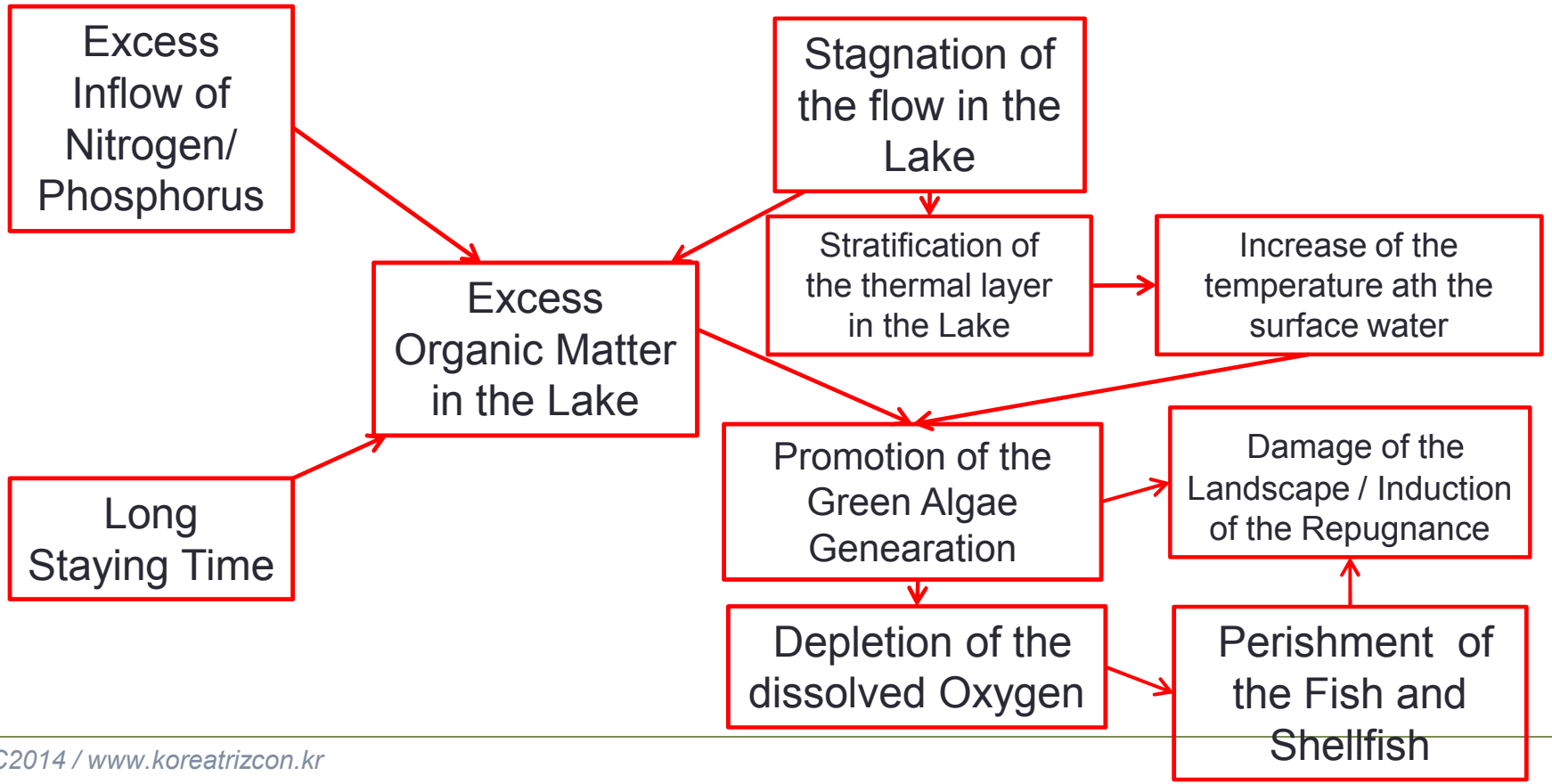
A GREEN ALGAE CLEANER DEVELOPED BY THE CAUSE & EFFECT TECHNIQUE OF TRIZ SIMILAR TO A VACUUM CLEANER

