



2.000.000



2.00p



2.000p

2.0.0b





2.00% CAD Ob



2.00p



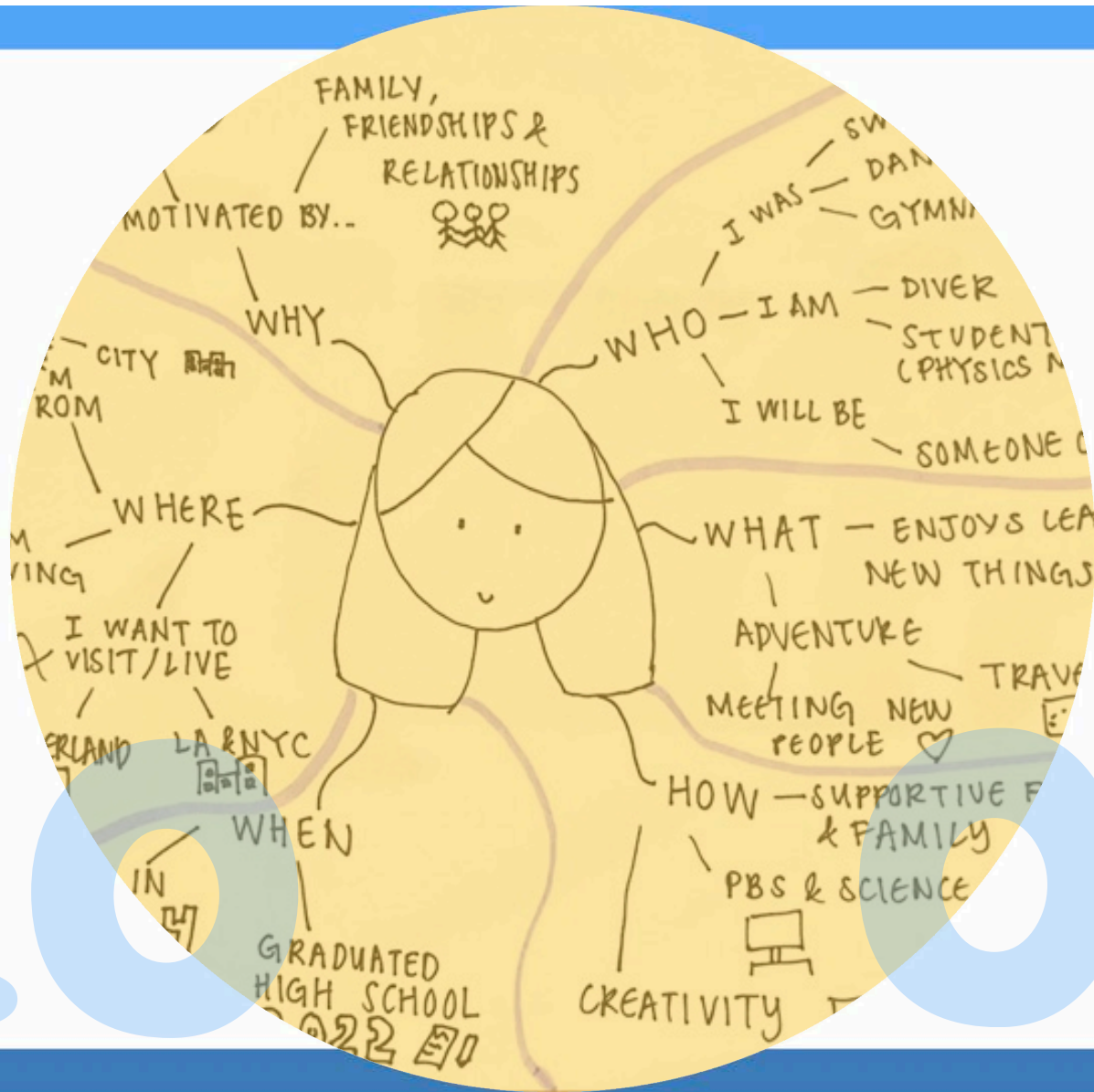
2.00p



2020

2.0 Job





2.0 b



2.0 ob



2.0 Ob



2.0 ob



