

MMEDIA 2024 : Perception and cognition for  
multimedia users



# Initial Methodology of Troubleshooting Assist System for Electronic Circuit Skills Training

Polytechnic University of Japan

○Tetsuya Hayashi, Kenji Terada, Masaki Endo

Tsuyoshi Tanaka and Shigeyoshi Ohno

m243202@uitech.ac.jp

# Contents

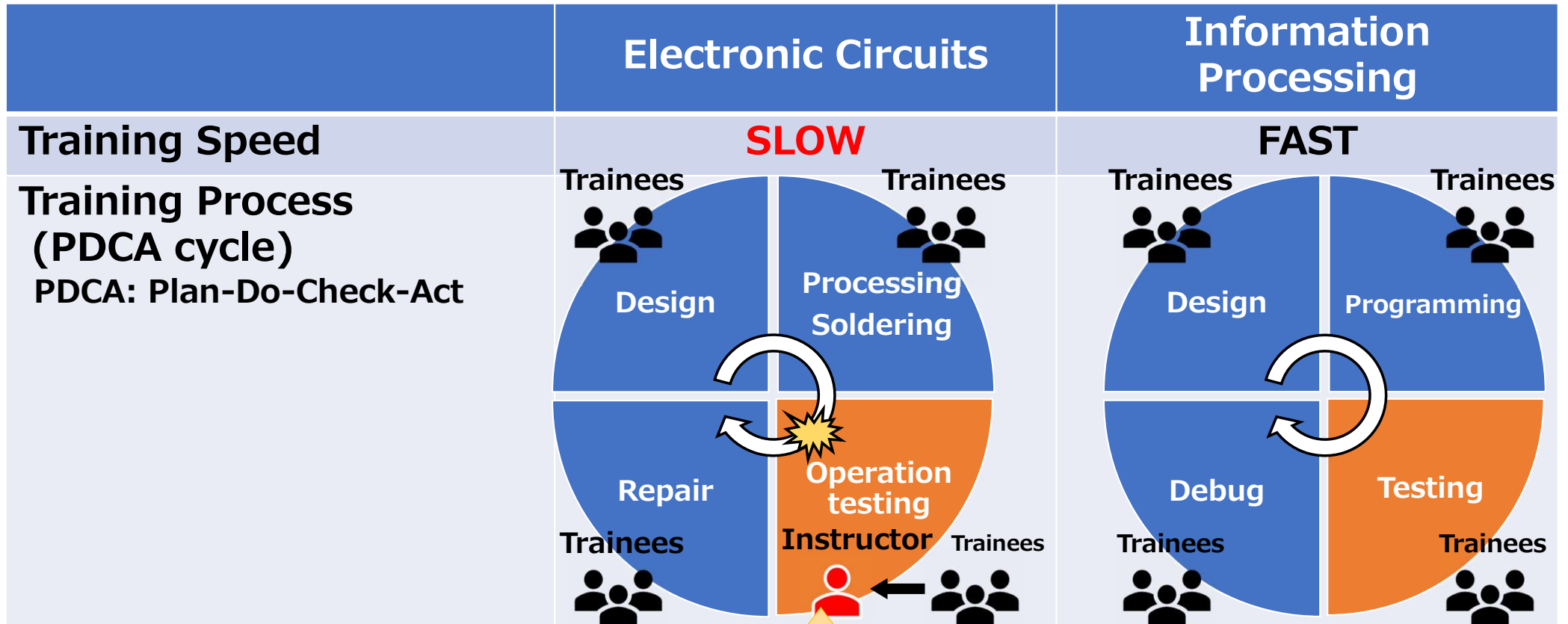


- 1 Introduction
- 2 Problem
- 3 Prior research
- 4 Objective
- 5 Idea and Solution
- 6 Evaluation methods
- 7 Conclusion and Future Works

# 1. Introduction

- In skills training at polytechnic college of Japan, dozens of trainees receive training and acquire knowledge and skills from around two instructors.
- In the electronic circuit assembly training, trainees learn a series of processes including design, manufacturing, and operation testing.
- Trainees do not have the knowledge about troubleshoot in each process, and they aren't sometimes able to deal with troubles.
- In particular, troubleshooting during circuit operation tests involves debugging training output make it difficult to find cause of troubles.
- However, there is no existing method for instructors to efficiently teach troubleshooting knowledge and skills to trainees.