Yoon Pyo Lee*, Bok Hee Cho
Korea Institution of Science and Technology,
Seongbuk-gu, Seoul 136-791, Republic of Korea

yplee@kist.re.kr

Cause of the **Green Algae**



Protection of the Green Algae by the splashing

Adsorption/Sinking by the spreading of Red Cray

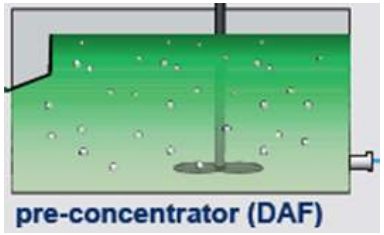
1. Analysis of the Process Problem by the Cause& Effect Technique

Raw water (Algae floating on the surface layer)

Pumping

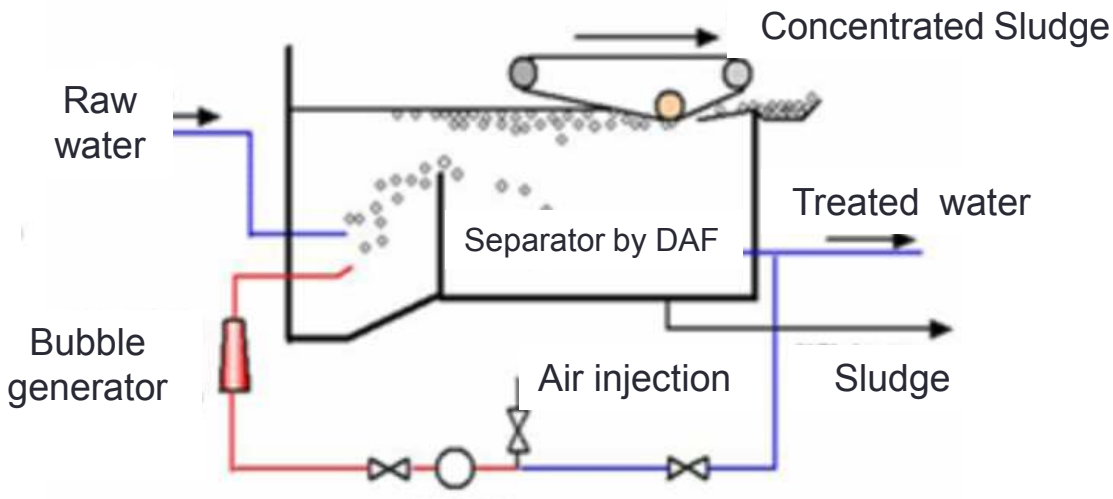
Mixing by Turbulence

Algae separation By Dissolved Air Flotation



Algae concentration

Algae sludge extraction



Application of the Big Man technique

Vacuum Cleaner

Dust on the floor

Green Algae Cleaner

Green Algae on the Pal-Dang Lake

Algae Suction → Wireless Navigation of the Algae Suctioner → Separation of the Algae → Drain of the Clean water

Thin Suction of the Surface Water

Field Test of the Green Algae Cleaner

Analysis of the unstable problem by the 9-windows

Timey	Before pumping	Present	After pumping
super	gravity, buoyancy, density, water, human, green al	gravity, buoyancy, density, water, human	gravity, buoyancy, density, water, human
Middle	intake	Intake	intake
sub	boat, pump, hose , Styrofoam	boat, pump, hose, Styrofoam	boat, pump, Styrofoam hose , **water in the hose**

Unstable Problem due to the conditions(wave, at the spot of start)

List of the resources

Classification of the matter-field resources in the system and upper system

Resources in the unwanted elements

material	characteristics
intake	suction the surface water and green algae
pump	suction by vacuum

Field	characteristics
Oscillation	Unstable

Resources existed in the operating zone

material	characteristics
water	flow
air	Mixed in the water/ break vacuum
Green algae	Float at the surface water

Field	characteristics
gravity	constant
Buoyancy	Linearly depend on the volume underneath the water

Resources near the Operating Zone

Material	characteristics
boat	Float on the water
wave	Changed water level
hose	Changed the weight accord the water weight inside the hose

