*ETRIA TRIZ Future Conference 2008*
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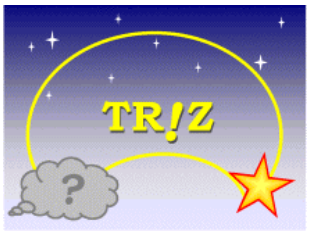
*in Enschede, The Netherlands*




# Applying TRIZ/USIT to A Social & Technical Problem: Auto-locking Door System of Apartment Building

**Toru Nakagawa and Arata Fujita**
**Osaka Gakuin University, Japan**

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*The University of Twente*
*Enschede, The Netherland*

## Outline of our Talk:

Based on Thesis work by Fujita + further research by Nakagawa.

To try to solve an everyday problem creatively:

'How to Prevent Unauthorized Persons from Entering the Auto-locking Door of Apartment Building'

Such a person can enter the door, simply by following a resident.

We found 3 main causes: technical, human psycological, and social ones.

Students' group discussions were guided with TRIZ/USIT, and analyzed with the KJ method and RCA+ diagram, etc.

We propose a new Scheme/System of Auto-locking Door:

IT & logical system of door control is introduced over the current Mechanical & physical control system.

This will solve all the three aspects of problems together.

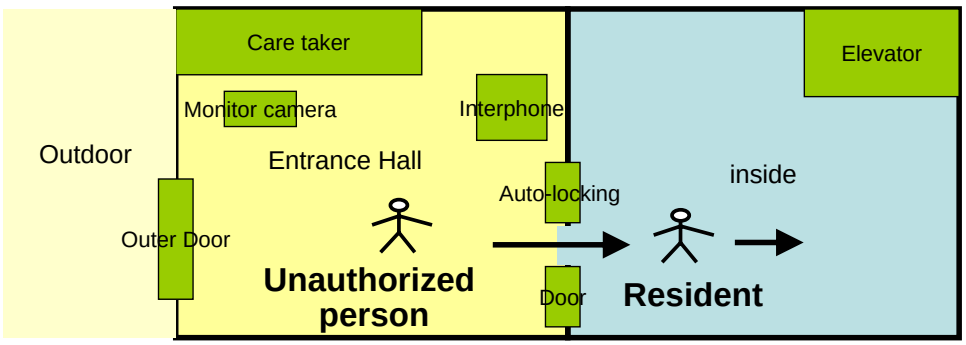
# Problem Definition

USIT method

**(a) Undesirable Effect:** In an apartment building with an auto-locking door system, unauthorized persons can enter the door easily and endanger the security.

**(b) Task/Goal:** To ensure the security of the apartment building by preventing the unauthorized persons from entering the auto-locking door .

**(c) Sketch of the problem situation:**




**(d) Plausible Root Causes:** The unauthorized person, behaving like a resident, can enter the door opened by a resident simply by following him/her.

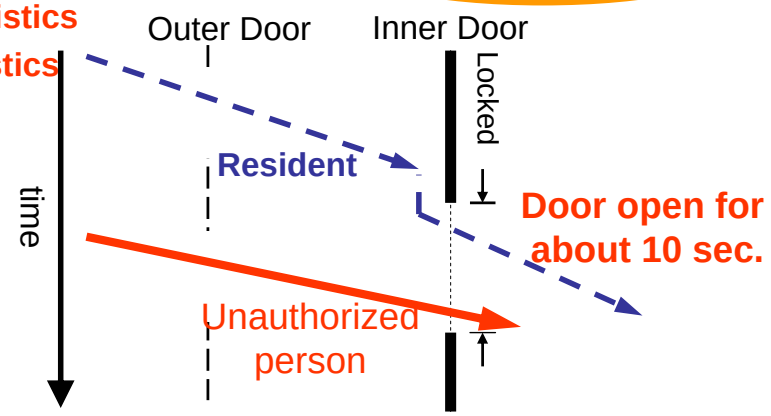
**(e) Minimum Set of Relevant Objects:** Entrance door, Control system, an unauthorized person, a resident who goes ahead

# Analyze the Problem

USIT method

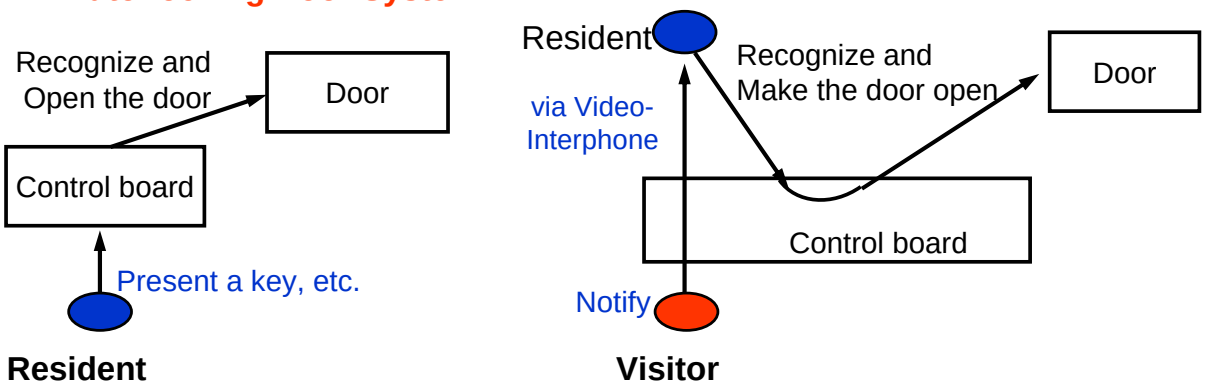
**(a) Analysis of Space Characteristics**