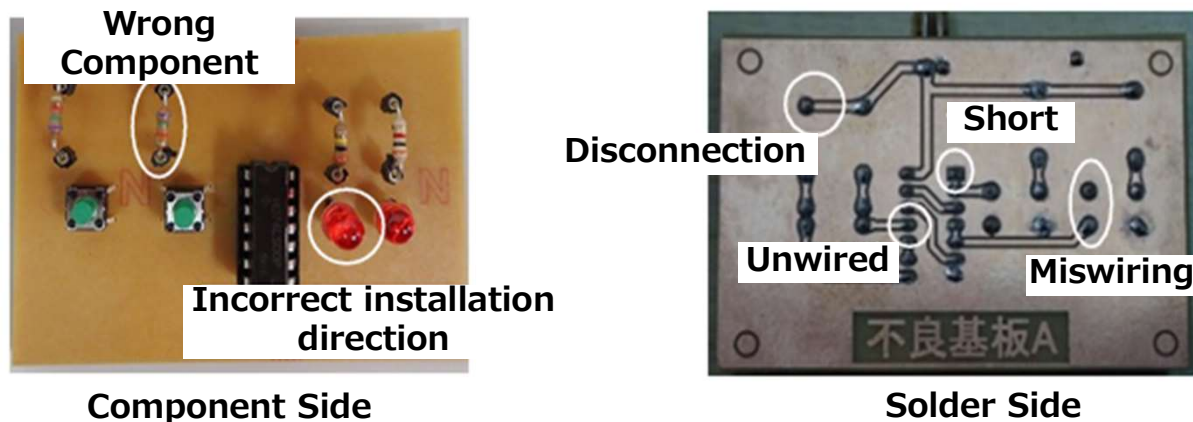
## 2. Problem



Training cycle bottleneck: One Instructor has to deal with **multiple trainees' problems simultaneously.**

# 3. Prior research

- Development of electronic circuits included malfunctions as teaching materials and have trainees learn how to repair them[1].