Field	characteristics
gravity	constant
Buoyancy	Linearly depend on the volume underneath the water
density	Green algae accumulator

АРИП-2009 (пт)

Selection of the prior resource

A. Availability of the resources for working of the system function

harmful	neutral	useful
Air, buoyancy	water	vacuum, sealing

B. Existence of the resources at the operating time and operating zone

permanent	temporal
buoyancy	Air, vacuum, sealing, electricity

C. Saturation of the resources

Saturation	Energy enough	Not enough
gravity	buoyancy	sealing, pumping force

D. Number of the resources

So much	enough	short
water, gravity	Green algae, air	vacuum

F. Field, resources at the OZ

Field & elements at OZ	Field and materials near the OZ and the element s	Field at the upper system
Intake, green algae, water, gravity, buoyancy, air	pump, boat, hose, electricity	Lake, scenery, wave, noise

АРИП-2009 (пт)

우선적인 자원의 선택

List of the prior resources

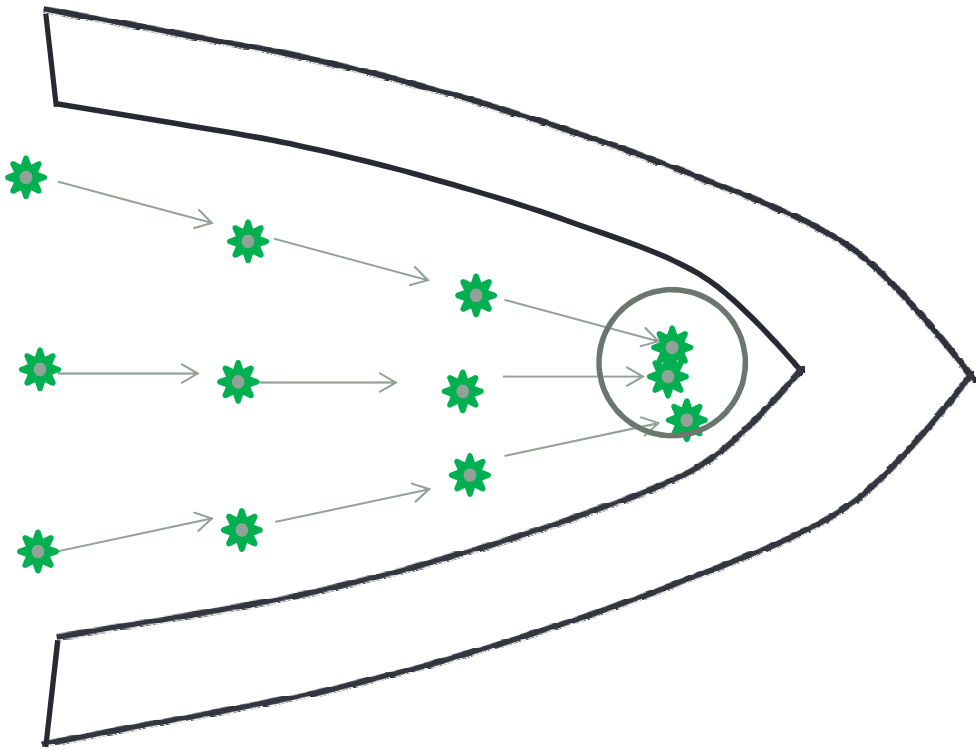
Characteristics	priority	resource	Characteristics	parameter
usefulness	harmful	air	break the sealing	degree of vacuum
	neutral	water, buoyancy	free	
inside the system	permanent	intake	solid	weight
	temporal	water in the hose	No air	%
Saturation of energy	saturation	gravity	downward	axis
	enough	buoyancy	Volume amount under the level	difference of the density
Number of resources	very much	green algae	float on the surfce	ppm
	enough	pump	sealing	gap thickness
Fields, resources at the Operating Zone, Time	fields & elements at OZ	accumulator	Thickeners of green algae	ppm
	Fields & Elements near OZ	Boat, hose, human, electricity	Floating, flexible, remote, operation	rolling

Ideal final Solution(IFR) :

