#29 **USIT Case Study**:

A Mom's Bicycle for Safely Carrying Two Children

■ Authors = Group at a USIT Training Seminar

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■ Approach

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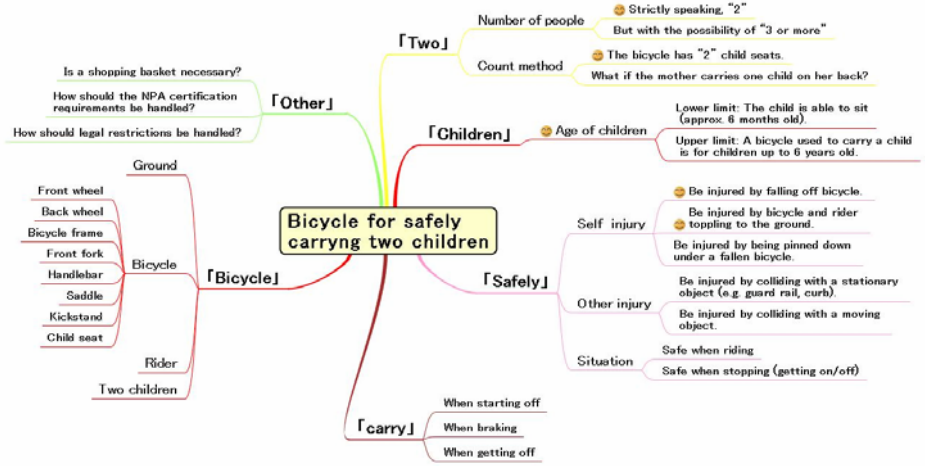
Open invitation, Organized by IDEA, Inc.
Instructor: Professor Toru Nakagawa, Osaka Gakuin University

■Background of theme selection (Suggested by T. Nakagawa)

- Carrying two children on a bicycle is currently Prohibited by the Road Traffic Law.
- However, under strong requests from mothers, the National Police Agency has recently shown the intention to permit it if safe bicycles are made available.
- This is a hot theme in Japanese society today and worthy of thinking about.

Problem Definition (Session 1)

①Sharing of Problem and Examining the Scope



⇒ **Basic strategy selected**

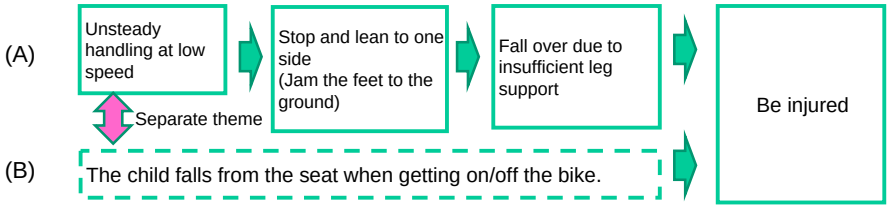
① Focus on a bicycle, but include the use of stabilizer wheel attachments and three-wheeled cycles.

② Do not impair the convenience of a standard bicycle.

Problem Definition (Session 1)

② Problem Definition Statement

★ Unwanted effect



⇒We have chosen the problem (A) more significant.

★Problem definition statement :

The design should enable steady riding at low speed, easy supporting with legs when stopping and leaning to one side, and preventing from falling over.

★Sketch :