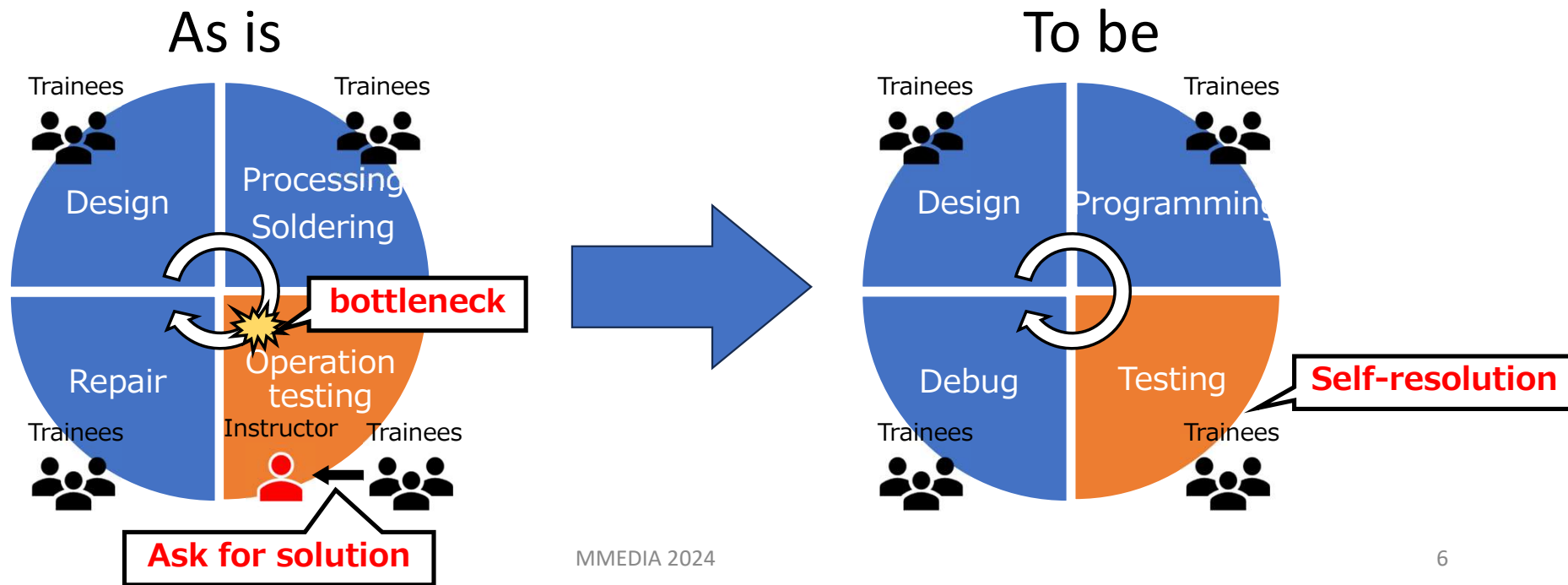


## Intentionally defective circuit boards[1]

[1] Masatoshi Saito, [Development and effectiveness of educational materials to improve skills in identifying defective locations on circuit boards] Kairo kiban no furyou Kasho wo tokutei suru ginou wo koujou suru tameno kyouzai kaihatsu to Sono kouka (in Japanese), Polytechnic University of Japan (PTU) Forum 2023, 24-A-3, Nov. 2023.