1. Unstable problem of the intake → Stabilize by it self!

2. Increase of Ideality

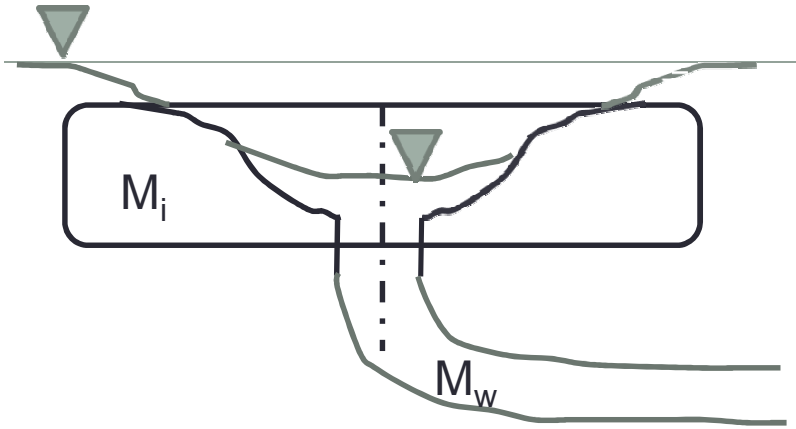
$$\text{Ideality} = \frac{\sum \text{Beneficial Functions}}{\sum \{\text{Cost} + \text{Harmful Effects}\}} \Rightarrow \infty$$



Beneficial Functions ↑
1. Accumulator
2. Floater

Harmful Effects ↓
1. Weight
2. Flow Resistance

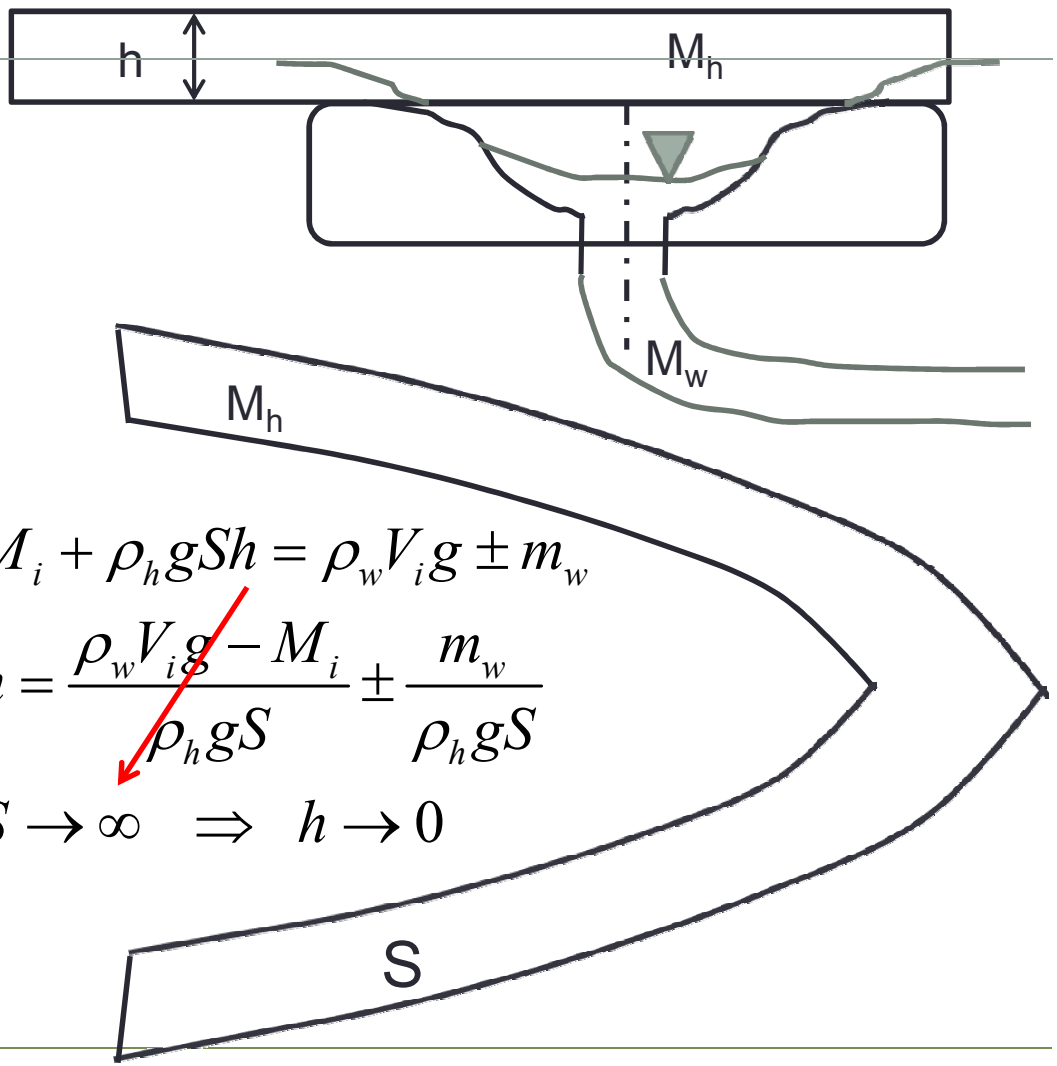
3. Transfer the function to the upper system → **introduction of the floating accumulator**