Next slide

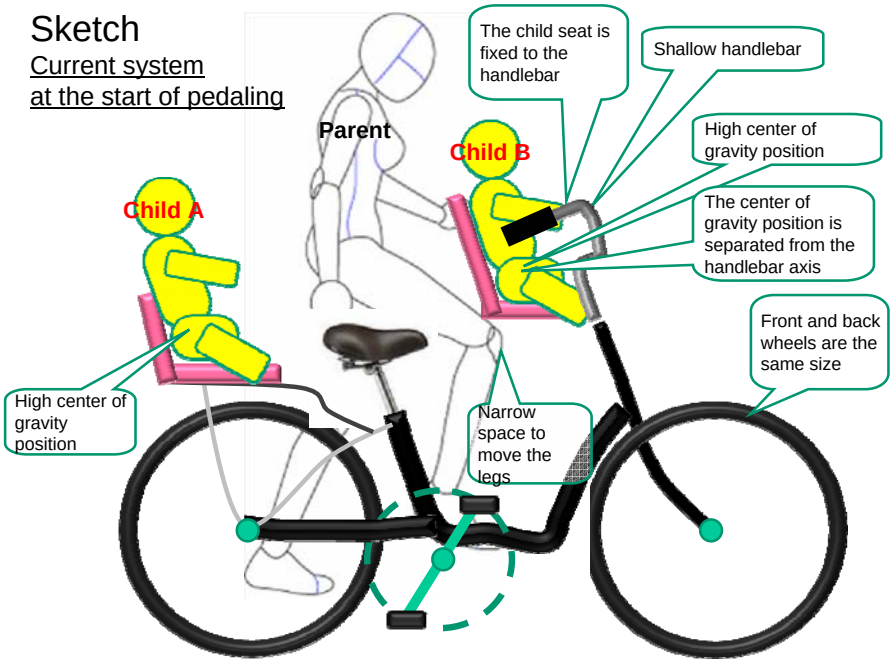
★Root cause : **When a bicycle stops, it falls over without a support.**

