



TRIZ in Robot Education

- Application of Block Robot to TRIZ Education -

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1983: Yamanashi University graduation

1985: Yamanashi University graduate school completion

1985: Hitachi Ltd.

It is engaged in **the magnetic head's** for hard disk development, design, and manufacturing.

The magnetic head is the weakest to static electricity in all electronic devices.

→ **Static electricity measures technology**

2003: Hitachi Global Storage Technologies Ltd.

2010: Assumption of Professor of Suzuka National College of Technology, Department of Electrical and Electronic Engineering

< **Industrial human resources development in the future** >

Importance of Intellectual Property in Enterprise

The **problem discovery and the problem solving ability** are necessary and indispensable for "Engineer who has the technology and contributes to the society".

Three Ps necessities because of product development in enterprise

- 1. Patent (literary property and patent)**
- 2. Paper (thesis, technological material, and report)**
- 3. Product (product)**

Especially, **the literary property** is important when the publication of the article and the product are announced confirmed, and it is indispensable in undertaking activities.



Kousen advances a further reform aiming at the upgrade of the Kousen education on the 50th anniversary of foundation. It is "Kousen for the society", and "Kousen for 50 next years." to aim

Key word for 50 next years are,

①It is possible to take an active part globally valuing the region.

It is talent ([global talent](#)).

②It has wide view such as the environments and the resources.

[It is talent who can develop continued technology.](#)

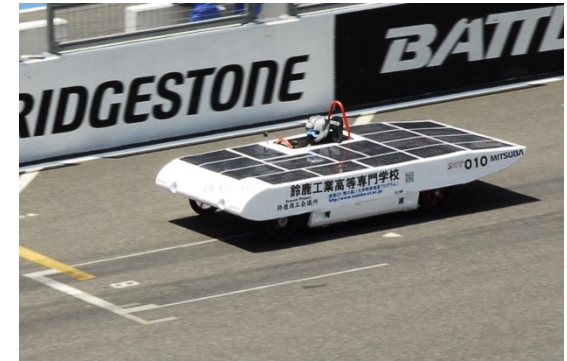
③It is assumed that it is talent's ([innovation talent](#)) who can develop the conception aiming at them promotion.





Suzuka Industrial Technical Colleges

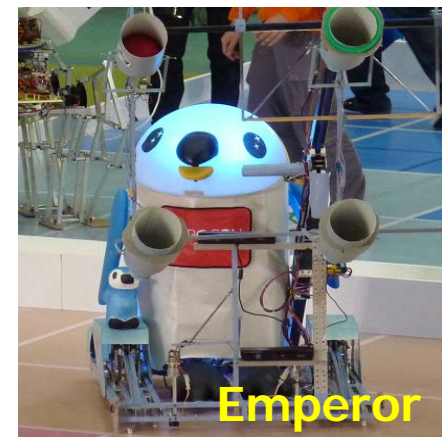
Suzuka Kousen is in famous Mie Prefecture Suzuka City in Suzuka Circuit. Suzuka Kousen came the 50th anniversary of establishment. It aims **at the promotion of the engineer of the value creation type** that flaps in the world, and creative activities such as Robot Contests and eco-friendly cars are active.



It participates in the national athletic meeting 2 years in a row.

2013 best 4

2014 technological prize



Intellectual property education activity of Suzuka kousen

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
開発推進校事業	○	○	○		○	○	○	○	○	○	○	○	○	○ (展開型)			
授業(法学I・法学II)(4年生全学科)	→																
専攻科1年生対象知財セミナー	→																
3年生対象知財セミナー(全学科)	→																
発明クラブでの創造性実験ワークショップ	→																
校内パテントコンテスト 提案件数(件)	→ (学校行事化)																
							28	12	6	232	493	667	1283	704	(前期末9月→8月)		
課題研究(全学科1~5年生) 受講生数(人)	→																
											22	30	21	34			
新1年生対象入学時知財セミナー	→ (新学習指導要領対象学生フォロー)																
												224					
全1年生IPDL検索「情報」	→																
												224					
パテントコンテスト受賞							★ 1件			★ 1件	★ 1件		★ 1件	(ポルト締め忘れ防止コンテスト) (2件)			
地域の課題に学生が取り組む	→																
													発泡ガラス、透明骨格標本、中学生エネワンGP、3Dブロック				
学会・コンテスト応募(受賞)												3 (1)	3 (3)	5			

Innovation Education is Basic



It gives birth to the idea.
(creation)

It makes it to the right.
(protection)

It makes the best use of for the society.
(use)



Problem Research

(Outline of Problem Research)

(From the student manual)

1. Study to original of the guidance of the teacher, intellectual curiosity of the student, and various fields is roused. To improve the desire for study, it is assumed the study to be done by the lecture, the practice or the fieldwork that the teacher presents.
2. (1) **Study 30 hours or more.**
 - (2) Content shall be ranges of study, the class, and the practice, etc. of Technical College that the advising teacher can guide.
 - (3) Make the report etc.
3. The evaluation should be admitted a content that corresponds to **one unit** by the examination or the report.