2.0 ob



2.000b



2.0 ob



2.0 ob

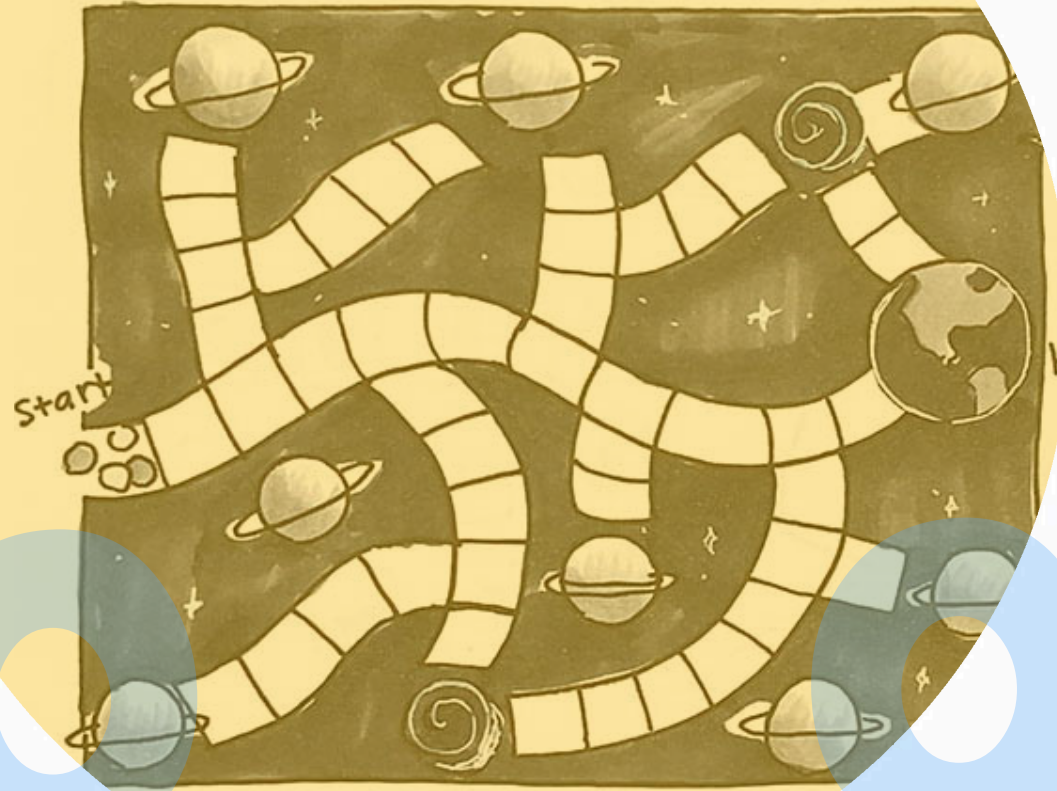


2.0 b



2020

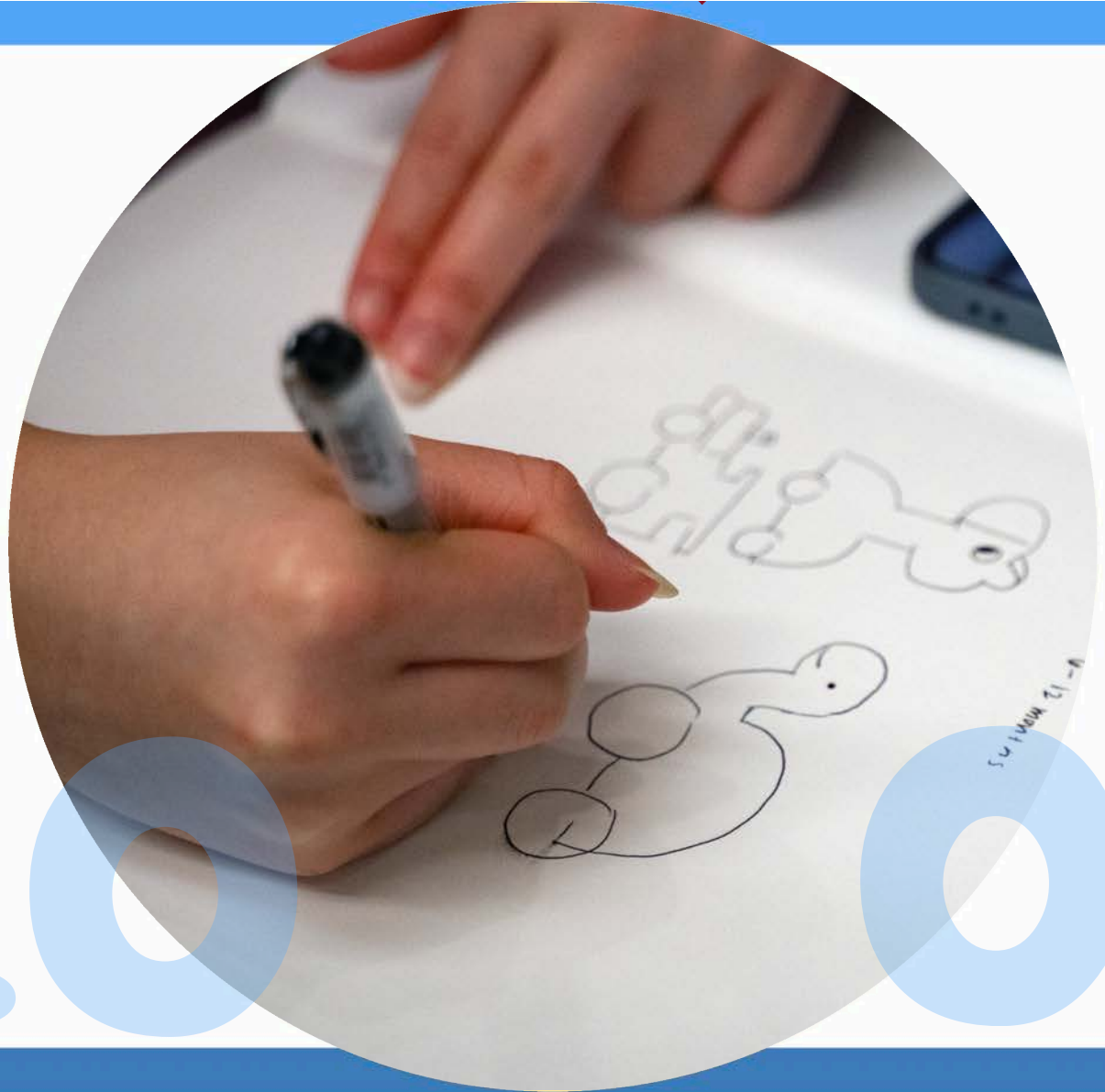
Space Race



200p



2.0 Obp