$$M_i = \rho_w V_i g$$

$$M_i < \rho_w V_i g + m_w : \textit{Sink}$$

$$M_i > \rho_w V_i g - m_w : \textit{Float}$$



$$M_i + \rho_h g S h = \rho_w V_i g \pm m_w$$

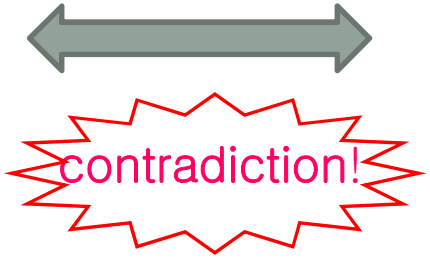
$$h = \frac{\rho_w V_i g - M_i}{\rho_h g S} \pm \frac{m_w}{\rho_h g S}$$

$$S \to \infty \quad \Rightarrow \quad h \to 0$$

Contradiction of the conditions

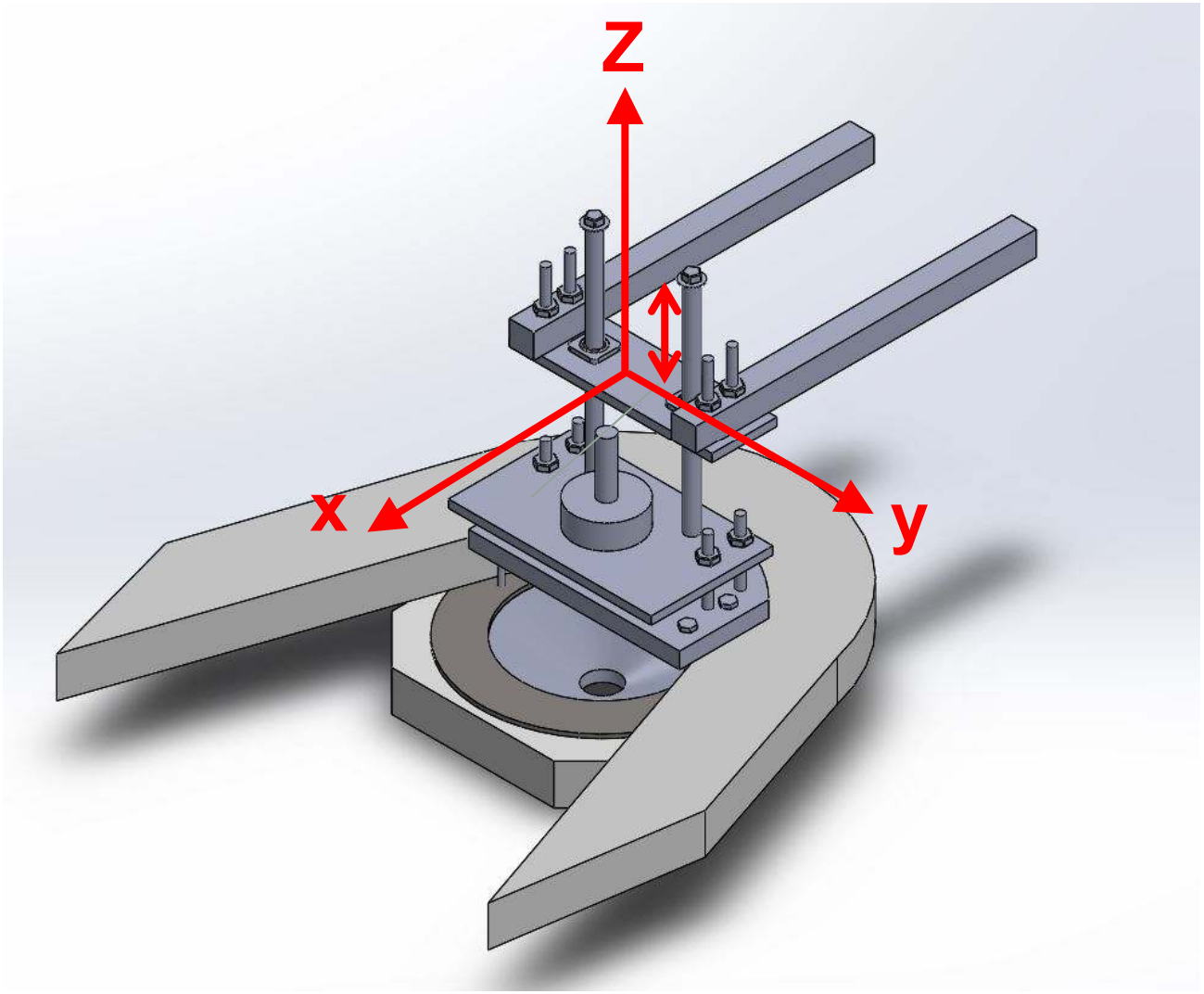
For the automatic navigation of the **Green Algae Cleaner**

