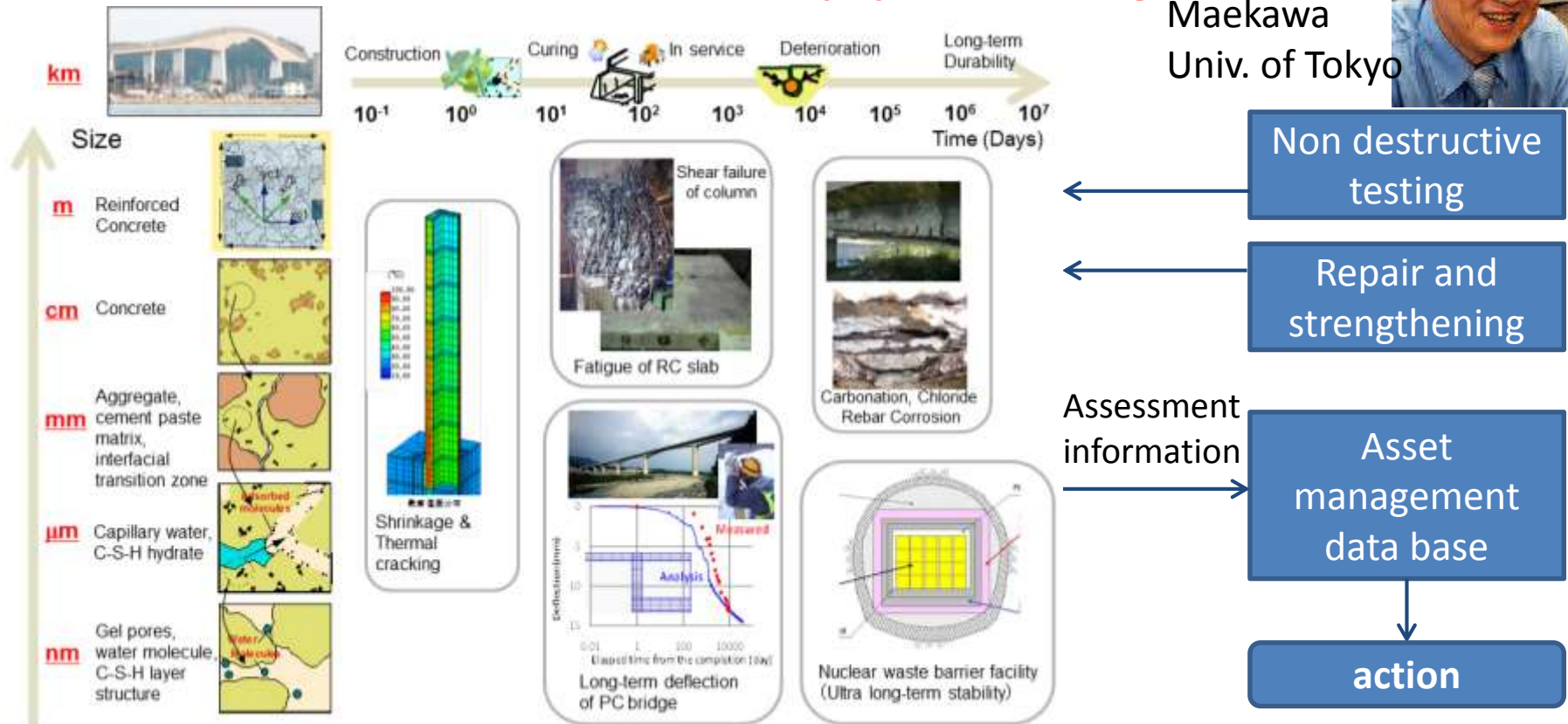


R&D for Long-life Concrete Decks

Management of concrete deck deterioration is essential → Assessment of remaining life and rational bridge management for PDCA cycle


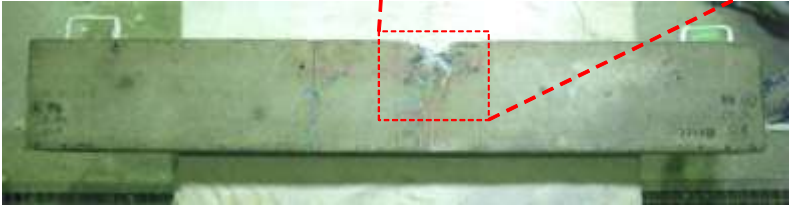

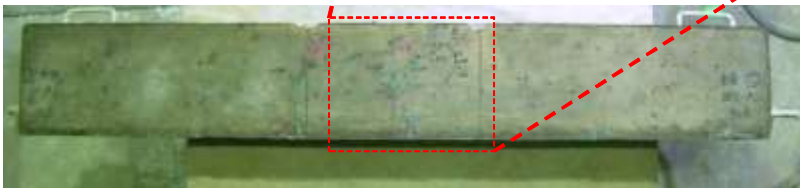
Base technology: **Multi-scale, multi-chemo-physics modeling**

Prof. Koichi Maekawa
Univ. of Tokyo



Super-high Durable Concrete

【Investigation of fatigue loading effects on freeze-thaw resistance in concrete】

Crushed sand	Blast furnace slag fine aggregate
<p>Top</p>  <p>Side</p>  <p>Freeze-thaw 360 cycles, Fatigue test 2.3 mil.</p>	 <p>Side</p>  <p>Freeze-thaw 600 cycles, Fatigue test 4mil.</p>

- Development of concrete strong against cold weather & cyclic loading with blast furnace slag
- Development of quality management system for blast furnace slag fine aggregate

To prolong life of concrete deck slab



1) Must be user-oriented

→ Must be attractive to users

2) Accurate, high speed and inexpensive

3) Reliable long-term prediction

4) Durable high-quality material

5) Wide-scale database management



After couple of years, fruitful outcomes are expected.
The work will continue even after SIP ends in 2019,

Infrastructure Maintenance, Renovation and Management

***We are looking forward to discussing with you
on outcomes of our R&D.***

Thank you for your kind attention!