2.0 ob



2.0 Job



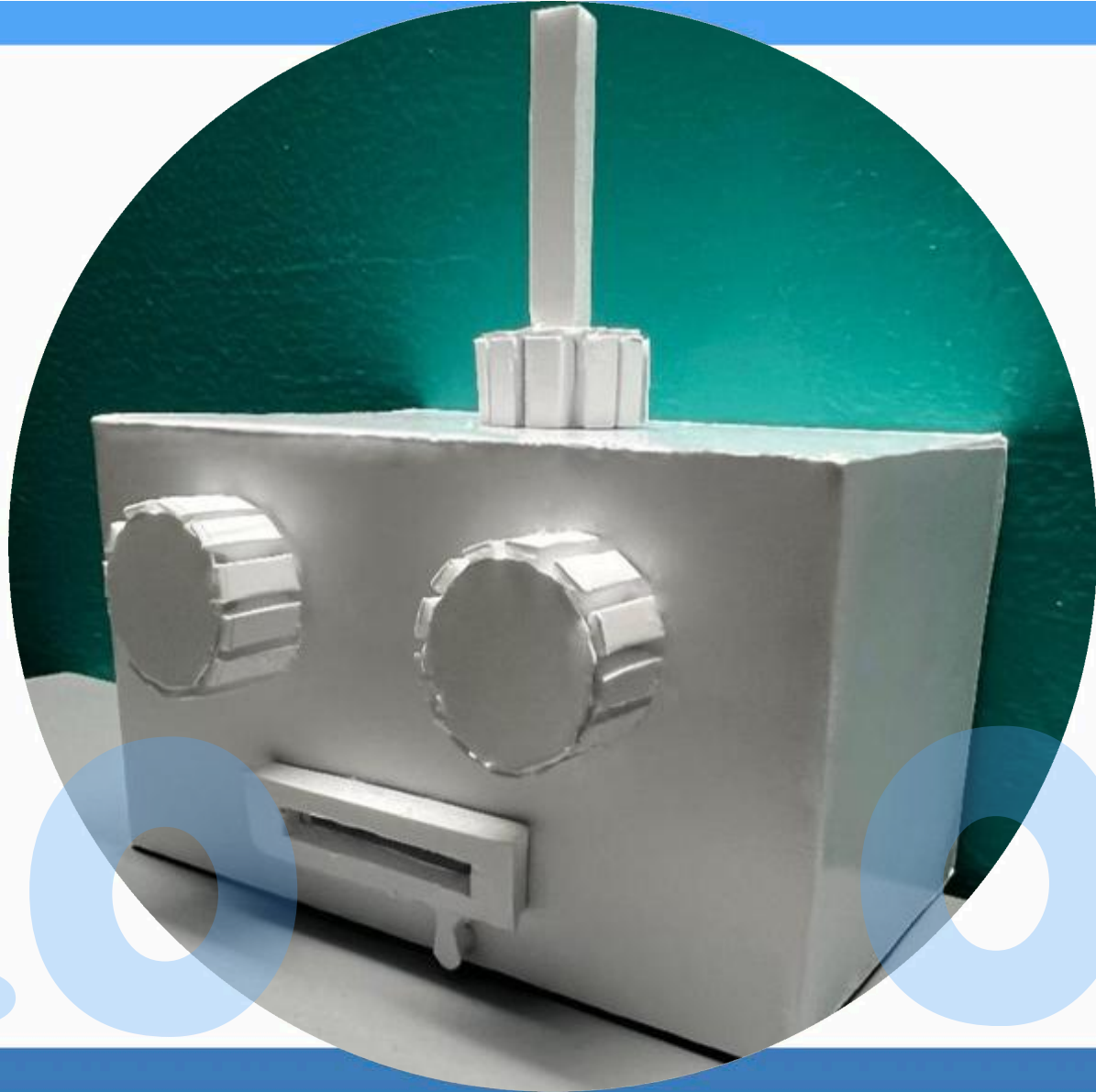
2.0 ob



2.0 b p



2.00p



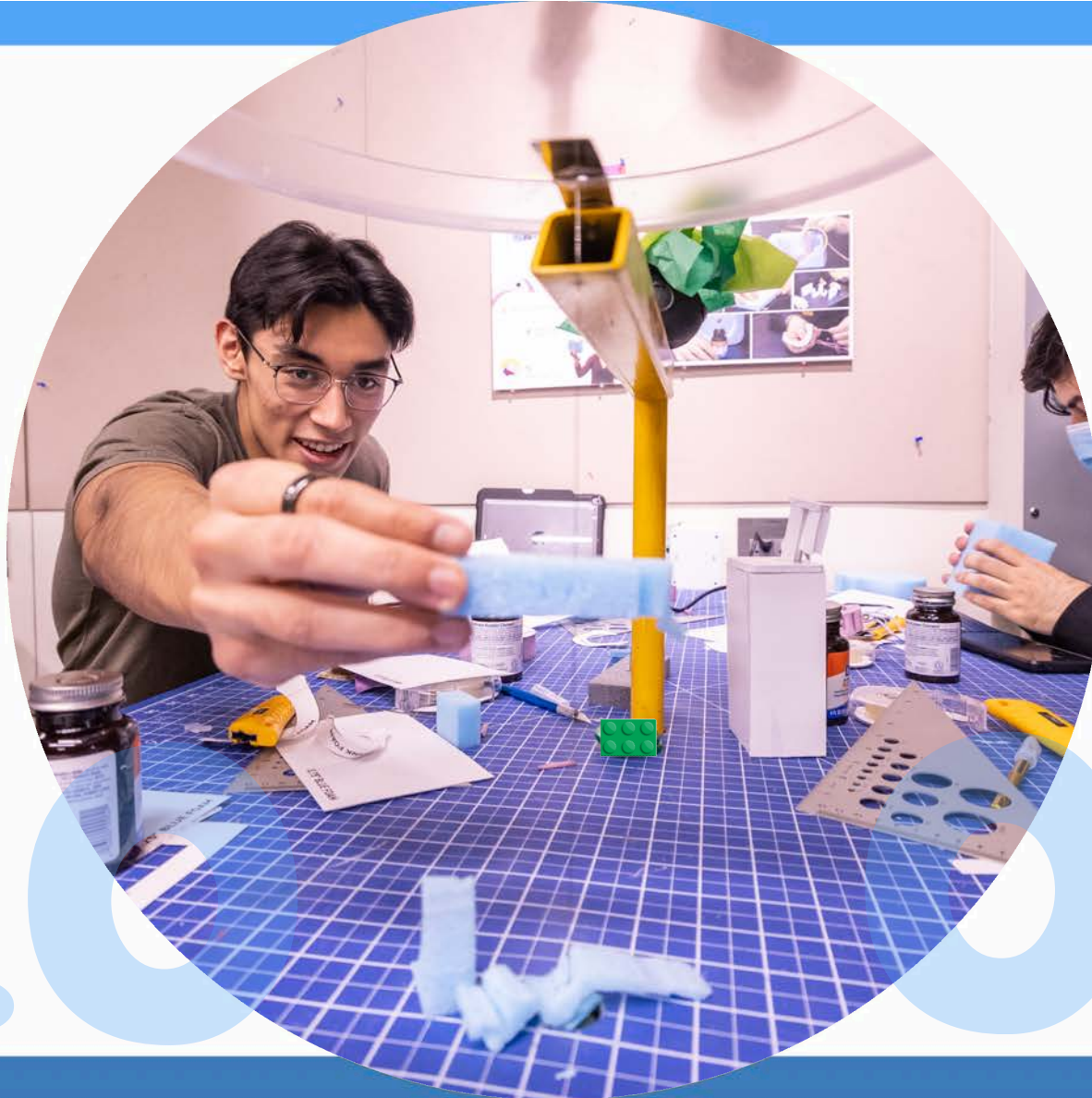
2.0.0b



2.00p



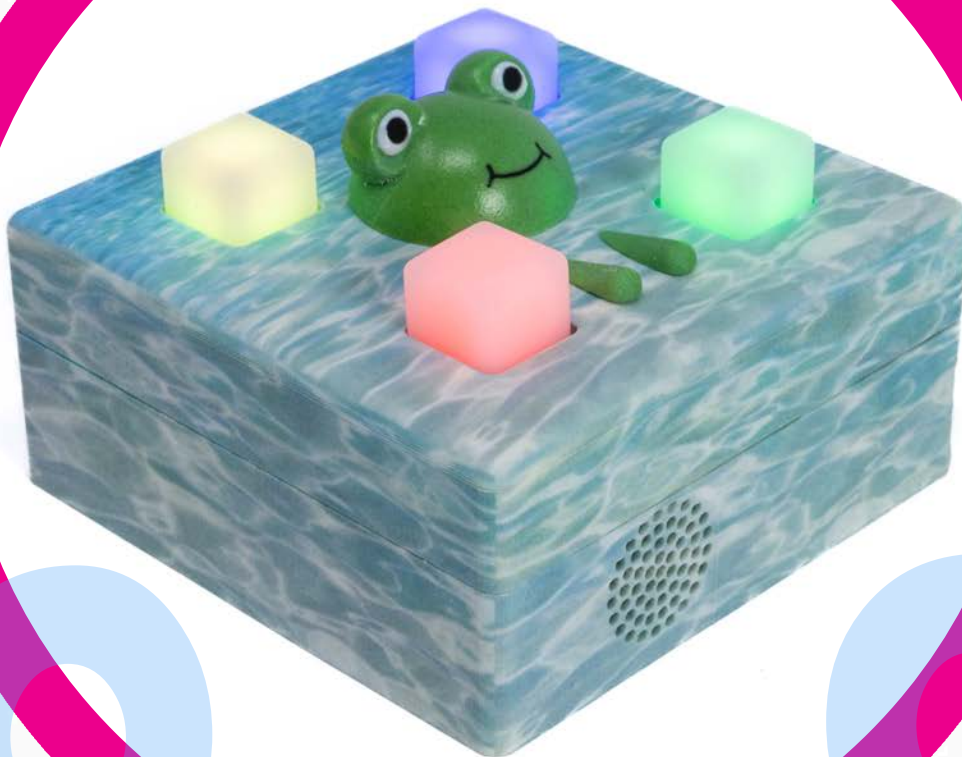