The Intake of the **Green Algae Cleaner** must be fixed to the navigator



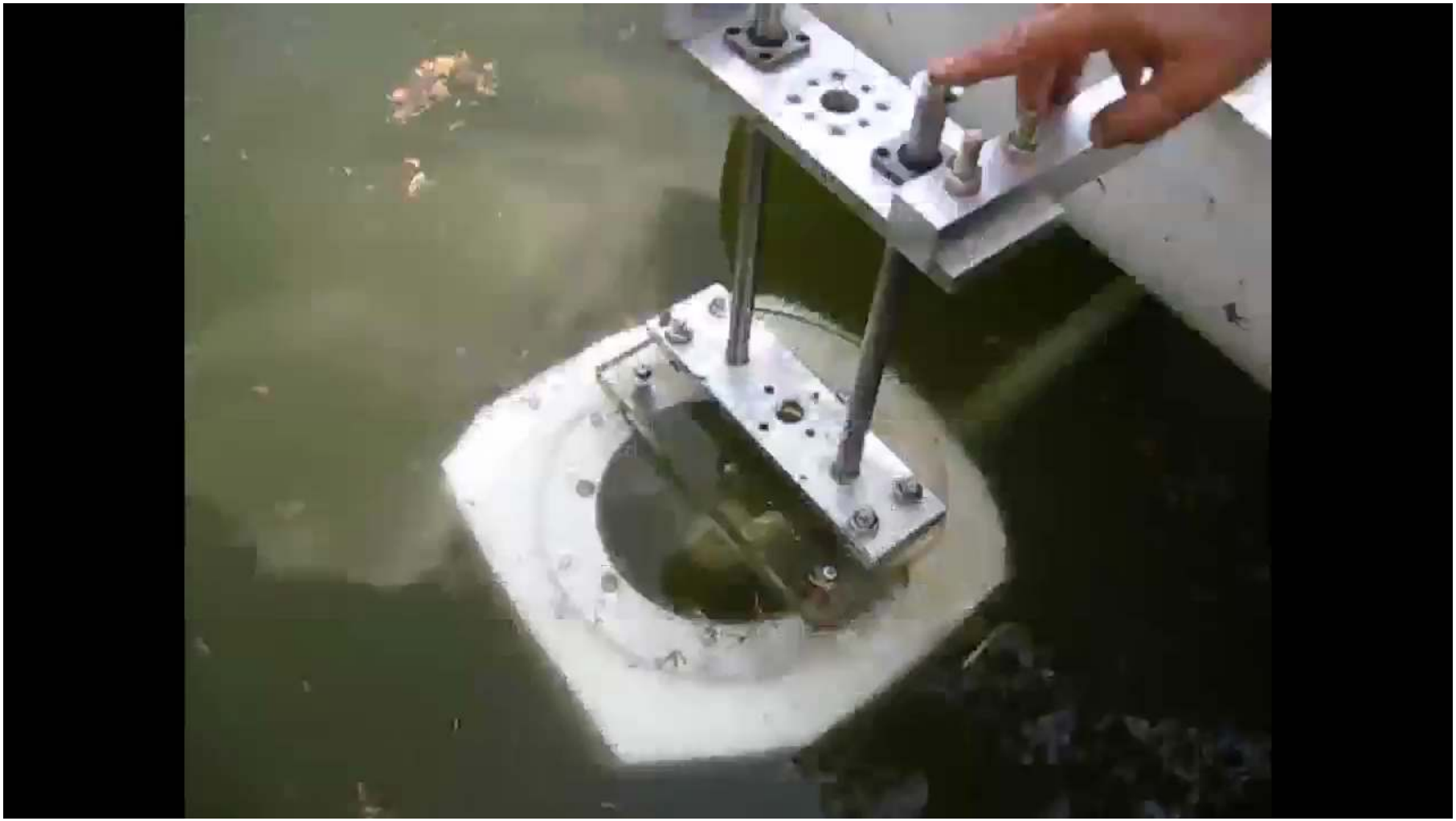
The Intake of the **Green