★Minimal set of related objects

Ground, wheels, bicycle components, parent, child A, and child B

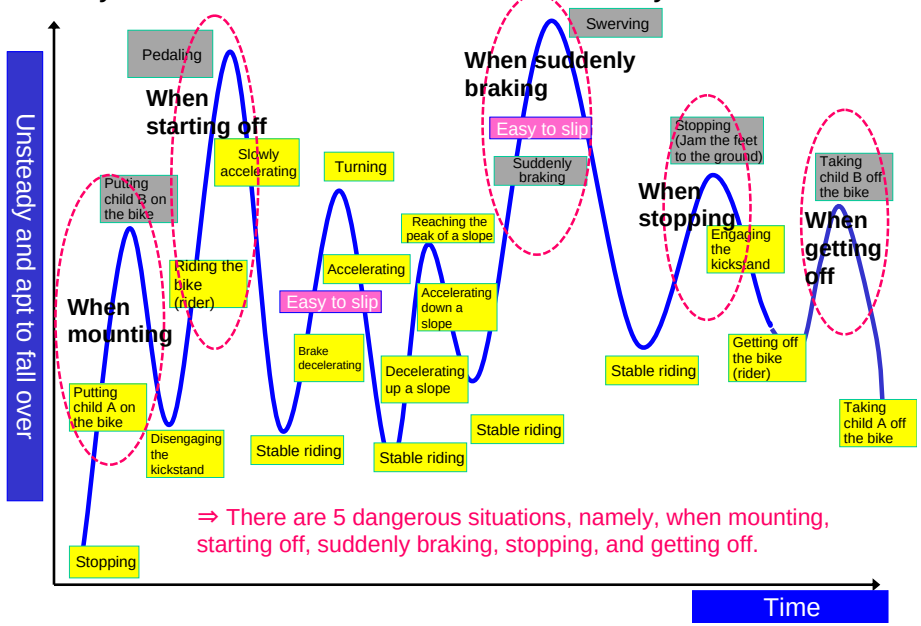
Sketch

Current system
at the start of pedaling

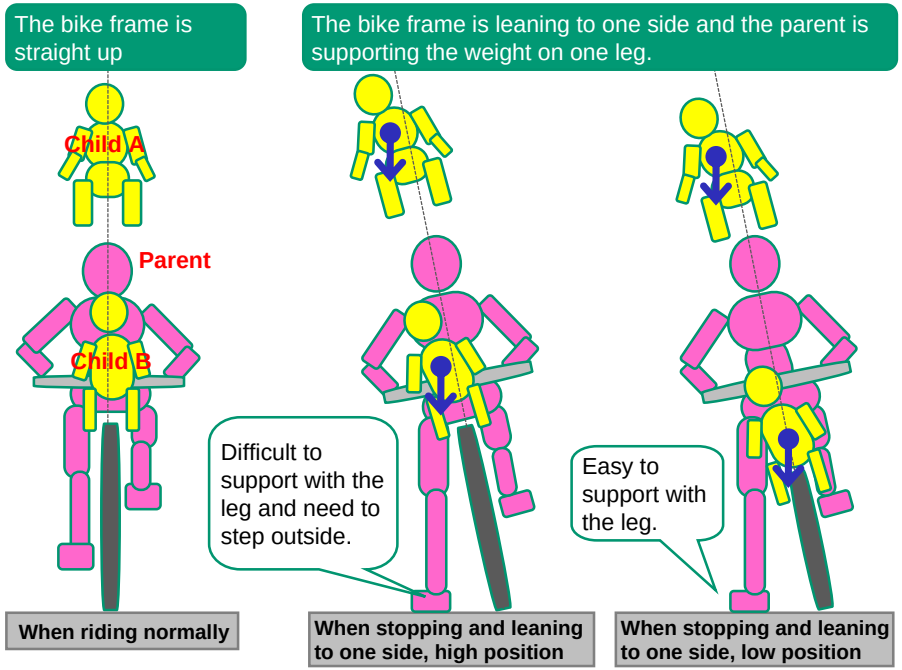


Problem Analysis (Session 2)

① Analysis of Time-Characteristics of Current System



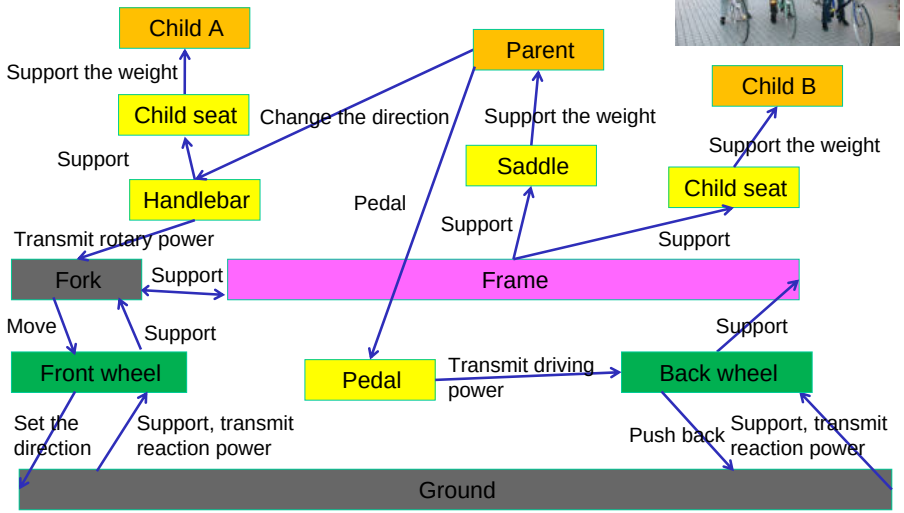
⇒ There are 5 dangerous situations, namely, when mounting, starting off, suddenly braking, stopping, and getting off.



Problem Analysis (Session 2)

② Functional Analysis of Current System

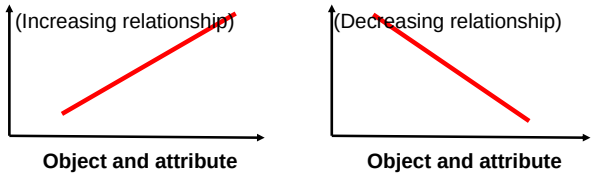
When riding normally ;



Problem Analysis (Session 2)

③Attribute Analysis of Current System

Unwanted effect



Unsteady at low speed

- Weight of 2 children
- Distance between handlebar axis and child's center of gravity
- Weight of bicycle
- Size of back wheel
- Size of front wheel
- Bumpiness of ground
- Length of wheelbase
- Grip force of wheel
- Friction with ground
- Height of child's center of gravity
- Height of bicycle's center of gravity

Difficult to support when stopping and leaning to one side

Height of child's center of gravity
Height of bicycle's center of gravity

Reciprocal relationship?
⇒ Weigh the advantages and disadvantages.
⇒ Sure enough, a low center of gravity is advantageous!