**(b) Analysis of Time Characteristics**




**(c) Current means:**

**Auto-locking Door System**



## (d) Analysis of Behavior of the Unauthorized

View from the unauthorized person
[Subversion Analysis ]

**Students' discussion was facilitated. The recorded the cards were reorganized in the KJ method (i.e. Affinity diagram method).**

**Unauthorized Person behaves just like a resident (pretending)**

- in a costume/ attitude fit with the situation
- just like a student
- in an ordinary business ware
- just like a housekeeper

**Can slip in (at a good timing)**

- disguise in a uniform of home delivery service
- saying 'package delivery service' or 'post-office express mail ' etc.
- disguise as if in the middle of a delivery service
- a sales person: try to access every resident via the interphone

**Once get inside the door, one can go anywhere and can do anything**

- follow a resident through the door in an innocent face
- Wait outside for a good timing
- Get a PIN in advance
- Watch and remember the PIN of a resident

- Force a sale door-to-door
- Press the button of any floor in the elevator
- Unlock an apartment door with picking or a special technique.

## (e) Analysis of residents' behaviors:

## Search for root causes in their psychology

**Students' discussion was facilitated. The recorded the cards were reorganized in the KJ method.**

**Some solution ideas came out**

**Residents allow the unauthorized persons to get in.**

**Because I thought he/she would be a resident.**

- We cannot recognize all the neighbors.
- Because she looks like an housewife.
- Because being accompanied with a child
- Because she was carrying a shopping bag.

**Because I didn't think he/she a malicious person**

- Usually we do not think people malicious.
- I let the door unlocked because I did not doubt about his word.
- Because I was in a hurry.
- We do not want to be impolite and unkind to people.

**Usually we assume our community being formed with good people in nature.**

- It is a kind manner to hold the door open for a next coming person.
- It is a kind manner to hold the door open for a person having a big bag.
- In case of a heavy door, we hold the door open for a next person.
- In case of a light door or an automatic door, holding the door open is not necessary.

- We must be precautious against risks.
- We do not want to get into trouble.
- In case we misjudge the person being malicious, we could be in trouble.
- The assumption of good people is a basis for a warm-hearted community.
- We will not block a person who happens to enter when we just go out.
- We will not stop a person who happens to enter next to us.

## (f) Collect all relevant information

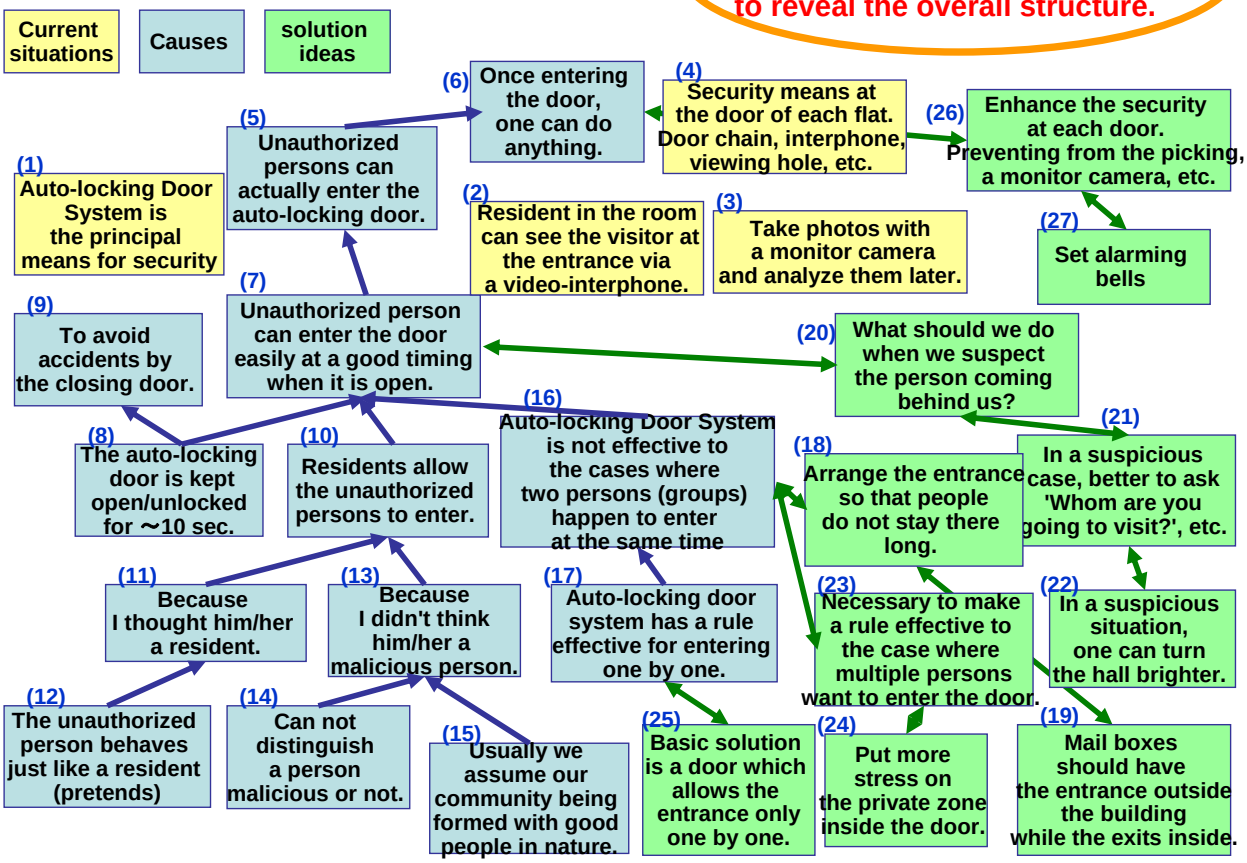
**How to Prevent Unauthorized persons from entering the Auto-locking Door of Apartment Building**