2.0 Job



2.0 b



2.00p



2.0000p

ROSE

BUD

THORN

2.000p



2.0 Job



2.0 ob



2.0 Job



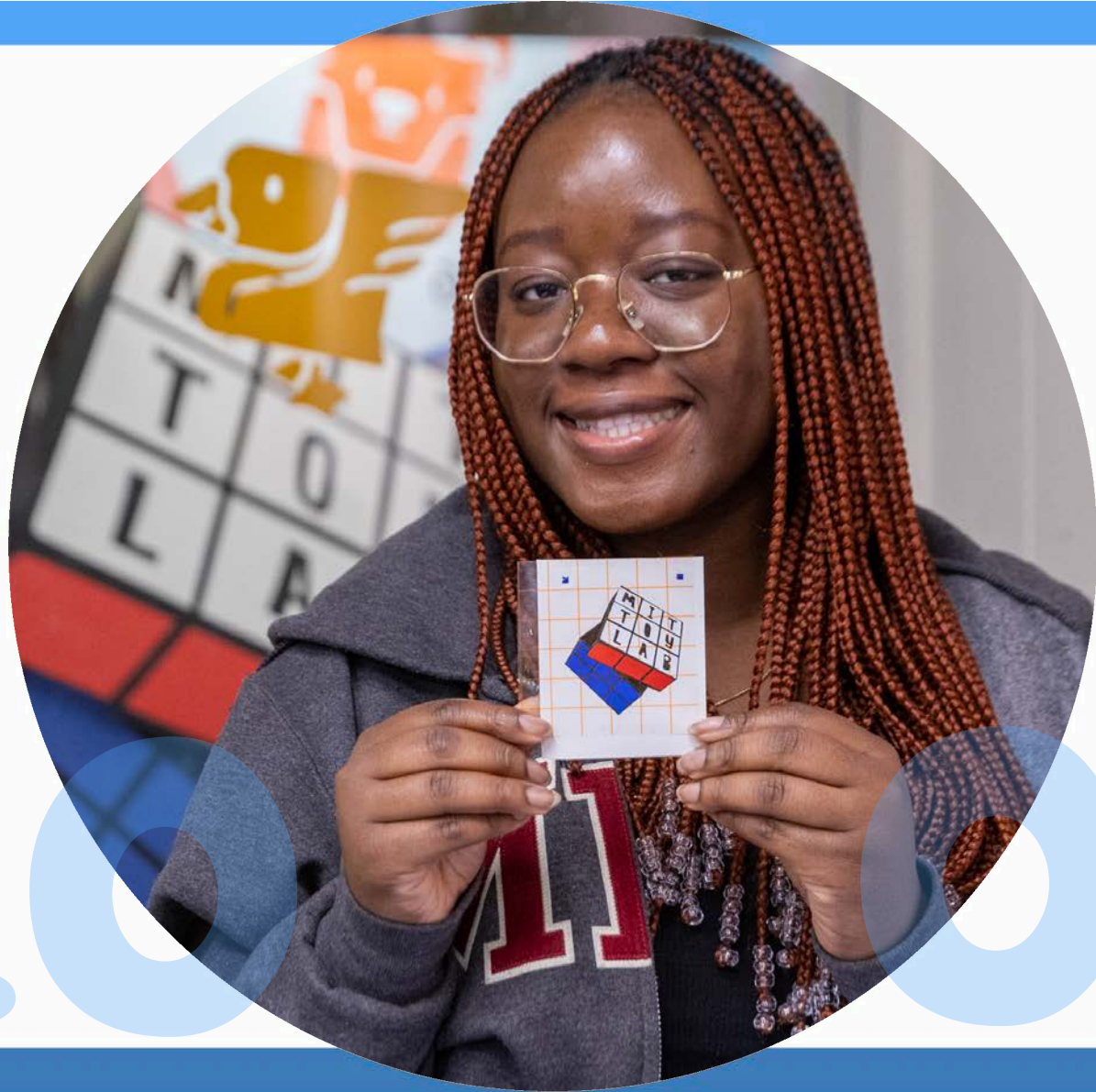
2.0 b



2.0 ob



