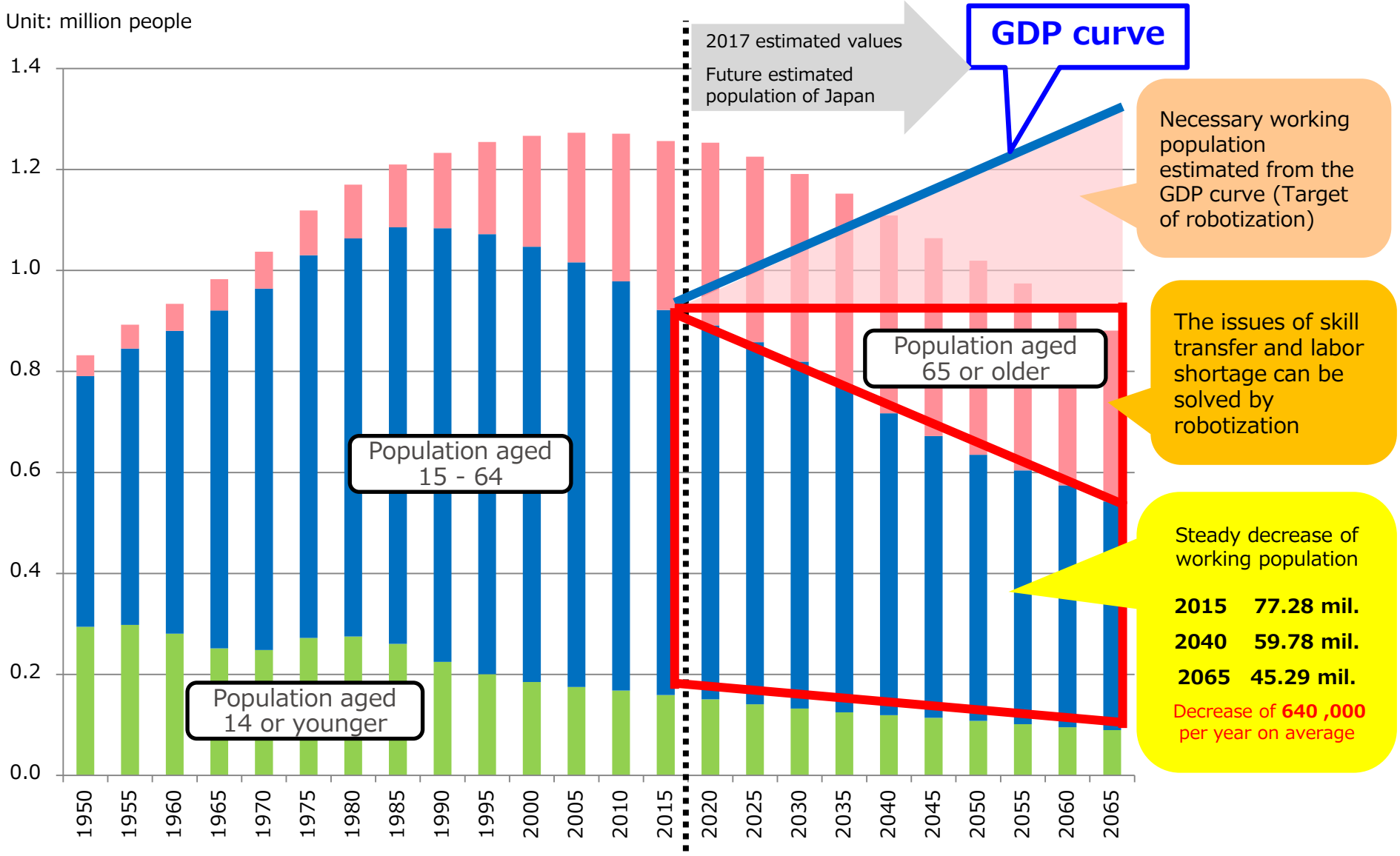
Launch of “Successor”, a New Robot System that Reproduces the Movements of Expert Engineers Through Remote Collaboration

- A new solution for fields where robotization has been difficult to achieve -

Kawasaki
Powering your potential

Issue of working population decrease in Japan

Source: National Institute of Population and Social Security Research
Future estimated population of Japan (2017 estimate)



Aging society as a global issue

Aging society

Respond to the decrease in workforce

Loss of technical skills as experts retire

Increased medical expenses and support costs of elderly people

duAro

Proposal for robots that can coexist and collaborate with human and expand in applications