Collect the upper-level cards and put them in a glance to consider the logical relationships among them.

- Auto-locking Door System is the principal means for security
- Can not distinguish a person malicious or not.
- Take photos with a monitor camera.
- What should we do when we suspect the person coming behind us?
- Mail boxes should have the entrance outside the building while the exits inside.
- Unauthorized persons can actually enter the auto-locking door.
- Can enter the door easily (at a good timing)
- Auto-locking door system has a rule effective for entering one by one.
- In a suspicious case, better to ask 'Whom are you going to visit?', etc.
- Residents allow the unauthorized persons to enter.
- The auto-locking door is kept open/unlocked for ～10 sec.
- It is not effective to the case where two persons (groups) happen to enter at the same time
- In a suspicious situation, one can turn the hall brighter.
- Set alarming bells which have switches in every flat and ring in the corridor of the floor and in the care-taker room.
- Because I thought him/her a resident.
- To avoid accidents by the closing door.
- Once entering the door, one can do anything.
- Necessary to make a rule effective to the case where multiple persons want to enter the door.
- Necessary for the resident in the room to see the visitor at the entrance via the video interphone.
- The unauthorized person behaves just like a resident (pretends)
- Because I didn't think him/her a malicious person.
- Usually we assume our community being formed with good people in nature.
- Basic solution is a door which allows the entrance only one by one.

## (g) Understanding the Overall Structure of the Problem

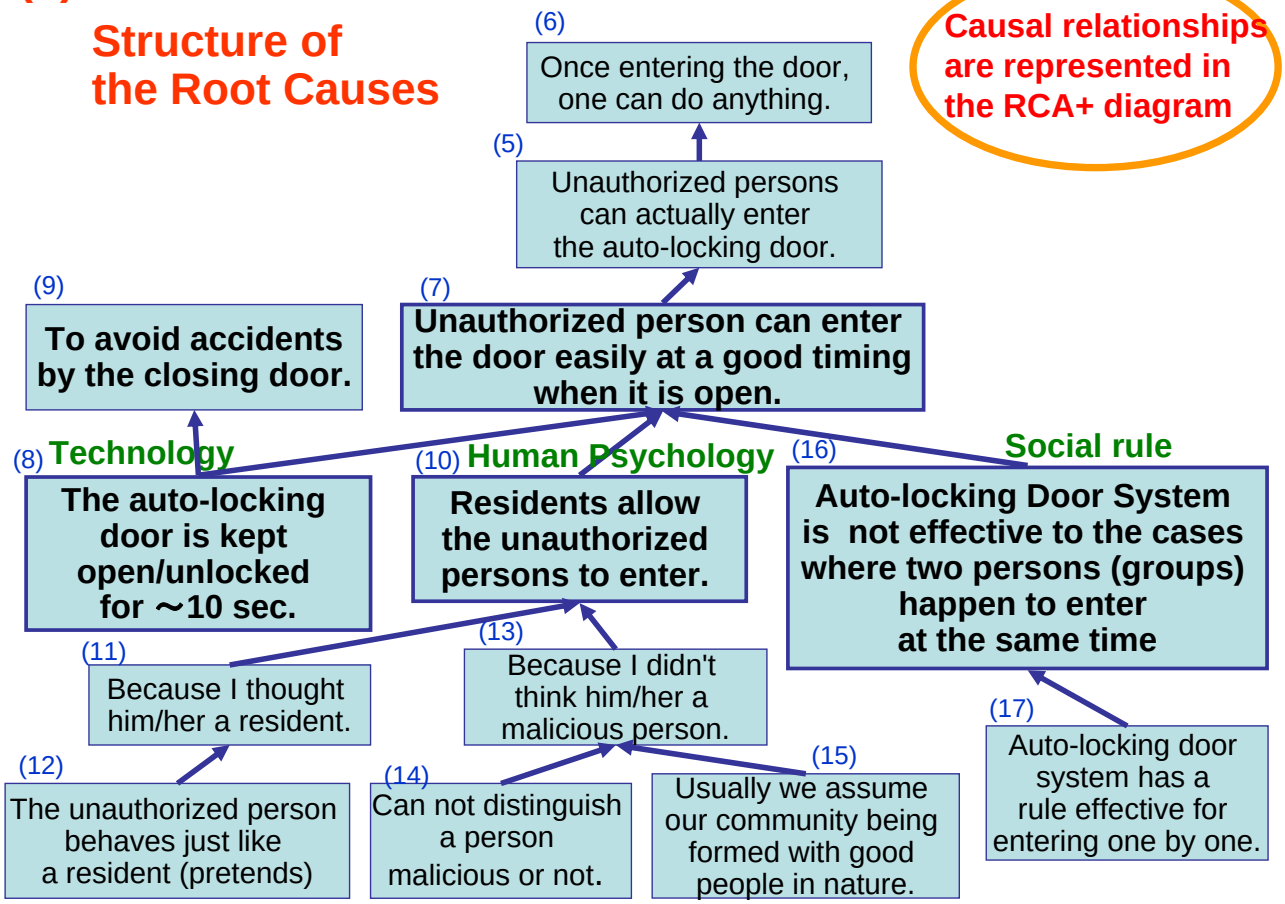
Use the KJ Method to consider the relationships among the cards and to reveal the overall structure.