Problem Research

Purpose: The idea is made a patent. It challenges the patent contest and academic conference presentation.

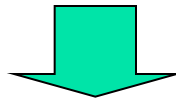
TRIZ is applied to practicing problem solution, and the idea is made the best use of for making the detailed statement.

- (1) Acquisition of basic knowledge of literary property and IPDL retrieval maneuver
- (2) Creation education
(patent contest, academic conference presentation, and content development)
- (3) Making practice of mock application document

Content of execution:

The student is recruited by theme name

“Power to learn idea creation method (TRIZ), and to invent the idea is acquired”.



Number of students of attending a lecture 34 people

The first grader: 12 people、 The second grader: Seven people、

The third grader: Seven people、 The fourth grader: Eight people

(Machine: One person、 Electricity: Eight people、 Information: Three people、

Biology and chemistry: Seven people、 Material: 15 people)



Problem Research

Execution scenery



Idea generation



IPDL retrieval



Detailed statement making



Symposium



JST Science and Technology Communications Business「Regional Type」

Scientist in the future whom regional industries bring up“Mie science network”

～Construction of Mie science network studied from agricultural fishery commercial industry～

Industry in the north central part, agriculture, forestry and fisheries industry in southern part, and travel industry, etc. the trait of industry in Mie Prefecture is made the best use of. Regional enterprise and higher education organization that practices science and scientific education, the science and technology communications by cooperation with the volunteer group act. And, the network in which it works on the promotion of the scientist and the engineer who bears the deepen of understanding to a regional business and the region of the future is constructed.

Long-term goal

(1)A regional enterprise, the volunteer group, and cooperation that has individually developed the science, the scientific education, the career education, and the educational activity such as environmental education up to now in various places are taken. And, the science and technology education activity enhanced adding the education of the science of Technical College and the university power, a technological, educational power, and the research power is created.

(2)Present when the innovation talent's promotion is made pressing need,

It touches the intellectual property education by discovering it about the creation and the improvement of the idea through practicing science communications activity that cooperates with the region. The uplift of the science search heart and the intellectual property heart is aimed at. And, it is possible to develop one's imagination and creativity and it aims at the personnel training in a science and technology lover bright as for the literary property.

(3)The teaching material obtained by cooperation and the education activities and the knowhow of the instructional method are accumulated. Furthermore, an appropriate scientific communication corresponding to characteristics of the region and needs is offered. That is, the cooperation enterprise, the organization, and the lecturer, etc. are made a data base. Everyone constructs accessible “Mie science network”. And, the scientific communication in various places is promoted, and lecturer's leadership is improved. Furthermore, it makes the best use of for continuance and the development of the activity after it ends for this business support period.



Execution of TRIZ Education in Earlier Age

STEM is educated in the United States. The science, the technology, engineering, and the mathematics education are improved and the balance has been improved. On the other hand, the science and mathematics are subjects of the examination, and the time of the technology is little in Japan. The junior high school with the club of the technology is fewer than the club of the physical education, the art as the practice subject, and music. The improvement of the balance of the STEM education is hoped for. Then, it aims **at the improvement of "Concern for the technology" in the kindergarten and the elementary school** and "Basic ability that can be discovered the problem and solved", the creation education by the TRIZ education is executed through the block robot.



Promotion of the industrial talent in the future
with characteristics of the region were made the best use of.

Mobility (auto sector)

Robot (automatic control and unattended operation)

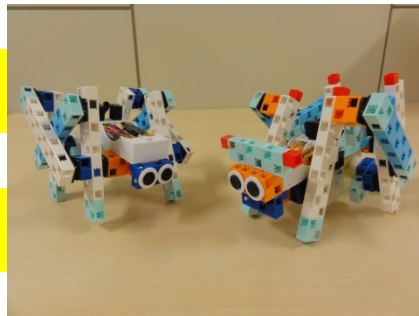
Medical treatment (nursing and movement)

⇒ **Promotion of the industrial talent in the future
with characteristics of the region were made the best use of.**

Mobility

Robot

Biology



Creation type science
education

Environment and energy



Experience type science
education



Mie Science Network Event System

科学プロセス	形を作る	動く(モータ)	動かす(リモコン)	制御する	体験する	挑戦する
対象	幼稚園	幼稚園				
		小学生低学年	小学生低学年			
			小学生高学年	小学生高学年		
				中学生	中学生	中学生
				高専生	高専生	高専生
創造課題	3Dブロック					
		3Dブロックロボット				
			3Dリモコンロボ			
				3Dマイコンロボ		
					エネワン自転車	エネワンカー
						