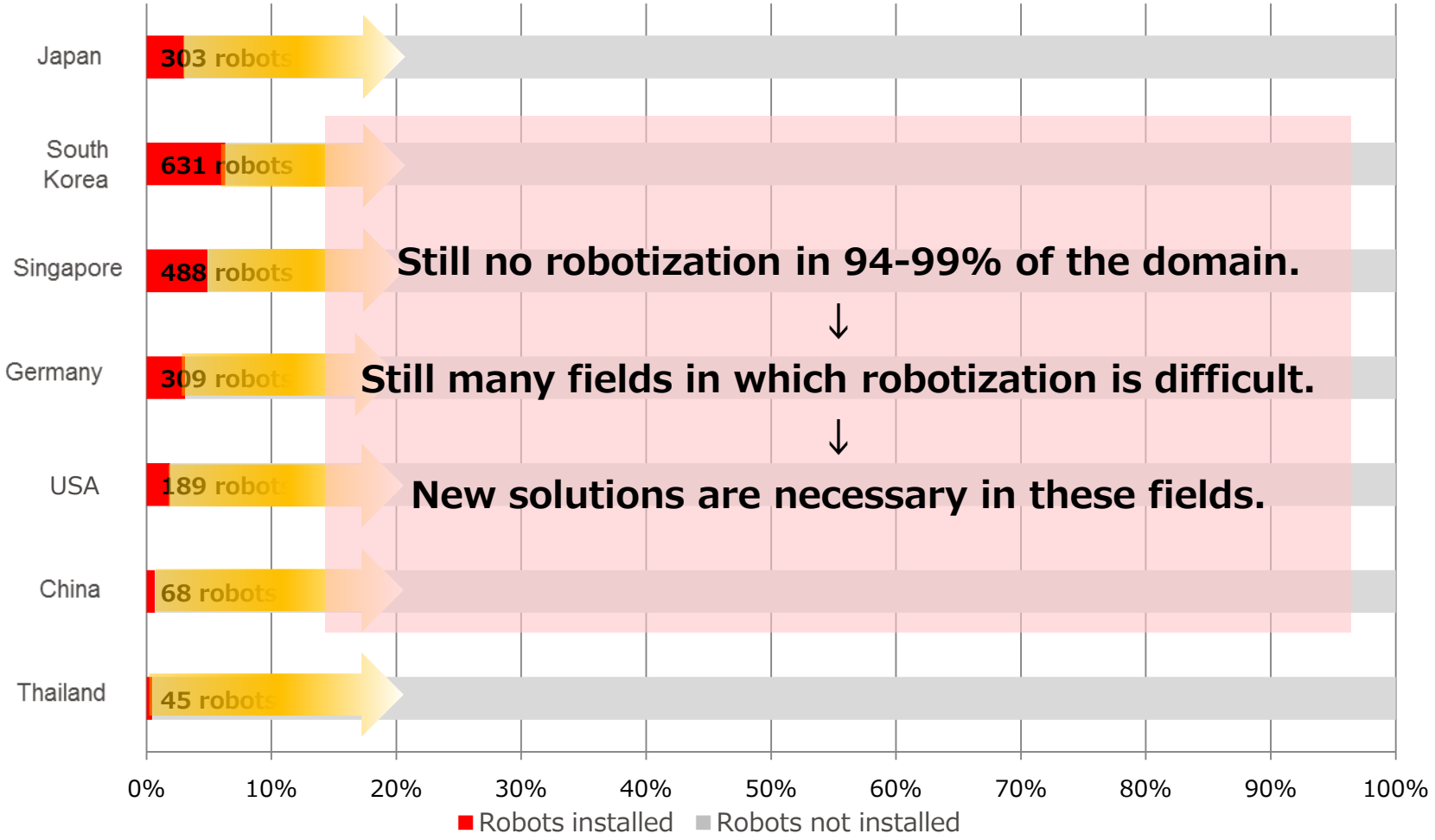
New robot system

Proposal for new robot system that can learn technical skills and pass them on to future generations