# (h) Essence of the Problem

## Structure of the Root Causes

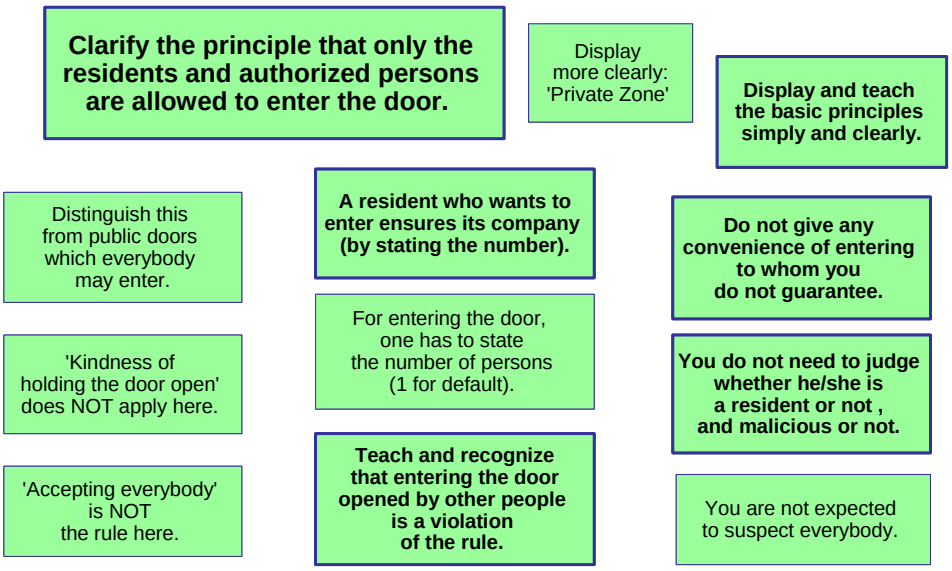
Causal relationships are represented in the RCA+ diagram




## Idea Genertion (1)

## Solution ideas to 'Residents allow the unauthorized persons to enter'

Ideas from students' discussions were later enhanced and reorganized.




**Clearly distinguish the Private Zone Entrance from the Public Entrances.**

**System should not request the residents to judge about others, but to declare about his/her accompanies.**

## Idea Generation (2)

## Solution ideas to 'System is not effective when two groups happen to meet.'

Ideas from students' discussions were later enhanced and reorganized.