Problem Analysis (Session 3)

Analysis of Ideal System

Desirable action

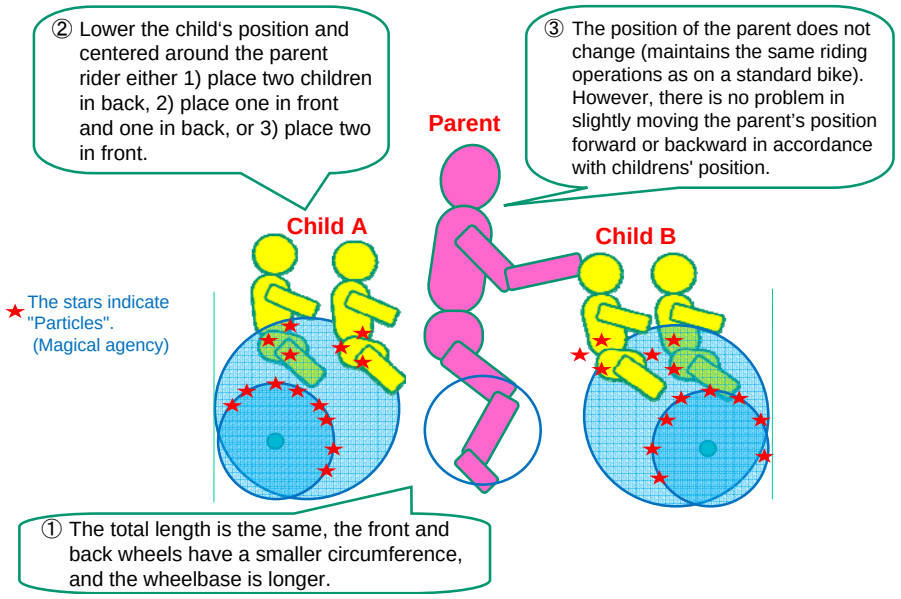
Steadiness at low speed ⇒ Bike does not fall over when stopping and leaning to one side

And

- Easy to find balance (stable)
  - **And**
    - The weight is distributed evenly on front and back wheels
      - Wheel size
      - Length of wheelbase
    - Nothing interferes with the handlebar movement
      - Position of handlebar axis
      - Handlebar shape
      - Position of fork axis
      - Relation between position of handlebar axis and child seat B
- **Or**
- Readjust when the frame likely to fall over
  - When it detects the likeliness of falling over, it turns the position back or supports itself.
    - Sensitivity of gyro sensor
    - Weight, position, and movement of counterweight
    - Movement of stabilizer wheel
- **Or**
- A frame that does not fall over easily (Does not fall over)
  - **Or**
    - Easy to return to a stable position by using the leg when the bike is leaning to one side
      - Height of child's center of gravity
    - The bike cannot fall over
      - Number of wheels

Ideal Image

Sketch of Ideal Solution



Solution Generation (Sessions 4 & 5)

Free Idea Generation and Systemization (Part 1)