Medicaroid

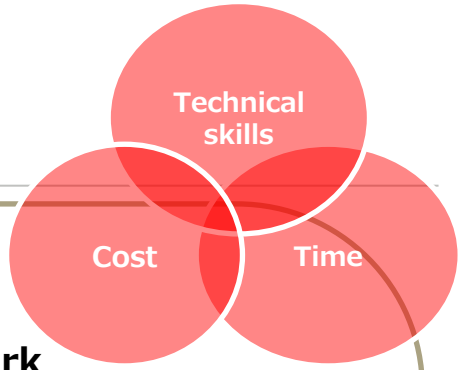
Proposal for robots that can reduce financial and physical burden of human in the field of medical care

Number of industrial robots used per 10,000 employees in the manufacturing industry (2016)



*Source: IFR Statistical Department, World Robotics 2017

Fields in which robotization is difficult:



●Fields requiring technical skills

Processes in which humans use their **senses** to carry out work (assembling, polishing etc.)

Large **dispersion** of parts accuracy (casting, pressed items etc.)

●Fields requiring disproportionate amounts of cost/time

Applications that are not achievable without the use of many **sensors**

Applications that require **modifications** of the production line or the whole factory

Processes and work for which **programming** and other preparatory work take too much time

ex) Non-mass production

Made-to-order products and items with slightly **differing** individual parts

Parts for products that **frequently change**, such as in small- and medium-sized enterprises

New robot system

A robot system proposing

a new concept for robots, including skill transfer through remote collaboration:

Successor

Challenges to the fields that are difficult to robotize

How can robots transfer skills?