Algae Cleaner** must not be fixed to the navigator

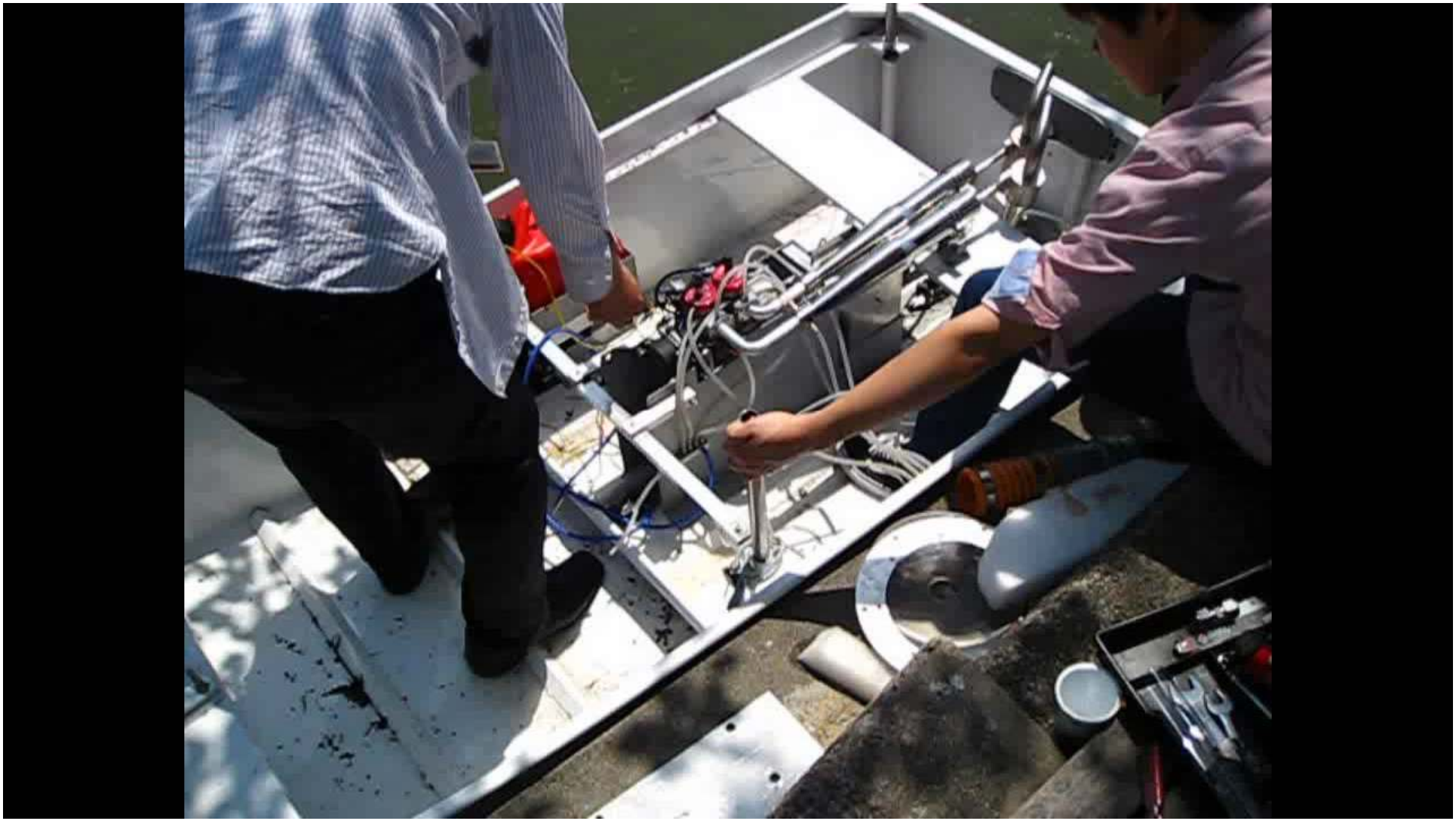
By the separation of the moving directions