創造ツール	3Dブロック創造					
		3Dペン創造				
				3Dプリンター創造		
未来人材育成 連携教育	白子幼稚園_創造性教育					
	松坂こどもの城_工作教室					
	すずかテラス_ブロックロボット教室					
		鈴鹿サーキット_科学教室				
		県立博物館_科学教室				
				中学生・高校生・高専生イノベーション教育		
				中学生エネワン		
	知的財産教育・日本TRIZ協会					

Promotion of the industrial talent in the future with characteristics of the region were made the best use of.

Suzuka Circuit is used as "Educational Property".

International Racing Course



KV40, KV-BIKE

<Junior high school student>

Lounge



3DScience room & work exhibition

<Kindergarten and grade-schooler>



About 3D Block Robot Teaching Material


The block is a good material that works easily by children, and is and confirms the creation to shape. Moreover, the concern for the robot and the vehicle is high in recent years. The ArTech block of the ArTech Co. (**3D block**) can assemble all to respect. The point said that it can achieve thought shape and mechanism is a feature. Then, it moves by AA Battery 2, and **2, 4, and 6 leg** robots are produced. Basic power of the robot is put from this. In addition, it unites with the wheel type robot. In addition, through a small supersonic sensor in the microcomputer board, the contact sensor, the motor, the servo motor, the buzzer, LED, and the control of the voice synthesis etc., **the process of the creation of the idea for the problem solution, the verification, and the improvement can be confirmed.**



Robot Education and TRIZ

The robot education is brought up as a creation education. Schoolchildren's concerns are high. When the innovation talent's promotion is called out now, The creation education system to the robot that unites with the intellectual curiosity is hoped for. There is TRIZ in the one.

Creation ⇒ protection ⇒ use

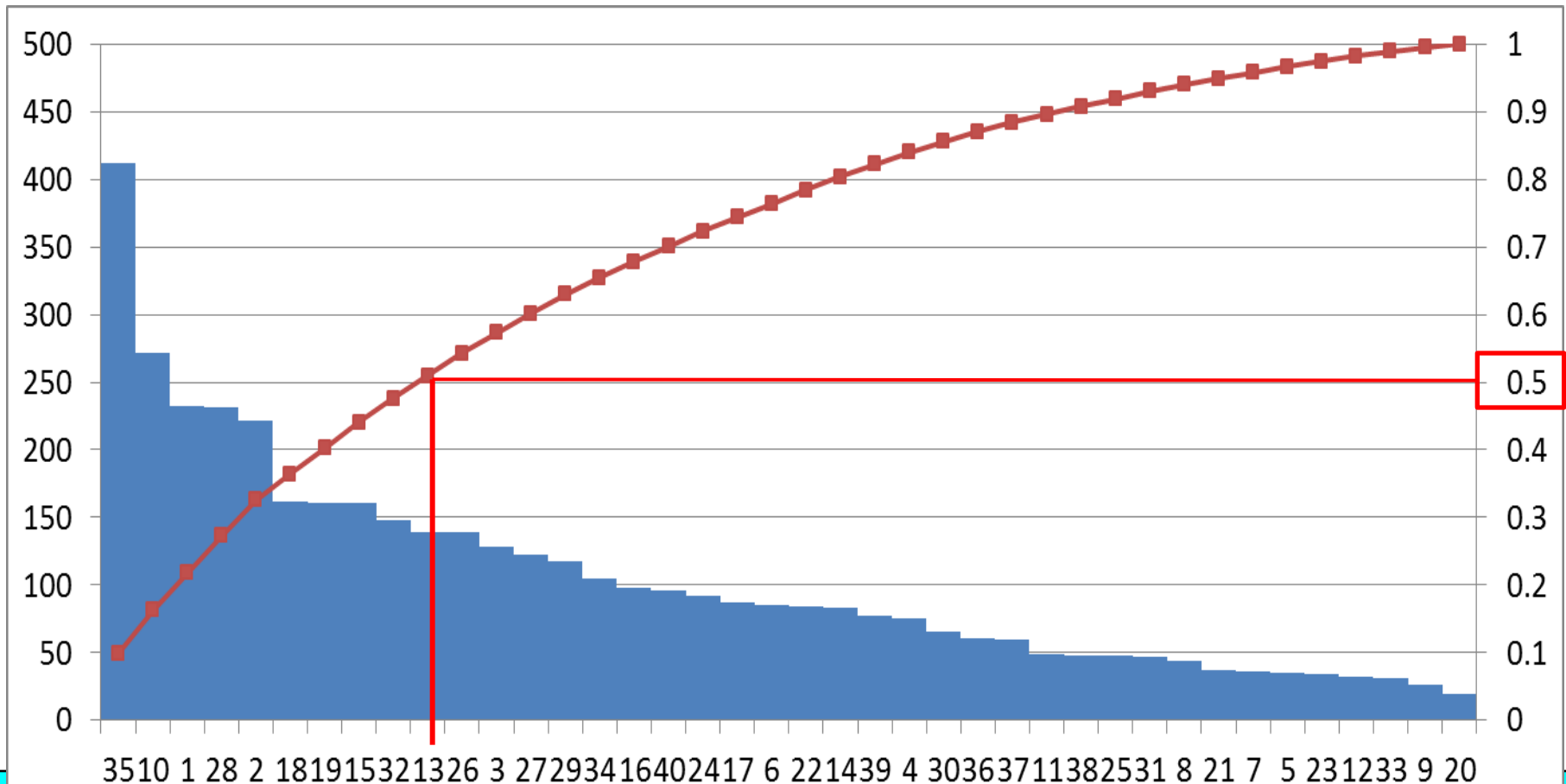
- 
- It is shape as for the idea.
 - It moves.
 - It moves it.
 - It controls.
 - It experiences.
 - It challenges.