Human-centered jobs

1. Work that requires sensation
2. Non-routine work
3. Work that requires judgment

Expert

New worker

Experts operate robots

Skill transfer

Skill transfer

Robots work as a training tool for new workers

Robot-centered jobs

1. Handling-centered work
2. Routine work
3. Work requiring accuracy

Robots learn human work using AI technology

Fully automated system

Control unit that realizes skill transfer to/by robots

Communicator for assembling

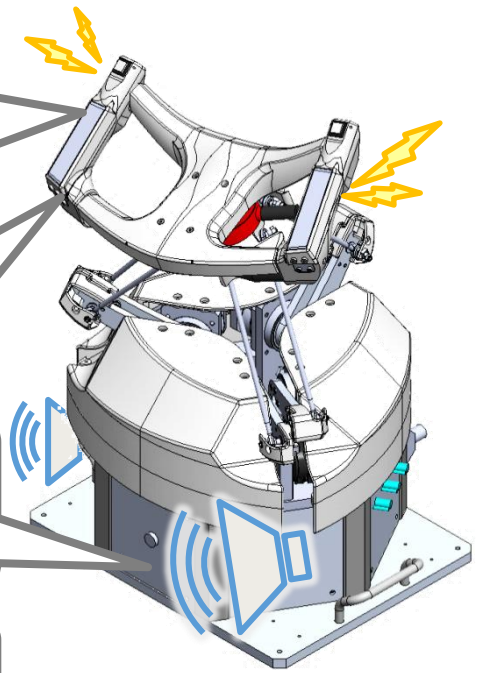
Replicate feelings with IoT technology

Force
Replicate impact

Touch
Replicate vibration

Sound
Replicate sense

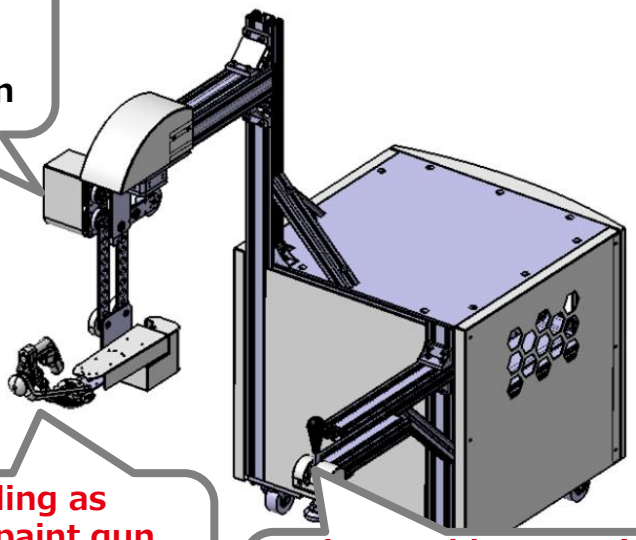
Vision



Communicator for painting

Natural maneuvering feeling by human dynamics

Weightless feeling
Easing burden



Same feeling as operating a paint gun
Smooth motion with the paint gun

Changeable operation scale
Operation scale can be changed

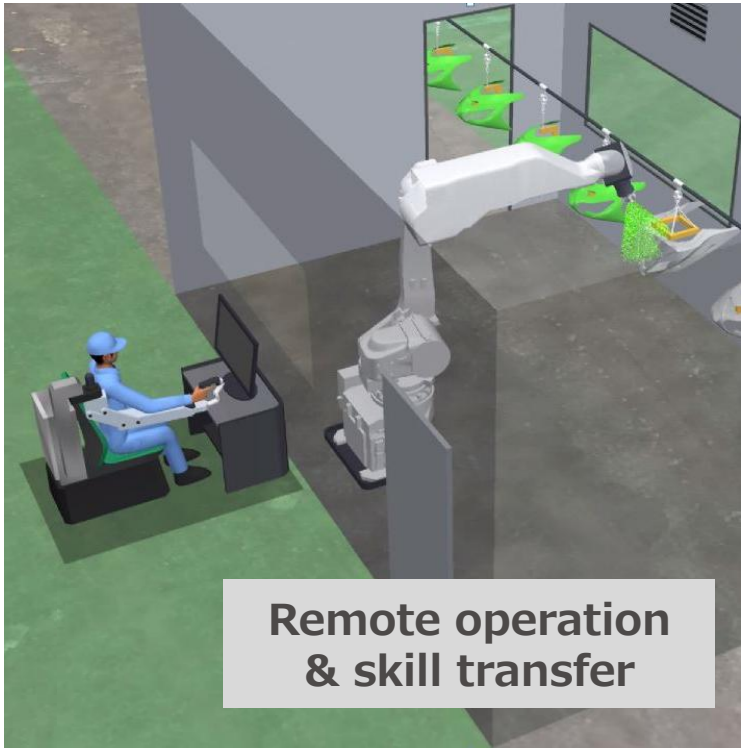
The *Communicator* helps intuitive operations and therefore the workers can feel as if s/he is in the real work environment.

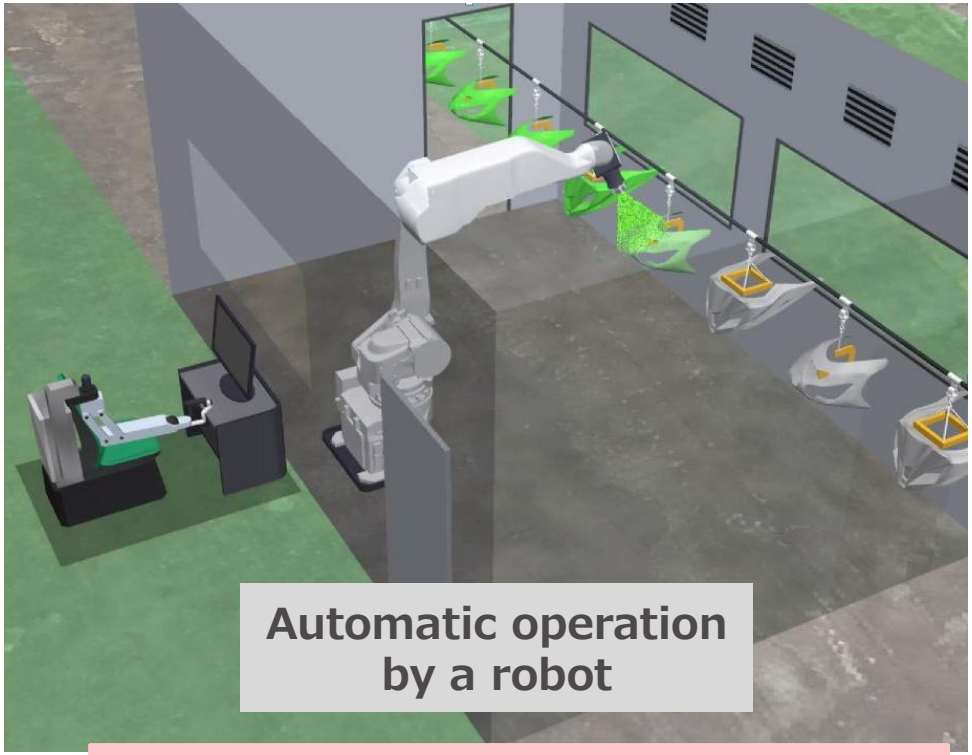
Features of *Successor*: Remote collaboration system

Remote collaboration system
Equipped with a system in which physical senses (e.g. sight, force, touch, sound) during the operation are fed back, giving the remote operator the sense of being at the place where the work is performed.