2.0 Job



2.0 Job



2.00b



2.0 Job



2.0 Job



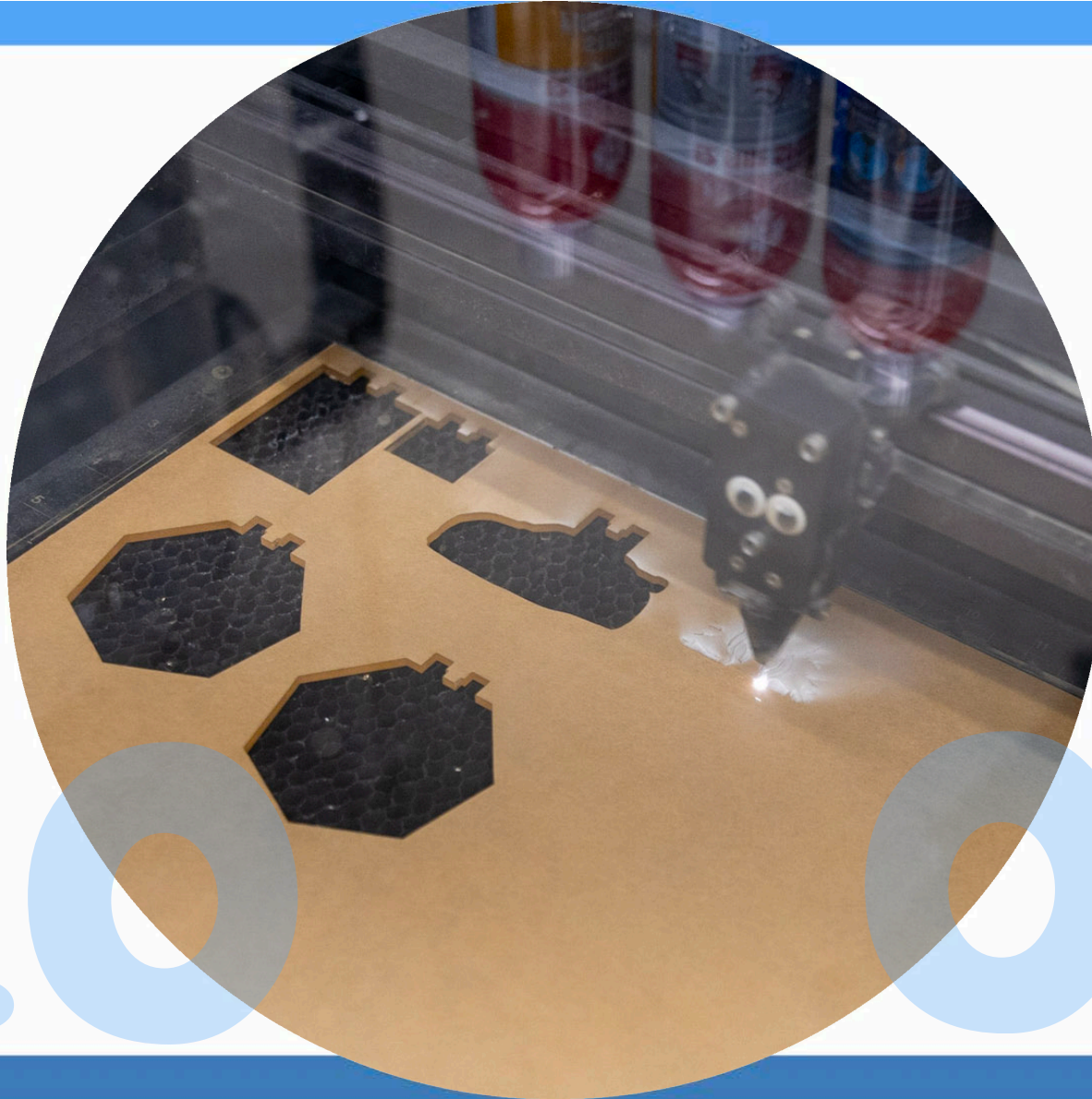
2.0 ob



2.00b



2.0 ob



2.00ob



2.0 Job



2.0 Job



2.0 Job

A quiz!