Creation education
Intellectual Property
education
(TRIZ)



Robot Education and TRIZ

The appearance frequency of the invention principle of TRIZ in the tenth high rank of contradiction matrix corresponds to 50% of the entire number. In a word, if the invention principle in the tenth high rank place is understood, half the problem can be solved.



Robot education and TRIZ

The tenth high rank place as follows.

35:Change in parameter

10:Advance action

1:Division

28:Perception of mechanism of another substitution/

2:Separation

18:Mechanical vibration

15:Dynamics

19:Periodic action

32:Color variation

13:Reverse-conception

These are the important factors the robot is developed.

To schoolchildren' robot educations、Main item 10 in the invention principle of 40 of TRIZ can be introduced.





Robot Education and TRIZ

(1) Control 1 of robot

To what kind of robot do you make it? It is important what you want to control.

“Invention principle 35 Change in parameter (Or, it is physical of the object. / Transition of chemical composition)”

What do you control according to the environment and the situation to be used including **the motor and the servo motor?** Is it good to change it?

(2) I/O 1 of robot

It thinks about the function (**technique and arms**) to prepare for the robot beforehand.

“Invention principle 10 Advance action (Or, the action is taken in advance.)”
The sound, light, the vibration, and the missile, etc. think about the function and the structure beforehand.





Robot Education and TRIZ

(3) Structure 1 of robot

It thinks about how to make the structure of the robot. Strength is necessary, and lightness is also necessary.

"Invention principle **1 Division** (Or, it subdivides.)"

It thinks about the structure and how to make like the metal, plastic, the all-in-one design, and the block assembly structure, etc.

(4) I/O to robot 2

The **sensor** as the perception of the robot is installed.

"Invention principle **28 Perception of mechanism of another substitution/** (Or, a mechanical method is converted.)"

It thinks what kind of sensor you install.





Robot Education and TRIZ

(5) Structure 2 of robot

It thinks about how to make the structure of the robot. The easiness of assembly and the improvement of maintainability are also important.

"Invention principle 2 **Separation** (Or, it separates and it removes.)"

It assembles with making it to the unit and it does. The improvement of maintainability etc. are effective.

(6) I/O 3 of robot

It thinks about the vibration of the robot, the mechanical resonance, and the application such as supersonic waves.

"Invention principle 18 **Mechanical vibration** (Or, it vibrates mechanical.)"

The vibration when the robot moves, **the mechanical resonance, the supersonic wave, and the sound** are used for the input and the output.





Robot Education and TRIZ

(7) Structure 3 of robot

"Invention principle 15 Dynamics "

A **new function** is invented by changing the structure of the robot (**transformation robot**).

(8) Control 2 of robot

The function of the robot and the movement of the structure are controlled.

"Invention principle 19 Periodic action"

The order, time is controlled, and it **programs** it. It combines hard as control board etc. (PWM) of the current for the miniaturization.





Robot Education and TRIZ

(9) I/O 4 of robot

It thinks the color variation is used to input and output, structural, and to control the robot.

"Invention principle 32 **Color variation** (Or, the color is changed.)" LED is low power consumption, and it is possible to use it effectively.

(10) Control and structure of robot

It thinks about the reverse-conception by structuring, controlling, inputting and outputting the robot.