- Must clarify the rule when two (or multiple) groups happen to meet in front of the door.
- **Each group is responsible for getting authorized by operating the key (or something equivalent)**
- **Passing through the door opened by a preceding group is a violation of the rule.**
- When you find the group next to you is suspicious, ask them 'Whom are you going to visit?', etc.
- **Display and teach the basic principles simply and clearly.**
- **Even while the door is open, System must be able to accept the authorization procedure by the next group.**
- System should detect that the next group is likely to violate the rule and make a notice immediately.
- **System must detect the violation by the next group and make an alarm immediately.**

- **Inconvenient rigorous rules do not work.**
- **The authentication need to be processed at any time.**
- **Our System need to be intelligent.**
- **The new social rule: "Every party must get the authentication for themselves regardless of the door being open or closed."**

## Idea Generation (3)

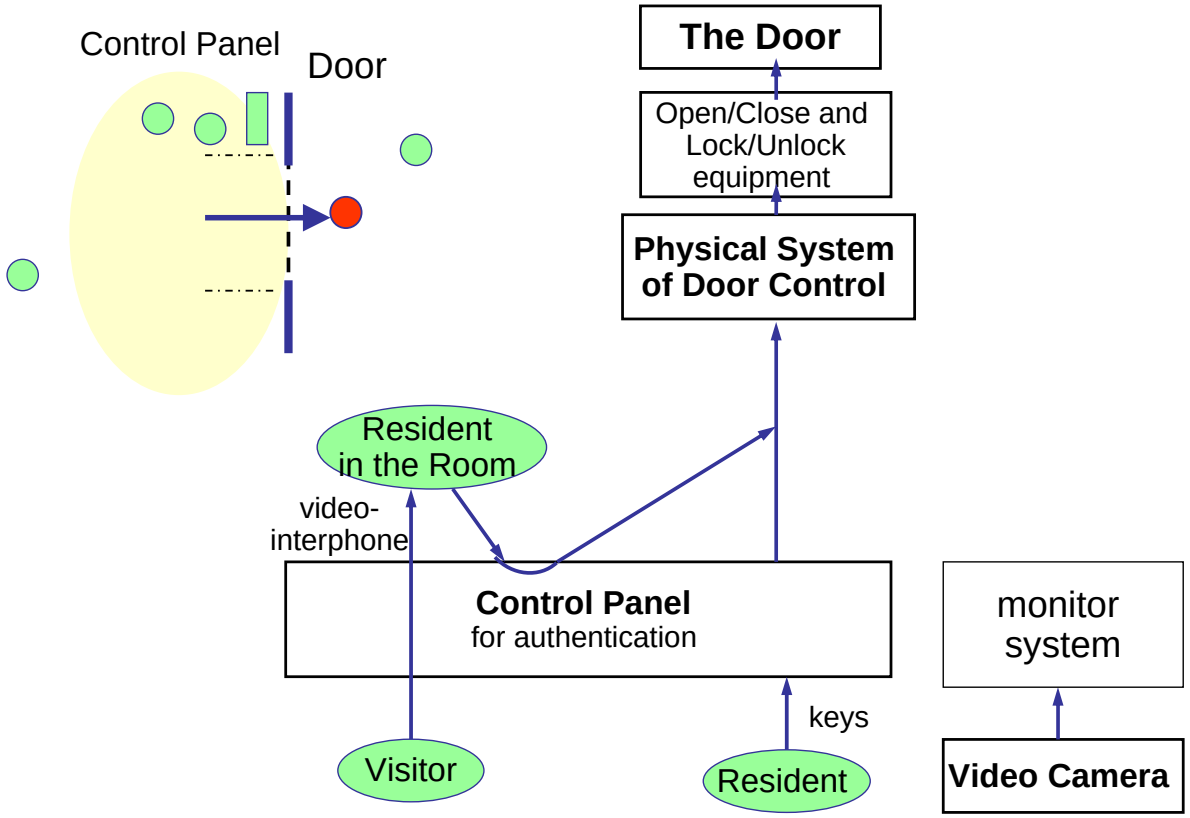
## Solutions to 'The auto-locking door is kept open/unlocked for 10 sec.'

Ideas from students' discussions were later enhanced and reorganized.