2.00ob



2.00p



2.00b



2.0 ob



2.0 Job



2.0 Ob



2.0 Job



2.00ob



2.000p



2.00b



2.0 Job

2.0.0b





2.0 Job



2.0 ob



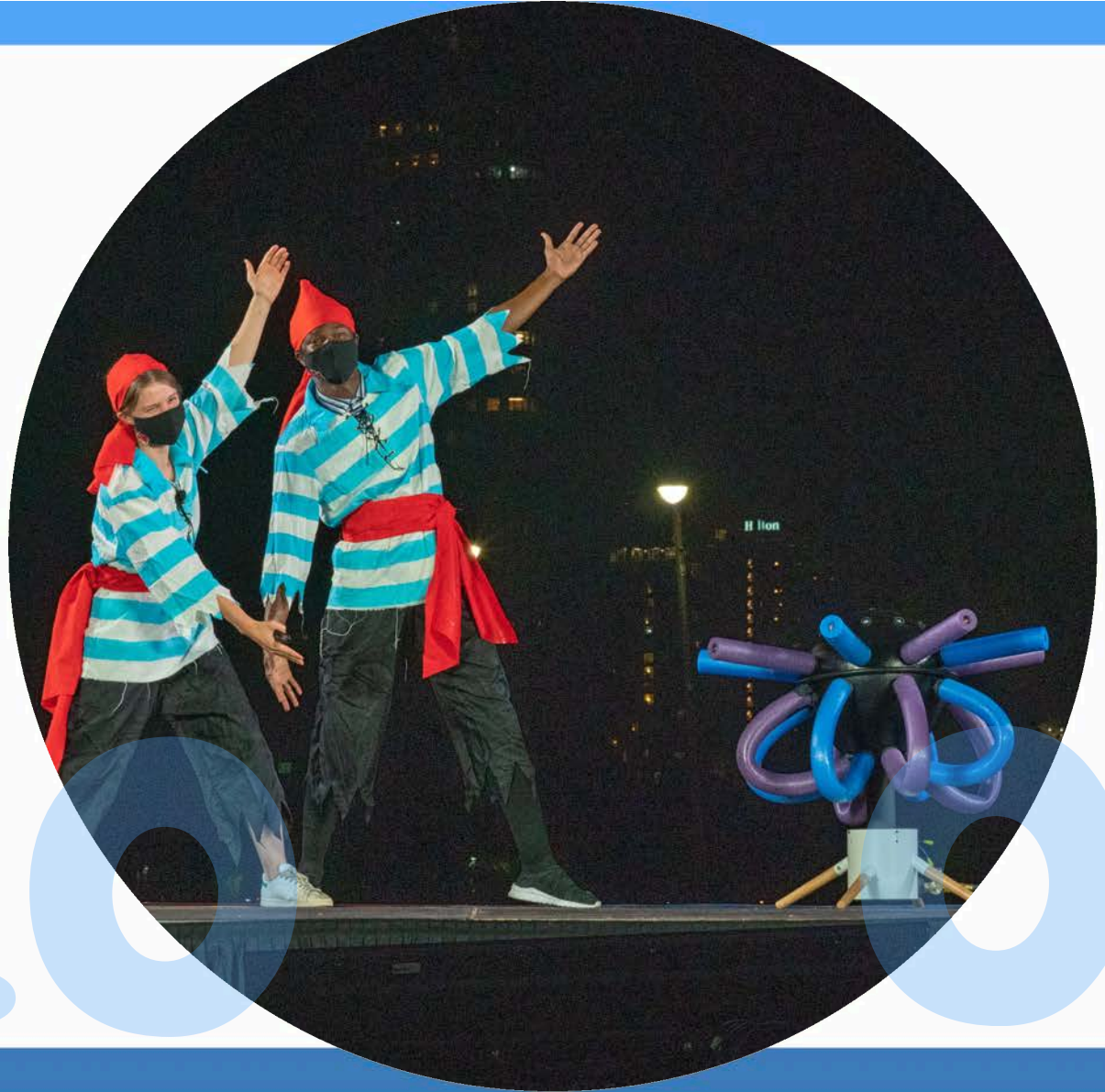
2.000p



2.000p



2.0 b



2.0 b



2.0 Job



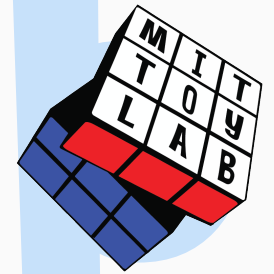
2020



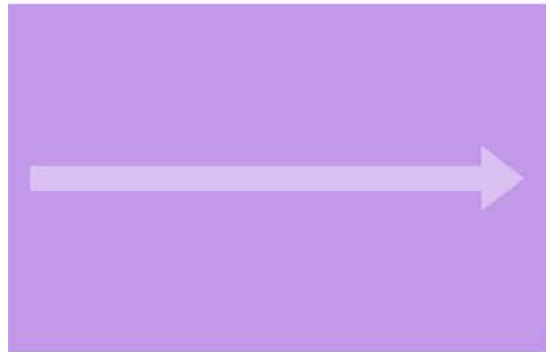
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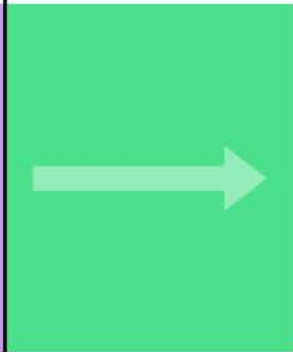
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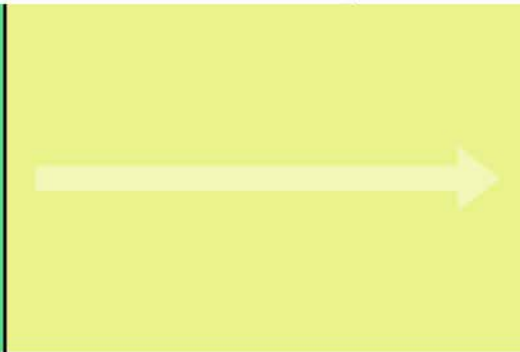
**Toy Pitch
Presentation**
March 10
3 ideas per team