"Invention principle 13 **Reverse-conception**"

The novel function happens by **reverse-concepts of the structure, stability, and the order, etc.**



Robot Education and TRIZ

The demand function to the robot is understood. The I/O (10,28,18,32)、Structure(1,2,15)、Control(35,19)、Control and structure(13)

These are important **in the process of the robotic development**. And, it becomes possible to recognize main item 10 in the invention principle of 40 of TRIZ.

Ten main items can be understood with the process in a word as follows.

I/O: 10Advance action、28Substitution of mechanism、18Mechanical vibration、32Color variation

Structure: 1Division、2Separation、15Dynamics

Control: 35Change in parameter、19Periodic action

Control and structure: 13Reverse-conception



Robot Education and Technological Contradiction

Technological contradiction by the robotic development has the following.

- When the robot is made strong, it becomes heavy.
- High strength and low weight are requested.
- I want to decrease the electric power in which the robot is moved.

The other

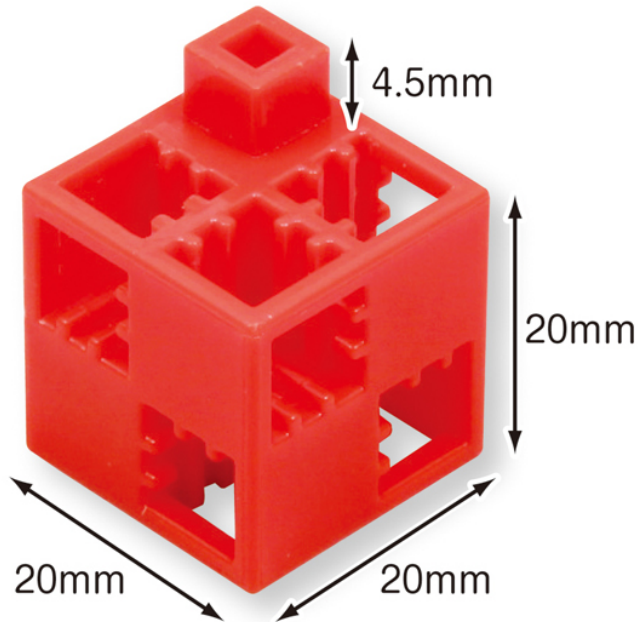
- The walking rate of the wheel robot is earlier than that of the biped robot.
- The biped robot can run on the irregularity side.

In using 3D block robot teaching material, It thinks about 1Division, 2Separation, and 15"Dynamics ", as a control with the microcomputer board verified easily, a motor, a servo motor, and various sensors, etc. can be put in. It is understood that it is effective as the teaching material of the approach on technological contradiction.



Example of Practicing TRIZ in 3D Block Robot①

(Kindergarten)

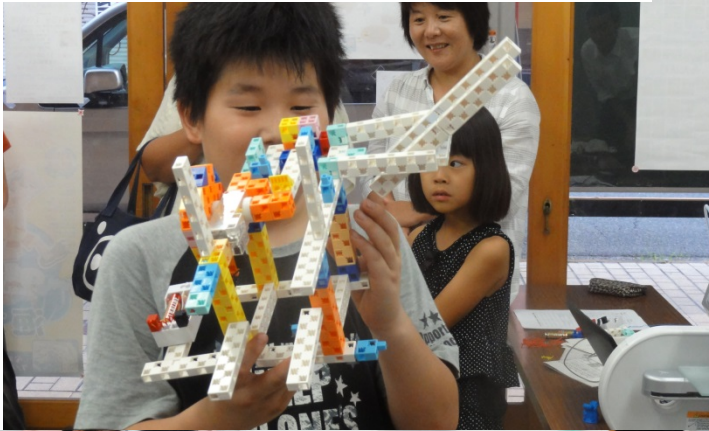


<The idea to shape ! >

「It arranges it to the straight line.」
⇒Growth is confirmed until 3D shape, the color, and the function are colored.

Example of Practicing TRIZ in 3D Block Robot②

(Grade-schooler)



< It moves, and it moves it. >
Biped robot and wheel robot
⇒ The addition of the new features included such as the soccer robots etc. confirm it.



Example of Practicing TRIZ in 3D Block Robot③

(Junior high school and Technical College) < It controls. >

The servo motor is controlled with the microcomputer board. The sound and light are controlled.