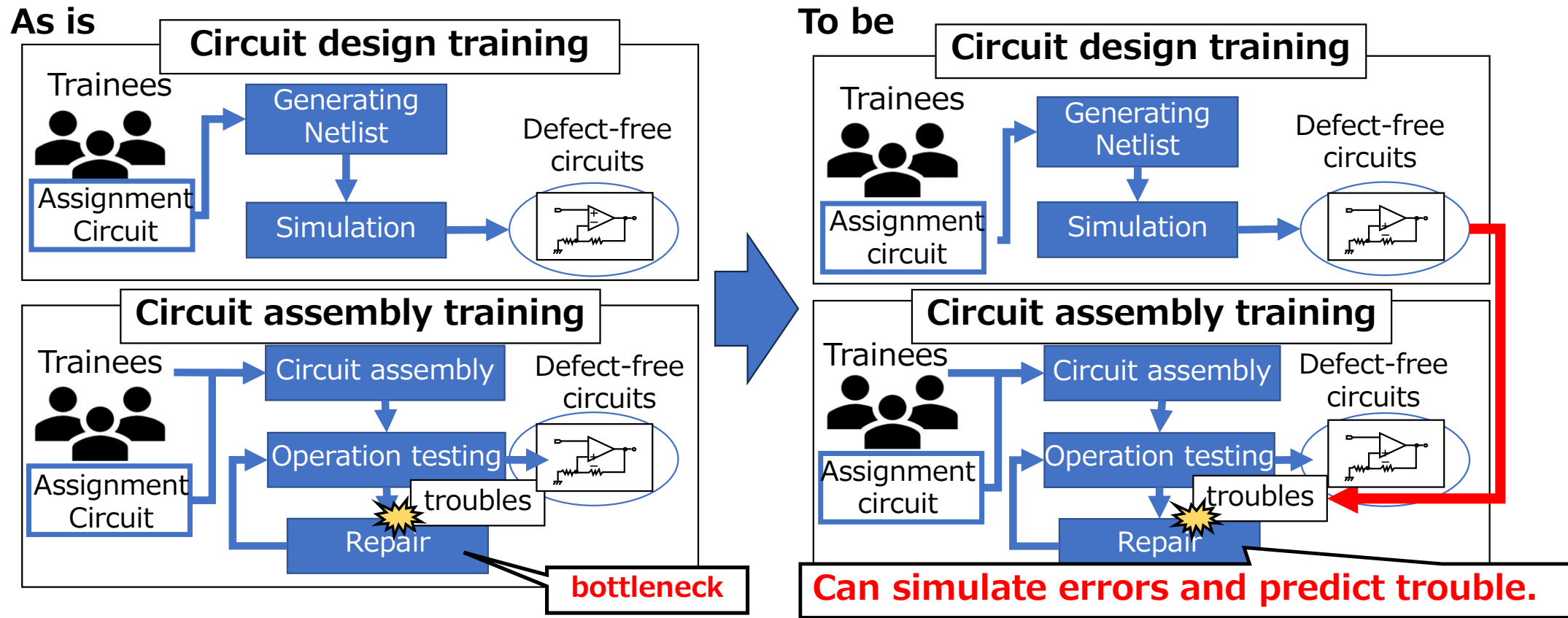
# 4. Objective

- Develop an efficient method for trainees to learn troubleshooting knowledge and skills by independently verifying the operation from the assigned circuits presented by the instructor



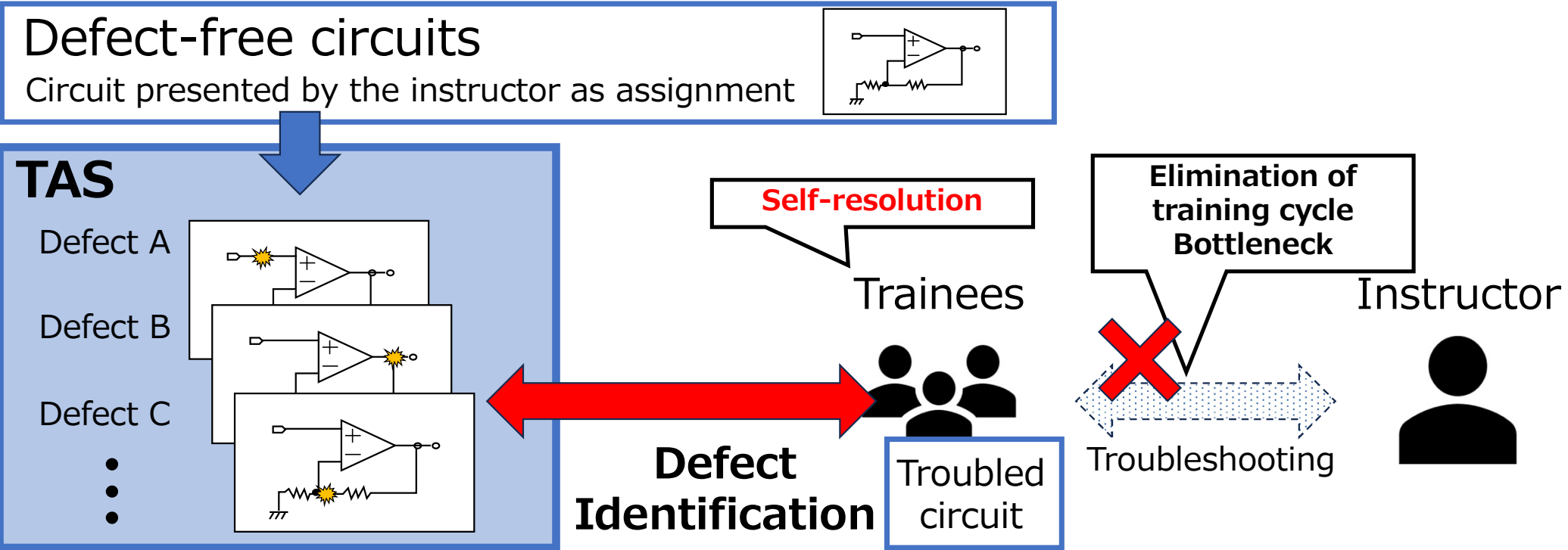
# 5.1 Ideas

Combining independent circuit training, the system automatically detects circuit problems and utilizes them for repair.