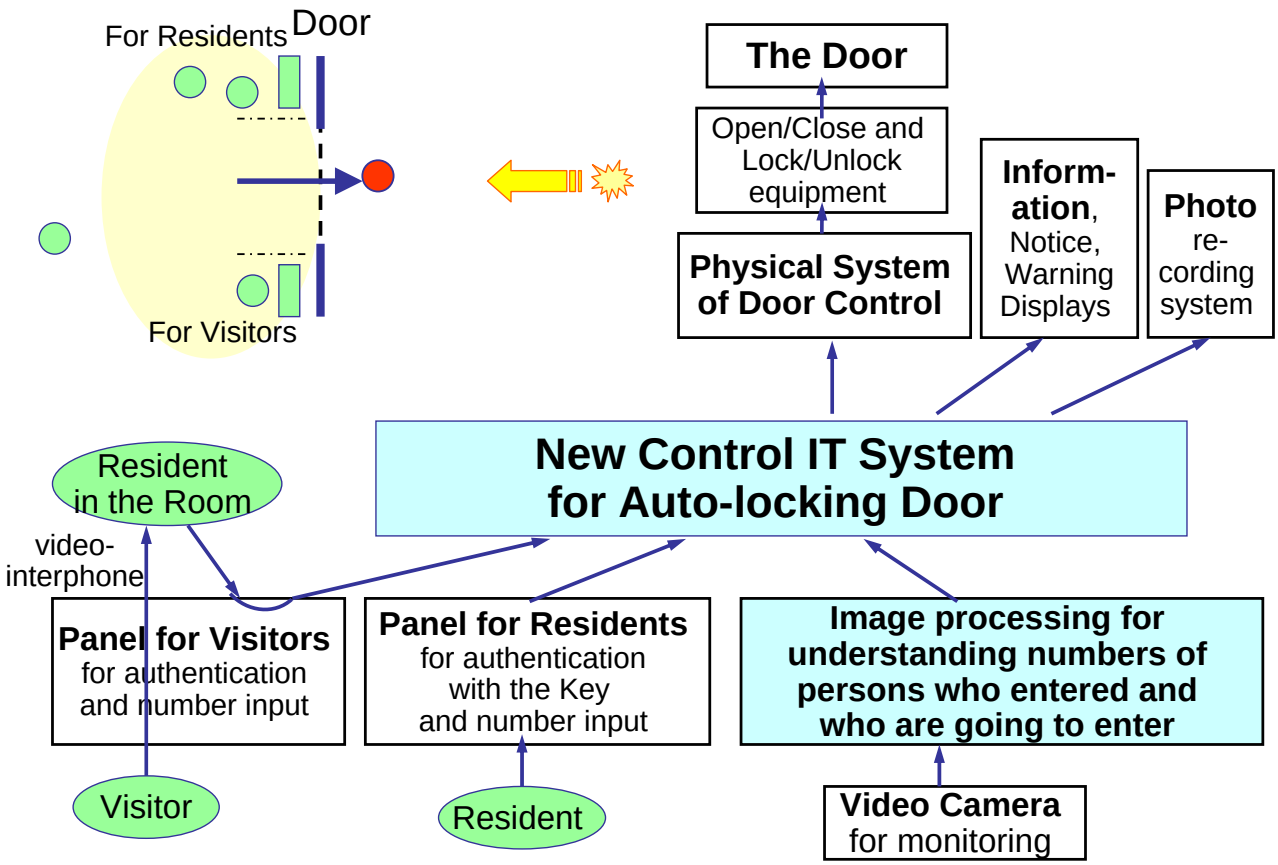
- **To avoid accidents by the closing door, the big, heavy door should be moved slowly and operated on the safety side.**
- After the number of people registered so far have entered, display 'After getting authorized, please enter the door.' etc.
- To avoid the entering from sides, set poles and ropes besides the door.
- **The number of people who have passed / are going to pass should be detected real time by an IT system.**
- With image processing, the System determines how many entered and how many are likely to enter.
- **When more than the registered number are going to enter, the System displays and announces a notice.**
- **When more persons have entered in violation, the System tells a warning and takes a photo with lighting.**
- **Display and teach the basic principles simply and clearly.**
- Responding in real time, proper displays and announcements are made for instruction and notice.
- Responding in real time, displays, announcements, alarms, photo recordings are made with increasing levels of alert.
- Records of alarm cases are analyzed later systematically to manage individually.

- **Confirmation of the safety-first principle.**
- **To abundon the idea of physically forbidding the violation. Warning is enough.**
- **To allow a declared number of people to enter.**
- **To introduce a virtual and logical door with intelligence.**
- **Separation of residents and visitors in space.**

# Current Control System of Auto-locking Door




# Our Solution : A New Control System of Auto-locking Door



## Final Solution Concept:
## A New Control System
## of Auto-locking Door (Part 1)

**Build up a solution concept,
in a consistent way.
Use all your capability!
(Nakagawa)**

(1) Display: **"Private Zone Inside This Door."**
"Residents and authorized persons ONLY are allowed to enter."

(2) Display: "Each person (or each group) should get authentication for yourself.
Even while the Door is Open, the authentication process is accepted.
**Independent of the Door status, start the authentication process.**
Entering the Door without authentication is a violation of the rule and law."

(3) Display: "Residents: Use the panel Left to the Door.
Visitors: Use the panel Right to the Door. "

(4) Display (on the Left Panel): "**For Residents: Insert your key, Input the number of your group** at moment (1 if you are alone), and turn and remove the key.

(5) Display (on the Right Panel): "**For Visitors:** Press the residence No. you are going to visit, and talk with the resident via the video interphone.
**Get the approval by the resident, telling the number of persons of your group.**
When lamp(s) turn on for your group, please enter the door."

## Final Solution Concept:
## A New Control System
## of Auto-locking Door (Part 2)

**Build up a solution concept,
in a consistent way.
Use all your capability!
(Nakagawa)**

(6) **The Door itself is operated slowly and safely**, just as usual at present:
Opens slowly, closes slowly, being unlocked for about 10 seconds,
and re-opens in case of any obstacle **for the purpose of safety**.

(7) **An IT system is built for giving door control operations.** The system must have image processing ability and work with the panels for authentication.

(8) The IT System monitors with a video camera around the door, and **understands in real time the accumulated number (*e*) of persons who have entered the door** (since the door is opened this time) and the number of persons who are going to enter the door.