Snake type robot
Dance robot



Example of Practicing TRIZ in 3D Block Robot④

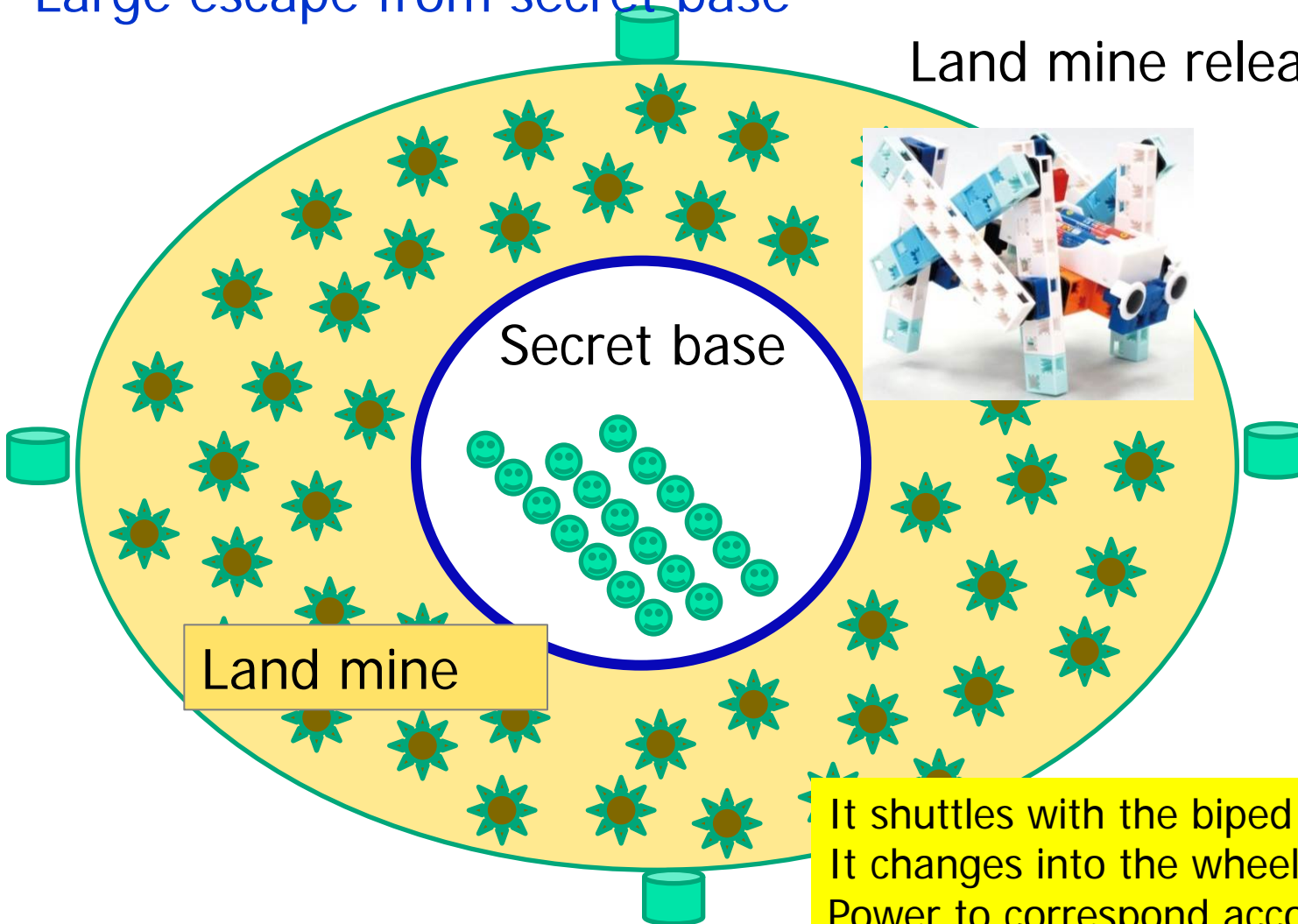
Large escape from secret base

- 18 members were confined in a secret base.
- A secret base will explode in 60 minutes.
- There is a land mine area in surroundings in a secret base, and the wheel cannot be used.
- There is a switch that turns off the land mine besides the land mine area.
- The biped robot can move the land mine area.
- There are parts of the robot that moves with 2leg or 4leg or 6leg in a secret base.
- **In 2leg, the four-seater and 6leg are getting on of six people to singles and 4leg.**
- It doesn't move as it is though there is a blueprint that serves as a reference.
- The dry battery that can be used : only by AA Battery2.
- If the land mine is turned off, the wheel robot can be used.
- **Wheel robots are getting on of five people.**
- Can you escape from all members within 60 minutes?

Example of Practicing TRIZ in 3D Block Robot④

Large escape from secret base

Land mine release switch



It shuttles with the biped robot.
It changes into the wheel and it shuttles.
Power to correspond according to situation



Example of Practicing TRIZ in 3D Block Robot⑤



Grade-schooler



Junior high school student 1

3D block car

- How to unite strength UP
 - How that doesn't come off easily to put it
- The problem is got over.
It participates in Ene-One GP.

⇒ Design prize winning



Kindergarten



Junior high school student 2



Junior High School Student Challenges the Ene-One Grand Prix.