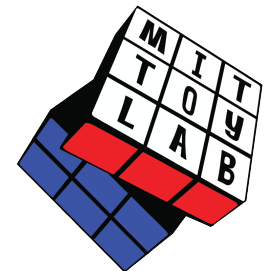
**Sketch Model
Presentation**
April 16-17
2 concepts, 4 models



**Design
Review**
May 2-4
1 concept, 2 models

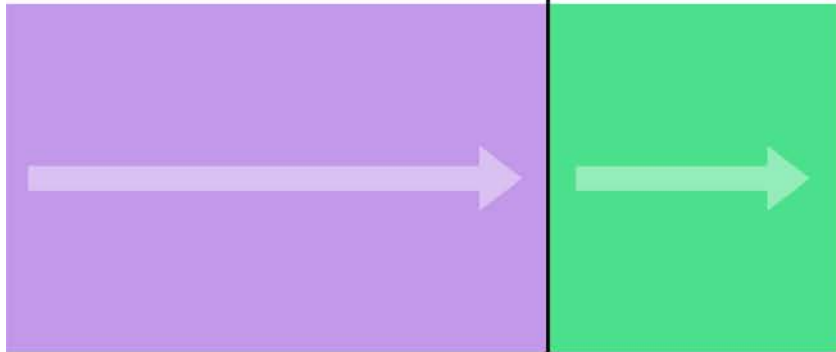


**Final
PLAYsentations**
May 15
1 final prototype



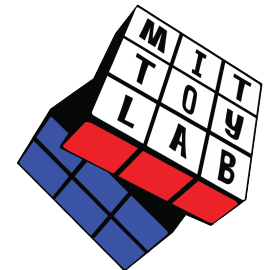
**Toy Pitch
Presentation**

March 10
3 ideas per team



**Sketch Model
Presentation**

April 16-17
2 concepts, 4 models

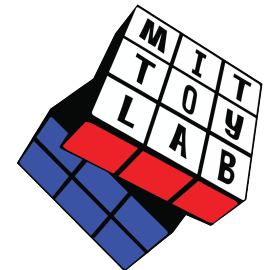


April

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
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May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
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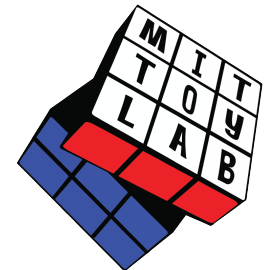


April

Su	Mo	Tu	We	Th	Fr	Sa
						1
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May

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7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

Su Mo Tu We Th Fr Sa



9 10 11 12 13 14 15



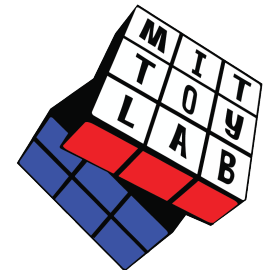
30

1
8
15
22
29

May

Su Mo Tu We Th Fr Sa

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

Su Mo Tu We Th Fr Sa

Team *

Please Select

Our team is *

- scheduled to present on Thursday, but am requesting to present on Friday
- scheduled to present on Friday, but am requesting to present on Thursday
- cancelling prior conflict request

Nature of conflict/reason for request:

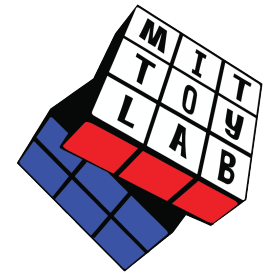
tonight!

Submit Conflict Info

May

Su Mo Tu We Th Fr Sa

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

Su Mo Tu We Th Fr Sa



9 10 11 12 13 14



30

1

8

15

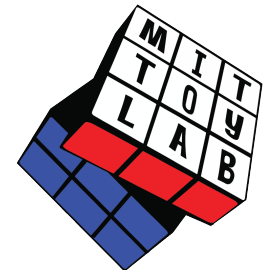
22

29

May

Su Mo Tu We Th Fr Sa

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

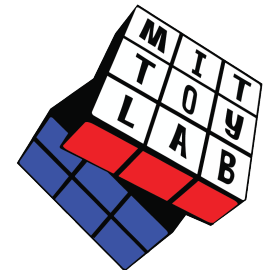
Su Mo Tu We Th Fr Sa



Th	Fr	Sa
2	3	4
9	10	11
16	17	18
23	24	25
30	31	

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

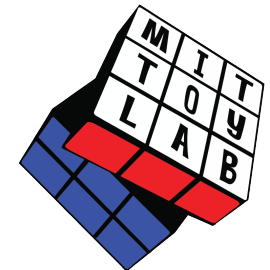
Su Mo Tu We Th Fr Sa



4 minutes!

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



Th	Fr	Sa
2	3	4
9	10	11
16	17	18
23	24	25
30	31	

April

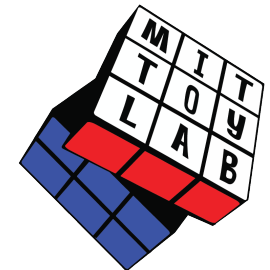
Su Mo Tu We Th Fr Sa



4 minutes!