(9) The IT System cooperates with the panel for authentication operation and understands in real time **the accumulated number (*a*) of persons who are approved** in the authentication (relevant to the door opening of this time).

(10) **'Number of persons left with authentication' (*p*)** is defined by 'accumulated number of authenticated persons' (*a*) minus 'accumulated number of persons entered the door' (*e*).
*p* is used for giving door-open/close orders and for controlling the notice/alarm displays.

## Final Solution Concept: A New Control System of Auto-locking Door (Part 3)

**Build up a solution concept, in a consistent way. Use all your capability! (Nakagawa)**

(11) While 'Number of persons left with authentication' ***p* > 0**, the System gives **the Open-Door direction** and displays 'Please enter' at the top of the Door.

(12) **While *p* = 0**, the System gives **the Close-Door direction** and displays as **'Please get authentication on the panel**, right (for residents) or left (for visitors) for entering the door'.
This is a normal state. If the Door is open, it will start the closing motion.
When the Door is closed and locked, the variables *a*, *e*, and *p* are reset to be 0.

(13) **While *p* = 0** and the Door is not locked, **if the System detects any person who is going to enter the Door**, it makes the display (12) on and off, and make an announcement for notice.

(14) **When *p* turns to negative** (and also increases in its absolute value with $p < 0$), **the System has detected a violation of the rule.**
Thus it turns the flash light on and **takes a photo** from front of the person who has just entered the Door. And it displays and announces as 'Since it is detected that more persons than those authenticated have entered the door, a photo is taken for the security reasons. To avoid this inconvenience, please enter the Door after getting authentications.'

## Final Solution Concept: A New Control System of Auto-locking Door (Part 4)

**Build up a solution concept, in a consistent way. Use all your capability! (Nakagawa)**

(15) **While *p* > 0 and nobody has entered for the last preset period of time** (say 10 sec), the System gives the Close-Door direction.
When the Door gets closed and locked, the variables *a*, e, and *p* are reset to 0.

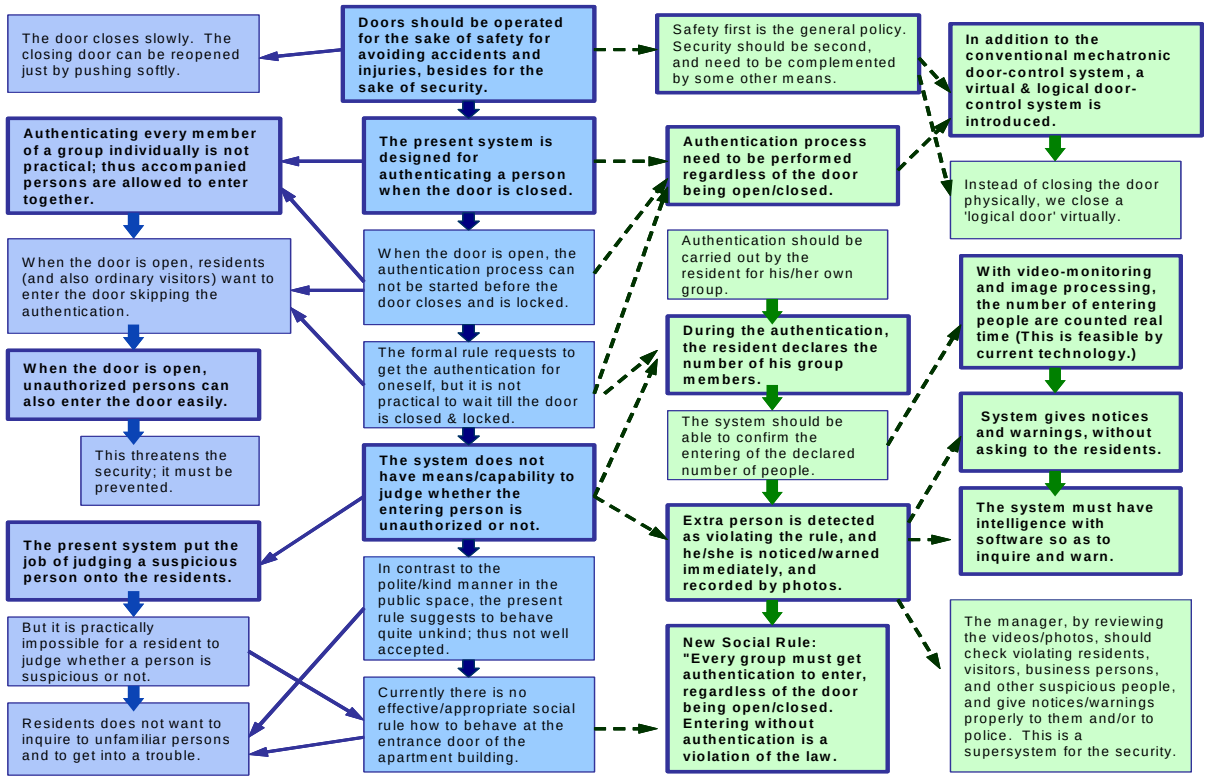
(16) **The records of operations, especially the photos taken, are analyzed later,** desirably every day, by the manager for the purpose of making appropriate means both individually and generally for increasing the security of the building.