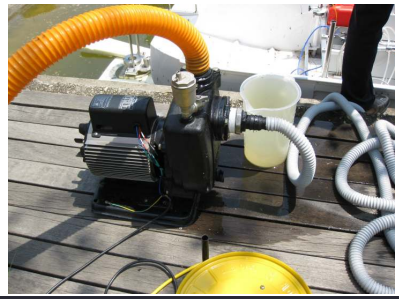
X-Direction: rigid
Y- Direction: rigid
Z-Direction : free

The effect of the floater

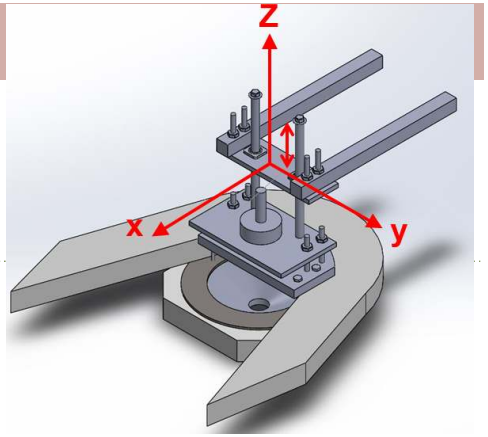




Advantage of the Changed Pump type

Pump Type	Volumetric	Turbo	Turbo /Volumetric
Photos			
Specs			
Suction Flow Rate[m^3/hr]	4	12	3
Motor[kW]	3.7	2.5	0.67
m^3/hr/kW	1.08	4.8	4.44
Weight[kg]	161	38	0.24
Head(m)	20	22(discharge)/8(suction	1.1

Concluding Remarks



- The green algae cleaner similar to the commercial vacuum cleaner was developed.
- The green algae cleaner sucks the surface water only where the density of the green algae is high.
- During the suction of the 1st prototype, the buoyancy of the intake part was varied because the water amount in the suction hose was changed.
- The situation of the sink-down by variable buoyancy makes the air be entrained in the water, and the centrifugal pump did not work because of the entrained air.
- A floater of which the z-axis is free was introduced, with those apparatuses the centrifugal pump can be operated regardless of the sink-down behavior of the propellant.