The Ene-One grand prix is the one of running three times in Suzuka Circuit (5.807km) with 7.8% inclination with 40 rechargeable batteries.

Mobility

<Regional needs>

- ① Want to increase the motor sports population of Suzuka Circuit.
- ② Want to give measures to the hated science of the prefectural education board and the city board of education.
- ③ Want to promote industrial talent who bears the future in the region from regional industries.
- ④ Want the teacher of the junior high school technical expert garden department to improve the concern for technologies of junior high school students such as "Cooperation with the Technical College Robot Contest" and "Cooperation in Ene-One".

Then, it talked with Suzuka Circuit, Mie Prefecture, the Mie Prefecture board of education, Suzuka City, the Suzuka City board of education, and Mie University, etc. And then, Challenge of "Door in the future that opens dream electric vehicle『Junior high school student Ene-One grand prix』" came to hold the event.



A state-of-the-art technology is taught, And learns for myself.



For course of F1、Effective technology

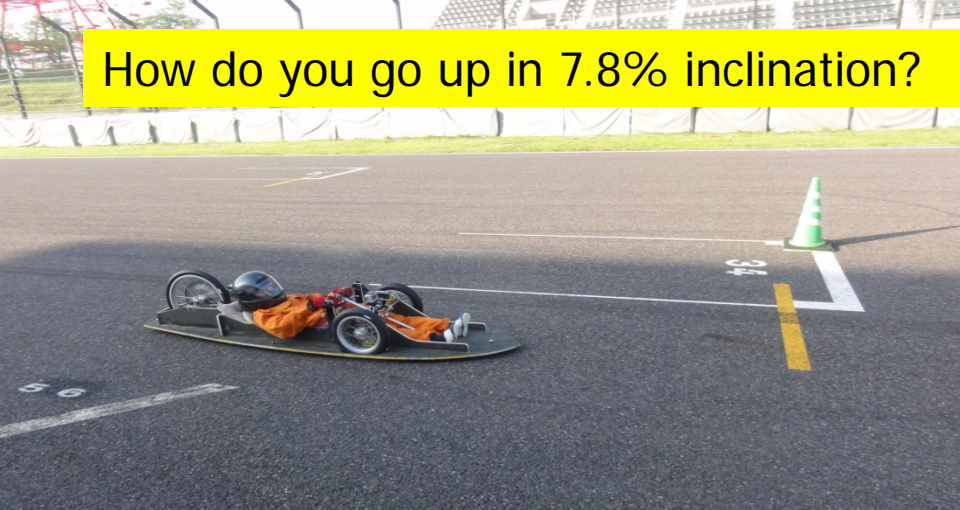
Electric vehicle to be started !



To run efficiently early.



How do you go up in 7.8% inclination?



To international Racing course.