# Discussions:

## Reconsidering the whole problem
### TRIZ Thinking (Nakagwa)

## Current System:
### Problems (results) ← Designs (choices)

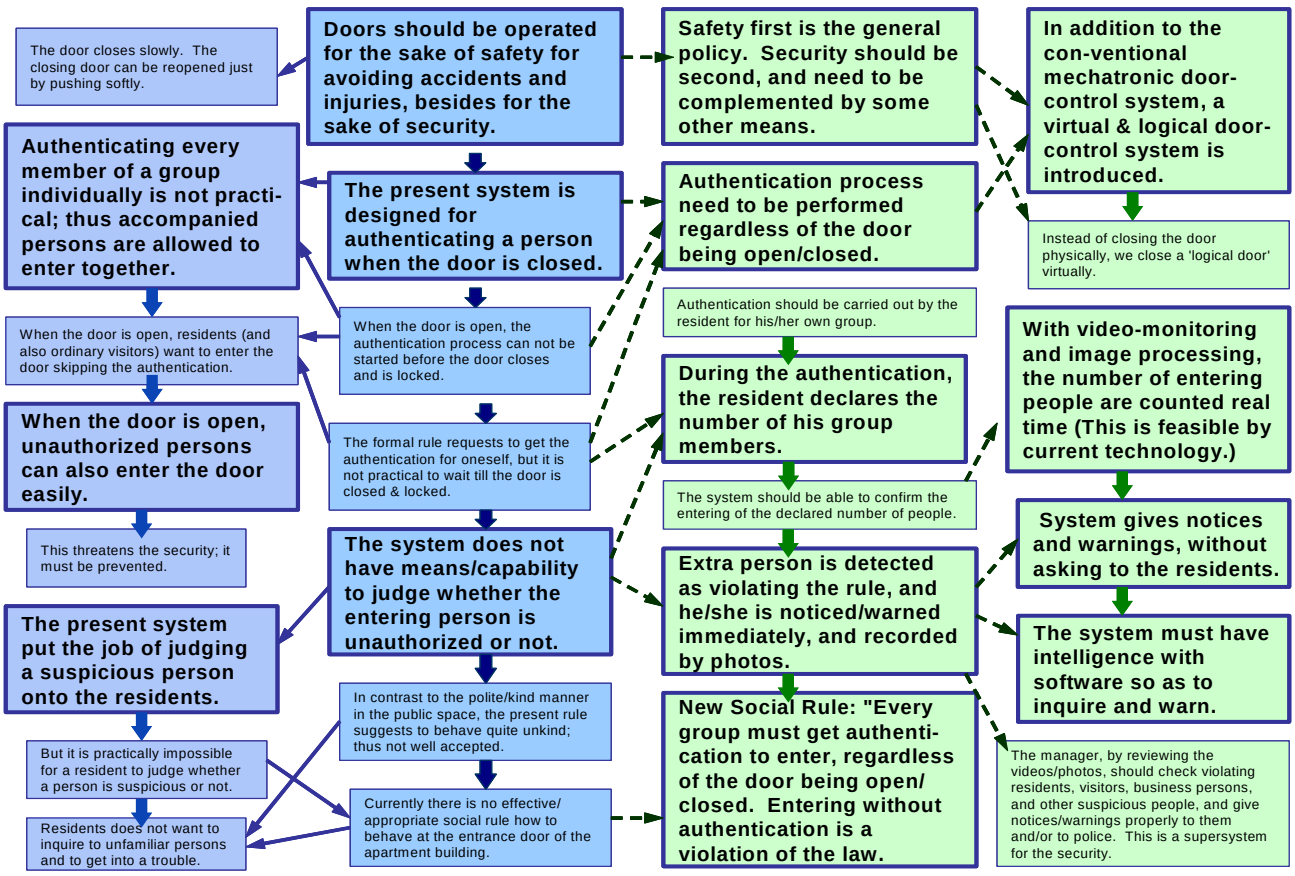
## New Solution System
### New Designs and expectations





## Current System:
### Problems (results) ← Designs (choices)

## New Solution System
### New Designs and expectations

# Conclusions

The **Auto-locking Door System of apartment buildings** has serious **security problems apparently related to human psychology and social behavior.** We tackled them with TRIZ/USIT.

Anlayses and ideas mostly came from students' discussions, guided with TRIZ/USIT and summarized with the KJ Method. They revealed many contradictions and possible solution directions.

A solution concept was built around the idea of
**IT-based Logical Door System**
**over the current Elecro-mechnical System.**

The solution was designed to solve many contradictions in the current system, with the guide of TRIZ thinking.

All the **psychological and social problems are solved**, hopefully, by the new design choices in the IT-based technolgy, in this case.