Design a frame that does not easily lean to one side

Grouping based on time

- When starting off (At low speed)
  - Light pedaling
    - Generating a large torque
    - ⇒Electric power assistance
    - ⇒Automatic gear shift mechanism
    - ⇒Automatic crank adjustment
    - ⇒Smaller wheels
  - A frame that does not easiy lean to one side
    - Supporting a return to a steady position after detecting that the bike is leaning to one side
    - ⇒Gyro sensor and counterweight
    - ⇒Stabilizer wheels automatically engage when leaning is detected
    - ⇒A balancing arm engages when leaning is detected
    - ⇒Improved steering
- When braking
  - A frame that does not fall over when stopping and leaning to one side
    - Providing good support when the parent jams her leg to the ground
    - ⇒Lower child seat (lower center of gravity)
    - ⇒Smaller wheels
  - A handlebar that can become immovable
    - ⇒Handlebar lock making the bike immovable
    - ⇒Kickstand attached to the front wheel
- When getting off
  - Improve the kickstand
    - ⇒Wider ground width of kickstand
    - ⇒Bigger and sturdier kickstand

○ Has a clear effect (advantage)

△ Requires technical examination or effect is weak

Solution Generation (Sessions 4 & 5)

Free Idea Generation and Systemization (Part 2)

Lower the center of gravity and position the child seat so that it has good balance.

Grouping based on child seat position

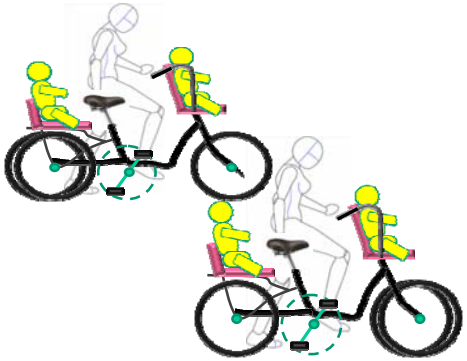
- Back seat
  - 2 in back
    - Back
      - •Move the parent forward.
      - •Make the wheelbase longer.
      - •Move the child forward of the back wheel.
  - 1 in back, 1 in front
    - Back
      - •Make the wheelbase longer.
      - •Move the child forward of the back wheel.
    - Front
      - •When riding over the handlebar, align the axis.
      - •Ride over the frame, not the handlebar.
- Front seat
  - 2 in front
    - Front
      - •Move the parent backward.
      - •Shift the fork axis and handlebar axis.
      - •When riding over the handlebar, align the axis.
      - •At the very least, 1 child should be seated over the frame.

The basic solution direction is “make the wheels smaller and thus lower the center of gravity!"

Solution Generation (Sessions 4 & 5)

Free Idea Generation and Systemization (Part 3)

- **3 or more wheels**
  - Cycle with 3 wheels
    - 2 back wheels
    - 2 front wheels
  - 3 or more wheels with attachment
    - Side car
      - The total width must be 600 mm or less (JIS bicycle standard).
      - ⇒Under current law, this type of bicycle could not be ridden on the sidewalk.
    - Rear buggy
      - The total length must be 1,900mm or less (JIS bicycle standard).



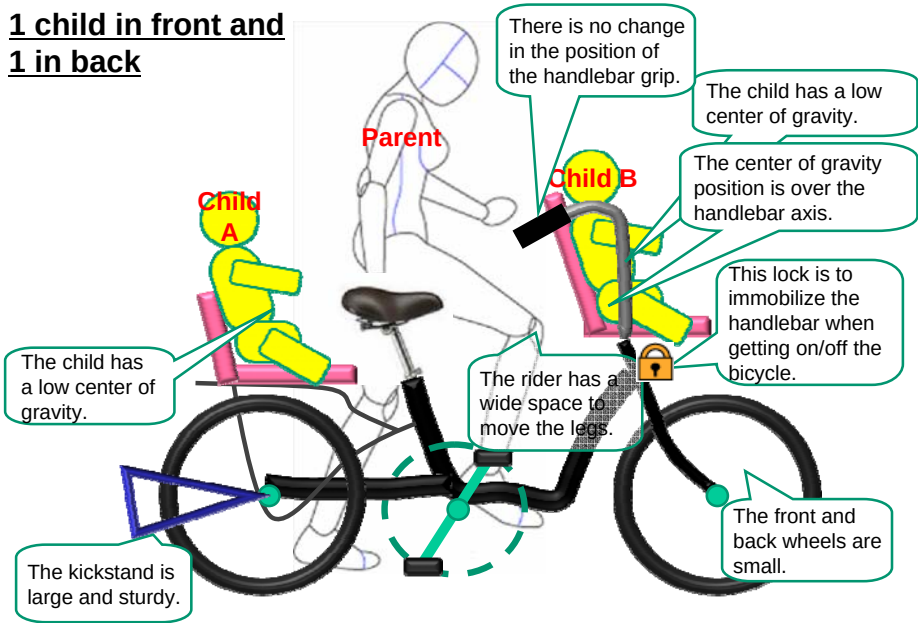
Both types would contribute to resistance to falling over and are thus practical solutions.