# 5.2 Solution

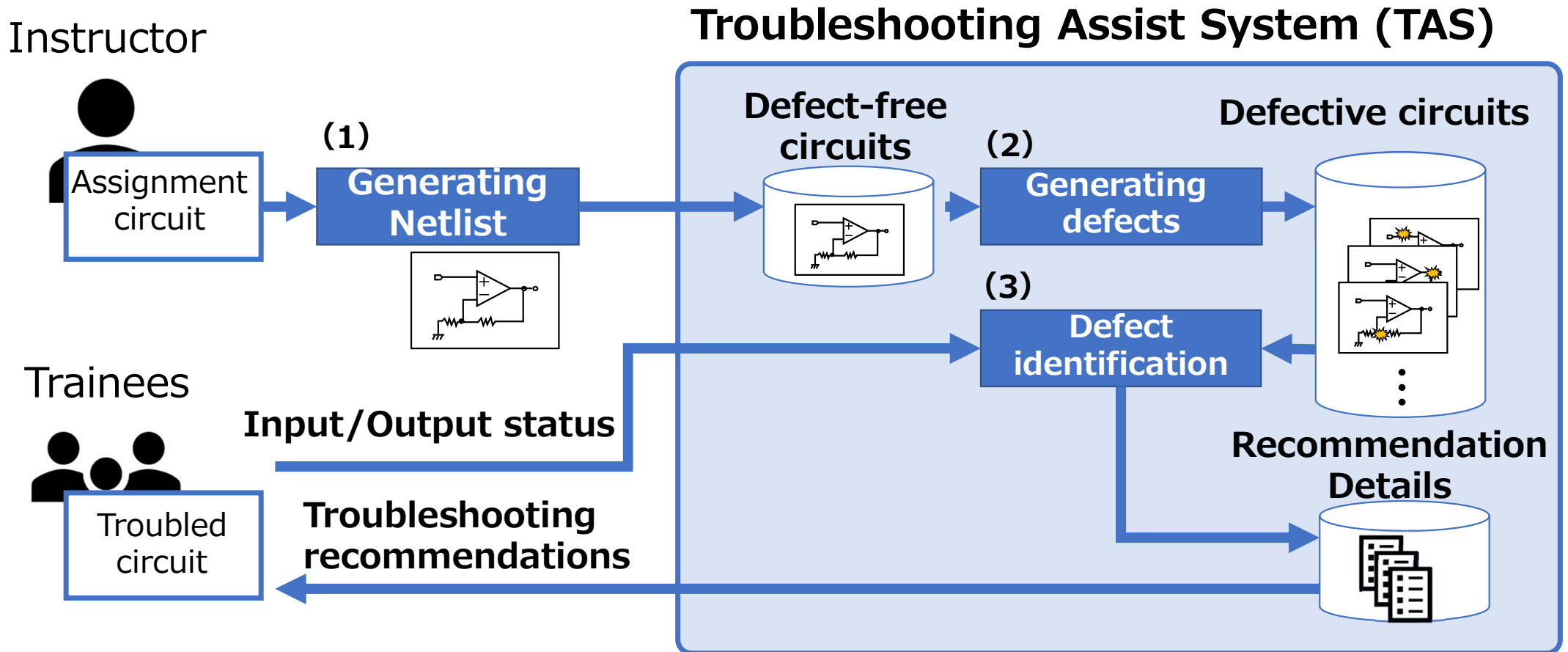
**TAS generate circuits automatically with possible defects in operation**



Troubleshooting Assist System (TAS)