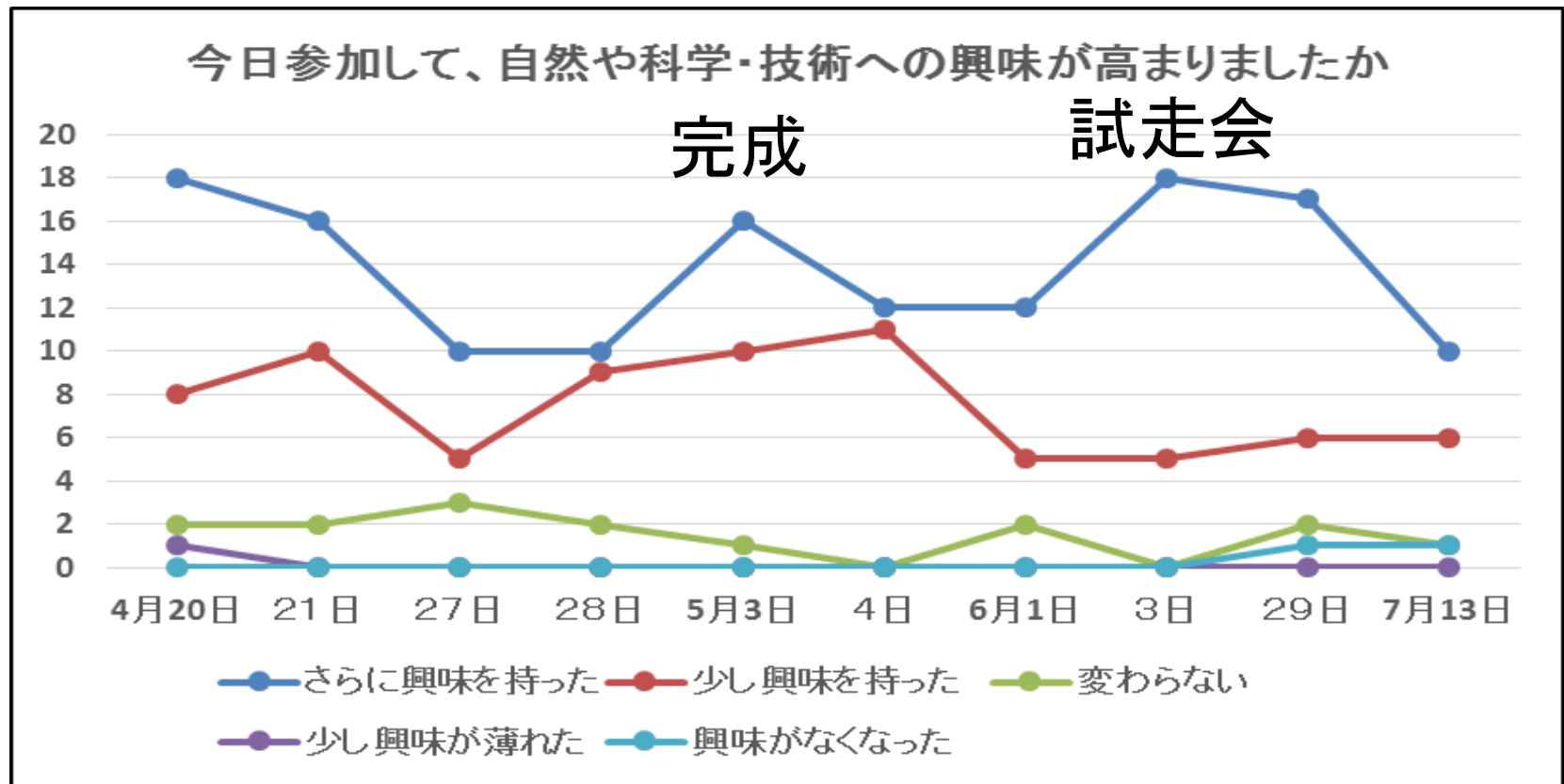


Junior High School Student Challenges the Ene-One Grand Prix.

Mobility

It changes in motivation through a continuous event.

The promotion of the method and the team work power of the match is understood.



So that the junior high school student may manufacture the car ?

【TRIZ】

3.Principle of local quality

- It is not a uniform metal. It makes it to composite materials that stick carbon fiber on both sides of the firing acrylic fiber.

10.Principle of preliminary action

- In doing work to absorb Resin to Carbon fiber, **the carbon fibre reinforced plastic can be made by oneself.**

1. Principle of division

- On the monotony of chassis, it is assumed **the BOX structure** that the front wheel axis and the rear wheel axis are installed.



How to go up in the inclination of 7.8% by junior high school student's knowledge?

【TRIZ】

28. Replacement of mechanical technique

A mechanical effect is replaced in technological, the sound or the effect of the smell etc. The place such as an electric, magnetic electromagnetisms is used to interact with the object. It shifts from the fixed one **to a changeable place with the time passage.**

⇒ How for the battery to be connected with the motor to tie is changed at high speed and a high torque.

48V Series 5A : High speed operation (smoothness)

24V Parallel 10A: High torque (inclination)



KV40(Electric vehicle section)

①Junior high school student White :

Junior high school student section victory (Synthesis 18th place/85)

②Junior high school student Red : **【Design prize】 Winning**

KV-BIKE(Electric bicycle section)

③Junior high school student Link1: **The third synthesis place/15**

(④Junior high school student section victory)

⑤Junior high school student Link5: The fourth synthesis place/15

(The second place of junior high school student section)

⑥Junior high school student Link3: The sixth synthesis place/15

(The third place of junior high school student section)

Regional industries are understood. The innovation is experienced.
Motivation that challenged the problem was obtained with the region.





Summary

1. The idea was made a patent by using 3D block. Can it move, it move, it control, it experience, and the creation education to along of the road map said that it will challenge be achieved.
2. Through the activity of 3D block robot、TRIZ (ten invention principle) from the earlier age can be acquired.
3. Through practicing science and technology education (industrial human resources development in the future) to which the problem in the region is solved by student's idea、the engineer of the value creation type that bears the future in the region is promoted.



Address of thanks

I wish to express my gratitude to everybody of the following and this school intellectual property committee.

Electric and Electronic Engineering Section

Mechanical Engineering Section

Electronic Information Engineering Section

Material science department

Biology Applied Chemistry Section

Academic department

Student division

Sangakukan CD

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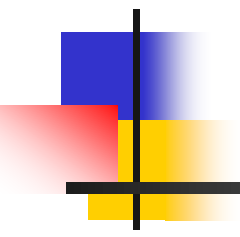


Address of thanks

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Thank you for listening.