Workers can operate outside the working range of the robot, ensuring intrinsic safety
↓
Enables collaborative work with large robots

Function of *Successor*: 1. Conversion function (learns human operations and converts them into automated operations)





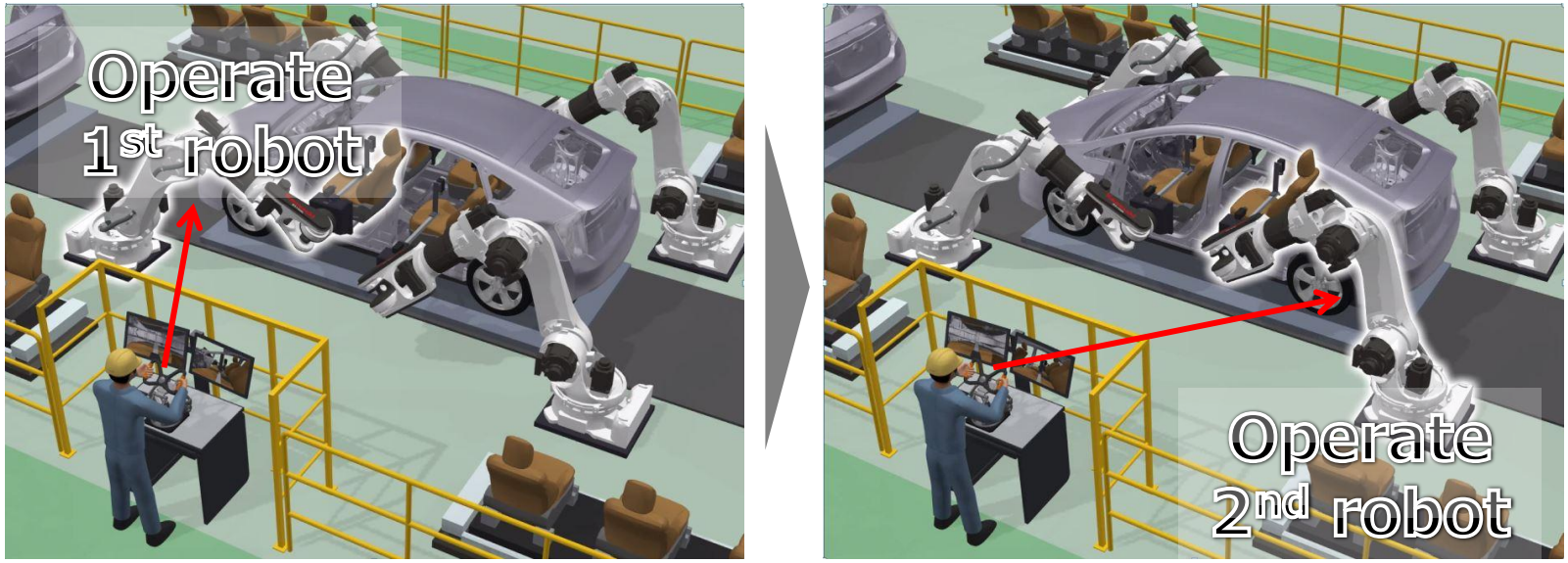
OJL : On the Job Learning
(learning human skills on the job)

Step 1: Operation → Step 2: Trial/Correction → Step 3: Automation
Teaching Training through repetition Mastery

Skill transfer to robots can be realized online

Function of *Successor*: 2. Hybrid function of automatic/remote operations & 3. Multi-control function (one *Communicator* operates multiple robots)

Both remote operation with the *Communicator* and automatic operation by robots can be switched easily



One *Communicator* can operate multiple robots

Function of *Successor*: 4. AI function (Robots learn to optimize movement with dispersion with AI technology and to convert it to automated operations.)

OJL : On the Job Learning
(learning human skills on the job)

AI technology

Step 1: Operation → Step 2: Trial/Correction → Step 3: Automation
Teaching Training through repetition Mastery

Skill transfer to robots can be realized online

Function of *Successor*: 4. AI function (Robots learn to optimize movement with dispersion with AI technology and to convert it to automated operations.)