# 5.3 Overview of TAS



# 5.4 Generating defects

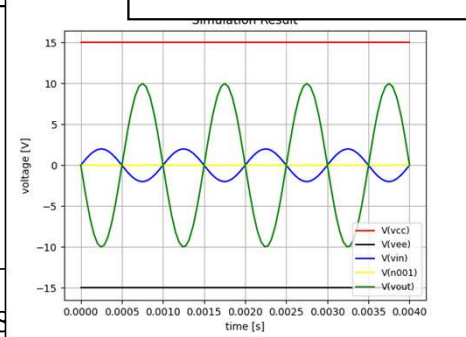
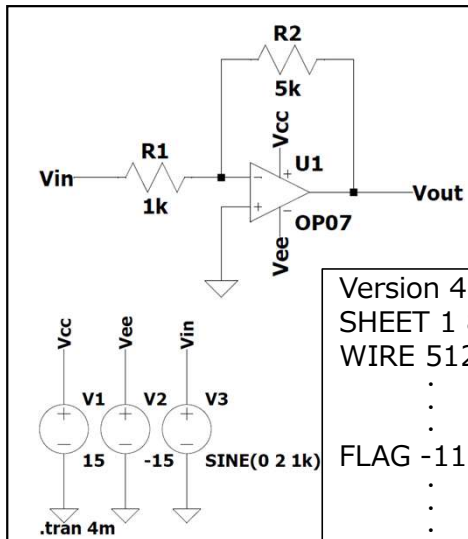
- Assignment circuit

(2) Obtaining and recording results

- Troubled circuit

(4) Obtaining and recording results

Disconnection of resistor R2

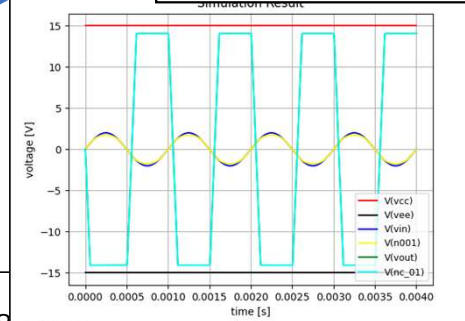
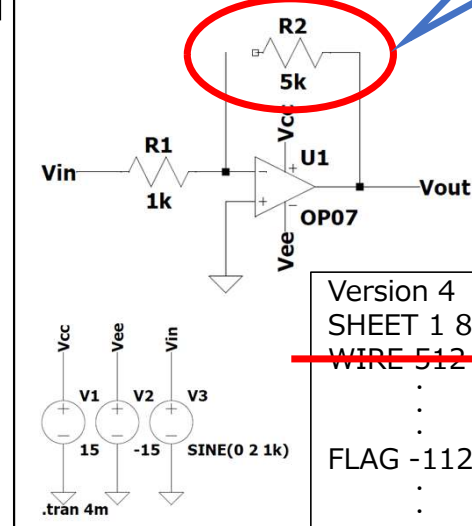


Version 4  
SHEET 1 8  
WIRE 512 0 480 0  
FLAG -112 256 0

(1) Netlist acquisition

```

SYMBOL voltage -112 96
R0
WINDOW 123 0 0 Left 0
WINDOW 39 0 0 Left 0
SYMATTR InstName V1
SYMATTR Value 15
...
TEXT -146 282 Left
2 !.tran 4m
    
```



Version 4  
SHEET 1 880 000  
~~WIRE 512 0 480 0~~  
FLAG -112 256 0

(3) Edit circuit  
e.g. wiring deletion

```

SYMBOL voltage -112 96
R0
WINDOW 123 0 0 Left 0
WINDOW 39 0 0 Left 0
SYMATTR InstName V1
SYMATTR Value 15
...
TEXT -146 282 Left
2 !.tran 4m
    
```