These types are problematic from the viewpoint of ridability and laws and regulations.

Solution Generation (Session 6)

Building Solution Concept

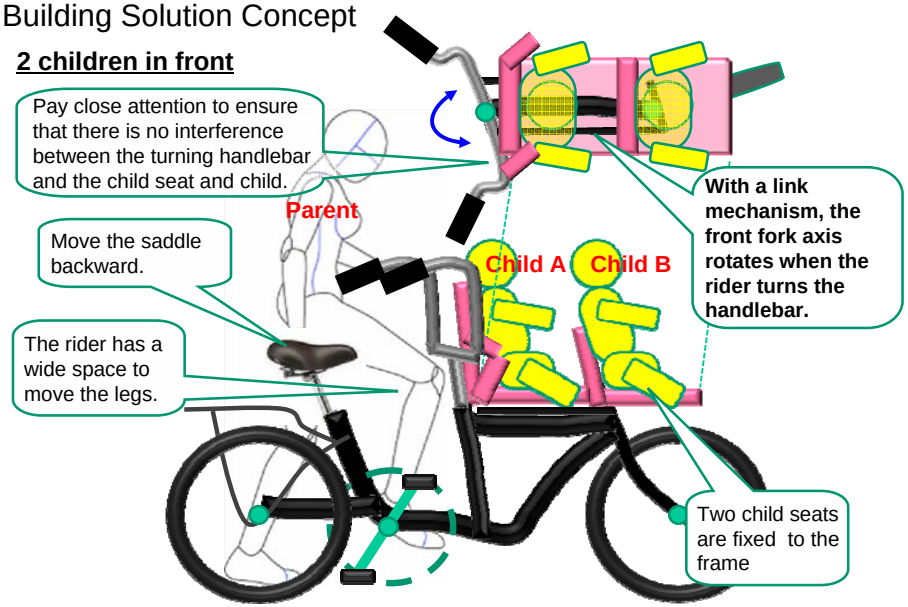
1 child in front and 1 in back



Solution Generation (Session 6)

Building Solution Concept

2 children in front



Welcome trial riding! Use it on a lease as long as you need it.
2 week trial period. May quit the lease at any time.

Conclusions

■ Applying the USIT method

- Problem definition: Starting with a provisional definition with plausible root causes, we have reviewed it at each stage.
- Problem analysis: We found it important to use different tools for revealing different aspects. Desirable actions of ideal system are important to think.
- Solution generation: We generated ideas freely and made them systematized. So we did not use USIT Operators intently; we need to study USIT Operators some more to actually use them.

■ Finding directions to solutions

- In the time-characteristics analysis, we found 'five dangerous occasions'. And by separating the problem of getting on/off, we focused on the problem while riding at low speed and while supporting with the leg during stopping.
- We noticed that “a low center of gravity” is essential for all the five dangerous occasions. This guided us the overall solution directions toward the smaller wheels and generating space between the rider and the front wheel.

Evaluation: Non-specialist participants from diverse backgrounds worked on this topic in cooperation and generated useful solutions within a limited time. Thus the training exercise and the afterward case-study writing were meaningful and satisfying experiences.