Validation of the AI function by case testing

Step1:
Analyze data from 22 cases

↓

Automatic operations

↓

Success rate 90% (27 out of 30)

↓

Step2:
Analyze additional data from failed cases

↓

Automatic operations

↓

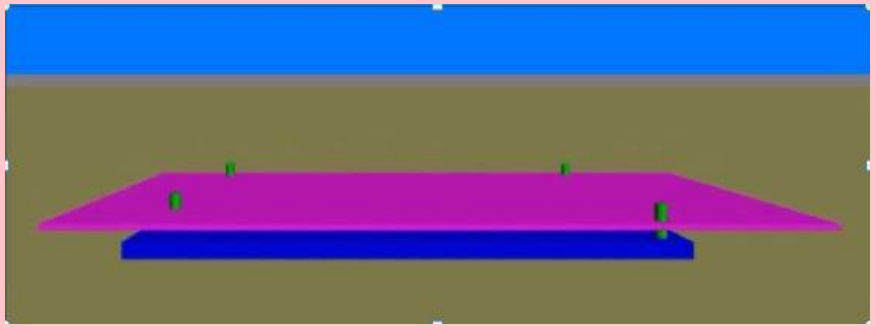
Success rate 100%

Failed cases

When it tries to insert it here, this side touches first

・Unexpected events for robots which knows Step1 data only

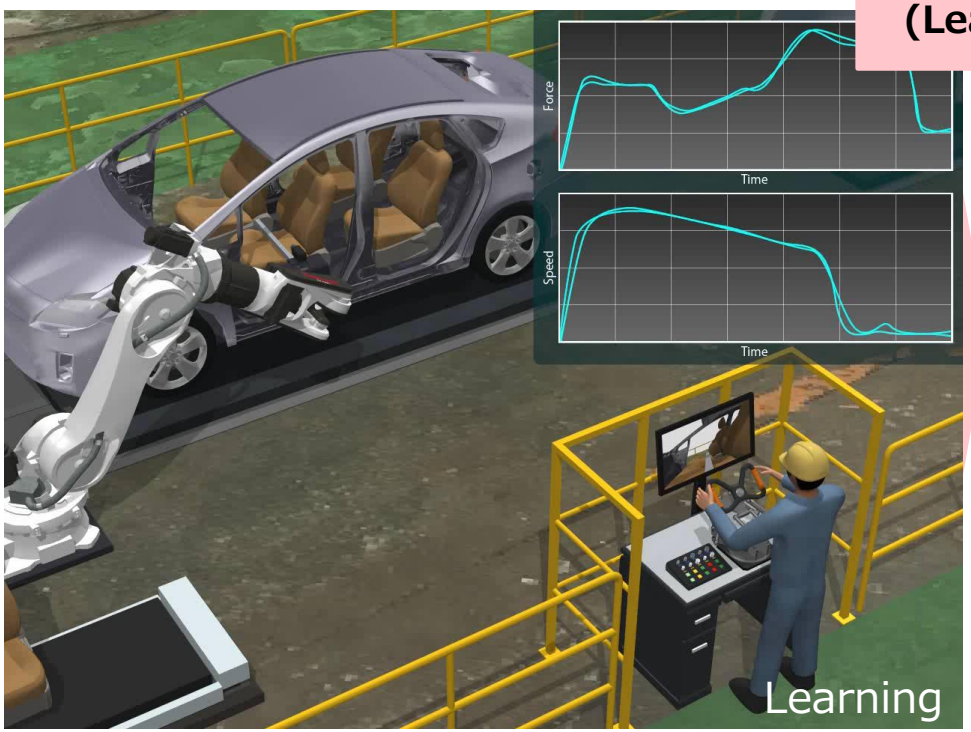
Success cases



Work by automatic operation was successful after learning with AI function

Function of *Successor*: 5. Training function (newcomers learn operations taught to robots by experts)