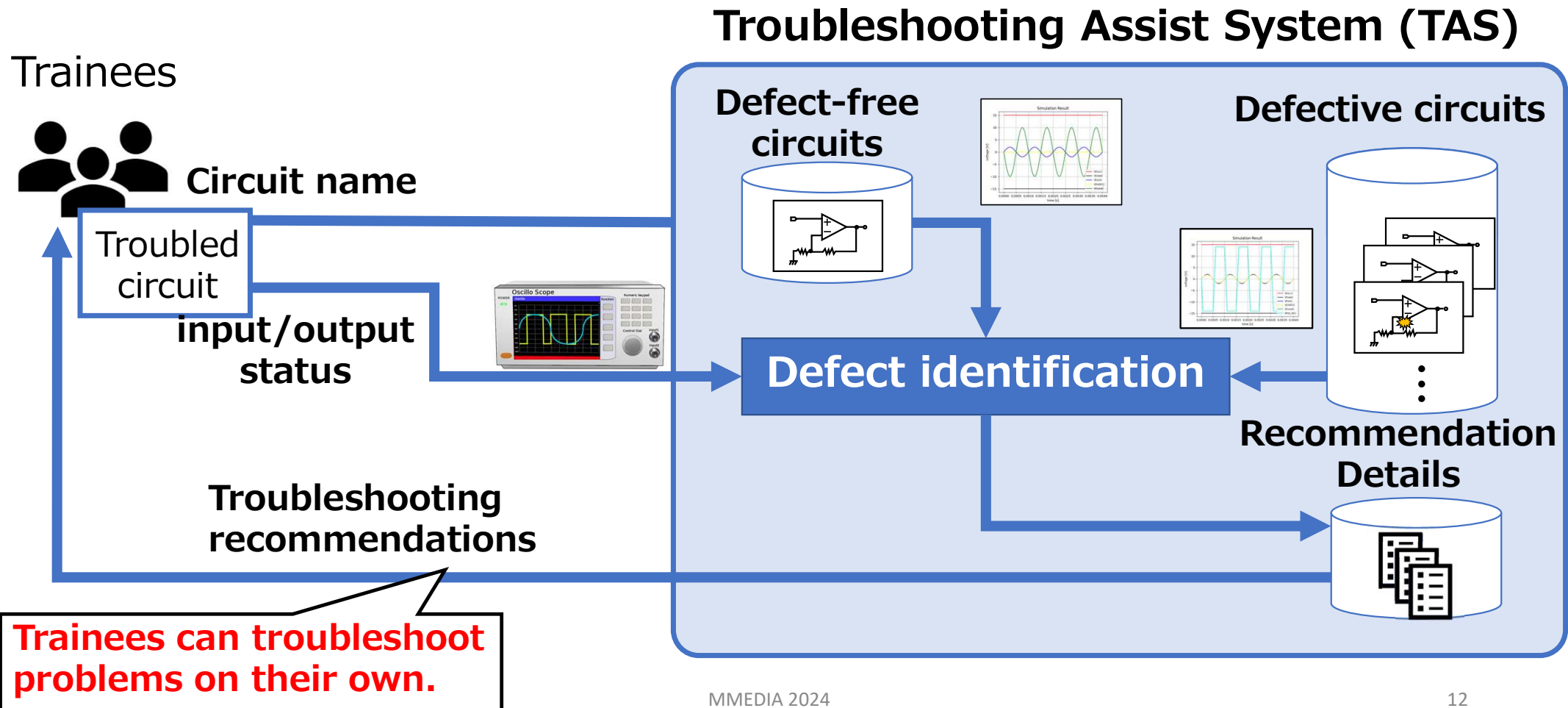
Automatically edit netlists to inject circuit defect



# 5.5 Example: Defect in negative feedback amplifier circuit (excerpt)

|              | Assignment circuit | Disconnection | Short |
|--------------|--------------------|---------------|-------|
| Schematic    |                    |               |       |
| Input/Output |                    |               |       |

# 5.6 Matching Troubles



# 6. Methodology for Evaluating TAS

- Evaluation of TAS functions
  - Troubleshooting comprehensiveness
    - Design error
    - Wrong wiring
    - Short circuit
    - Disconnection
    - IC mistake
    - Wrong direction of parts
    - Wrong parameter
    - Damaged parts
    - Bad solder
    - Not mounted/assembled
- Evaluation of training effectiveness via TAS
  - Measure the time required to complete the training when TAS is used and when it is not used.
  - Compare the measured times.

# 7. Conclusion and Future Works

- Proposing TAS
  - Automatically generate defective circuits
  - Match the defective circuit with the trainee's circuit and detect the trainee's trouble
  - Recommend troubleshooting techniques based on trainees' problems
- Evaluation methodology of TAS functions
  - Troubleshooting comprehensiveness
- Evaluation methodology of training effectiveness via TAS