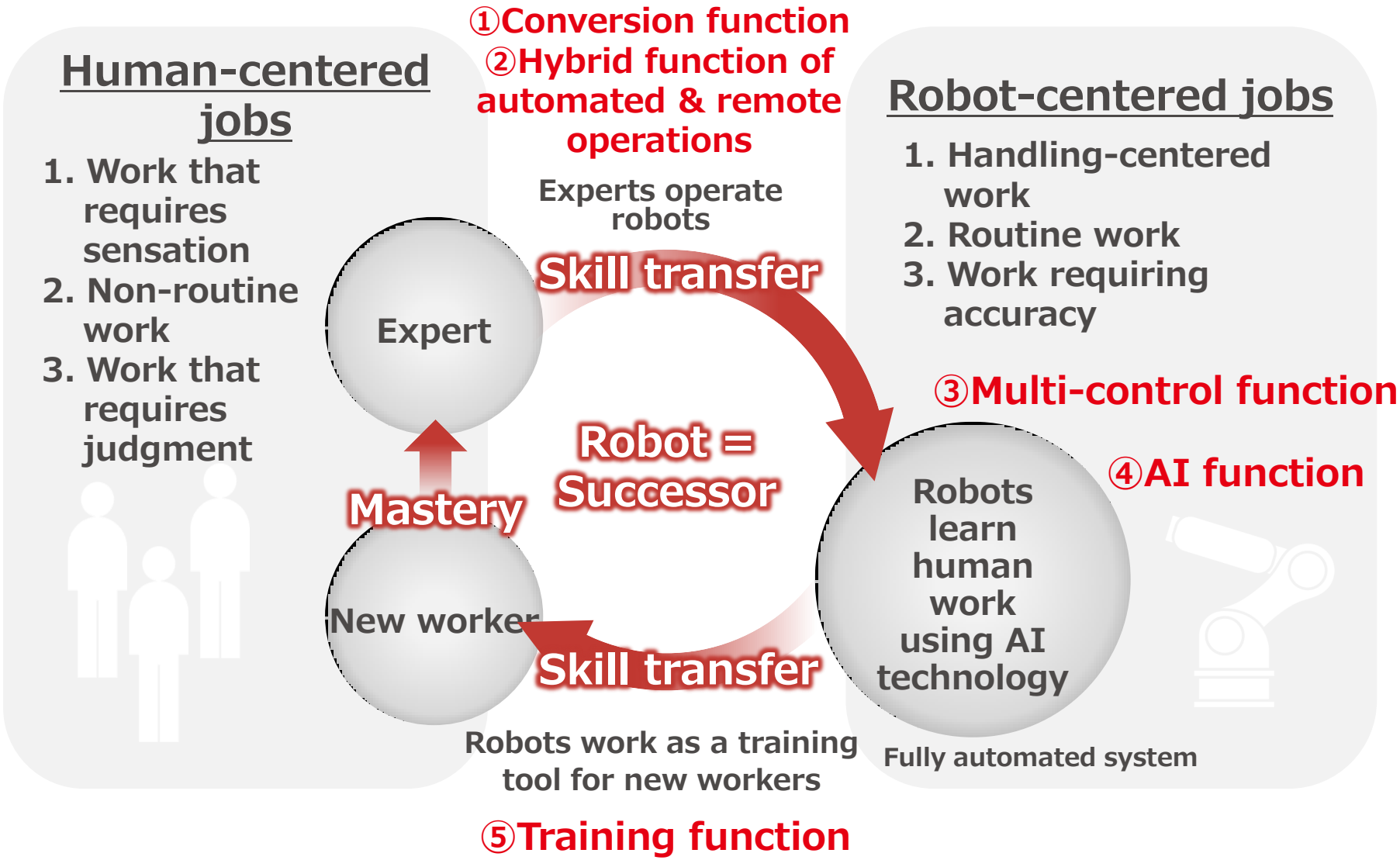
OJL: On-the-Job Learning
(Learn the skills of experts through robots)



Step 1: Operation → Step 2: Trial/Correction → Step 3: Automation
Teaching Training through repetition Mastering

Skill transfer to robots can be realized online

Summary of *Successor*'s functions in the fields that are difficult to robotize



Successor is:

A robot system that can be used with any robot

Robot that fits to applications+
The remote controlling unit, *Communicator*

What *Successor* can realize:

Implementation of robots are easier

- **Anyone can program robots without professional knowledge on robots**
- **Implementation cost and time for robots can be reduced**
- **Application fields are widened**

Increase productivity

- **Workers can be released from harsh working conditions**
- **Physical burden of labor is relieved from the elder**

Secure workforce and nurture next generation

- **Experts' skill can be transferred by robots**

Future vision of *Successor's* development

Operate and monitor plants around the world from a single location

Network/IoT

Robot + AI

Plants in USA

Plants in Europe

Plants in China

Plants in Japan

Kawasaki. working as one for the good of the planet

“Global Kawasaki”

Kawasaki
Powering your potential