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



Th	Fr	Sa
2	3	4
9	10	11
16	17	18
23	24	25
30	31	

April

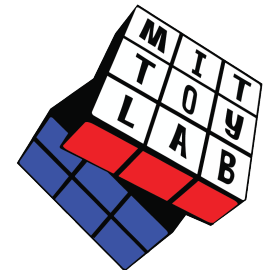
Su Mo Tu We Th Fr Sa



Th	Fr	Sa
2	3	4
9	10	11
16	17	18
23	24	25
30	31	

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

Su Mo Tu We Th Fr Sa



Cow

- Course Info
- Syllabus
- Course Staff
- Teams
- Care Bears
- Portfolios
- Slideshows
- Toy Museum



Accessibility

Reviewer Name:

Reviewer Email:

A copy of the review will be emailed to you if an email address is provided.

See [presentation videos and photos!](#)

Concept 1: Dodgeball-Cano

Dodge the balls that emerge from the volcano and return as many as you can before other players!

Plays-Like

Was it clear what question(s) the plays-like model was addressing?

yes maybe no

How effective was the plays-like sketch model at answering the question(s)?

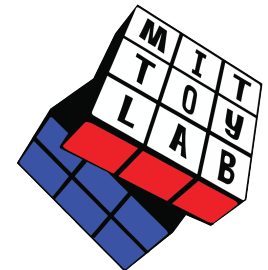
poor great! no model
 1 2 3 4 5 N/A

Comments. If the plays-like sketch model was or wasn't effective, why?

May

Su Mo Tu We Th Fr Sa

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			



April

Su Mo Tu We Th Fr Sa



9 10 11 12 13 14 15

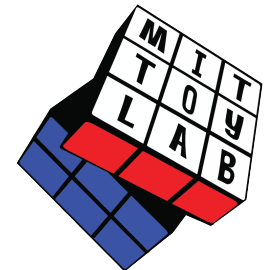


30

May

Su Mo Tu We Th Fr Sa

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
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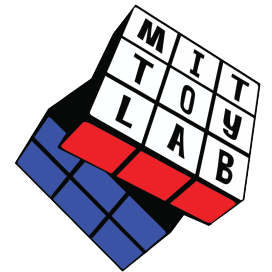


April

Su	Mo	Tu	We	Th	Fr	Sa
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9	10	11	12	13	14	15
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May

Su	Mo	Tu	We	Th	Fr	Sa
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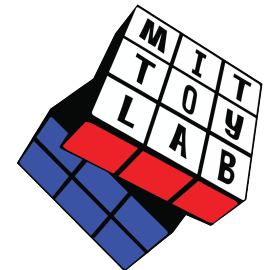


April

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

safety!

May						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

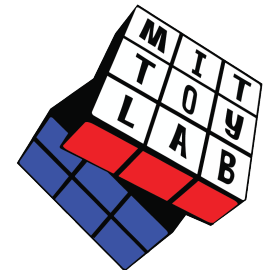


April

Su	Mo	Tu	We	Th	Fr	Sa
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2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
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21	22	23	24	25	26	27
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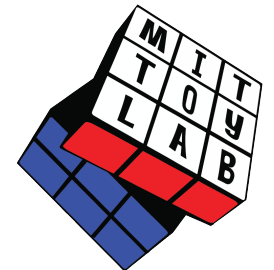


April

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

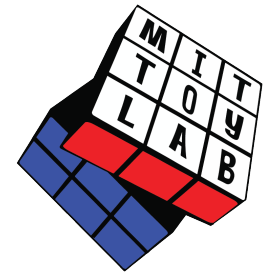
May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			





Plastics!?



Quiz!

1. What is your name?
2. Which are polymers?
wood, skin (dermis),
Jell-O, DNA
3. Where does almost
all plastic come from?
4. Which requires more
energy to produce: paper
or plastic bags?

ParSCORE™
TEST FORM
© ECONOMICS RESEARCH, INC. 1989

NAME Last Name, First Name
LAST FIRST MIDDLE

SUBJECT Course, Section, Instructor

DATE Test Number HOUR/ DAY Test Version (A,B)

T F T F

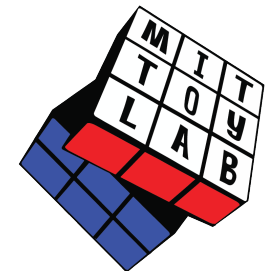
1 A B C D E	51 A B C D E
2 A B C D E	52 A B C D E
3 A B C D E	53 A B C D E
4 A B C D E	54 A B C D E
5 A B C D E	55 A B C D E
6 A B C D E	56 A B C D E
7 A B C D E	57 A B C D E
8 A B C D E	58 A B C D E
9 A B C D E	59 A B C D E
10 A B C D E	60 A B C D E
11 A B C D E	61 A B C D E
12 A B C D E	62 A B C D E
13 A B C D E	63 A B C D E
14 A B C D E	64 A B C D E
15 A B C D E	65 A B C D E
16 A B C D E	66 A B C D E
17 A B C D E	67 A B C D E
18 A B C D E	68 A B C D E
19 A B C D E	69 A B C D E
20 A B C D E	70 A B C D E
21 A B C D E	71 A B C D E
22 A B C D E	72 A B C D E
23 A B C D E	73 A B C D E
24 A B C D E	74 A B C D E
25 A B C D E	75 A B C D E
26 A B C D E	76 A B C D E
27 A B C D E	77 A B C D E
28 A B C D E	78 A B C D E
29 A B C D E	79 A B C D E

DIRECTIONS
USE ONLY PENCIL
• MAKE DARK MARKS
• ERASE COMPLETELY TO CHANGE
• EX. (A) (B) (C) (D) (E)

CUID
1 2 3 4 5 6 7 8 9
0 0 0 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1
2 2 2 2 2 2 2 2 2
3 3 3 3 3 3 3 3 3
4 4 4 4 4 4 4 4 4
5 5 5 5 5 5 5 5 5
6 6 6 6 6 6 6 6 6
7 7 7 7 7 7 7 7 7
8 8 8 8 8 8 8 8 8
9 9 9 9 9 9 9 9 9

Mark Test Version
TEST FORM
(B) (C) (D)

EXAM NUMBER



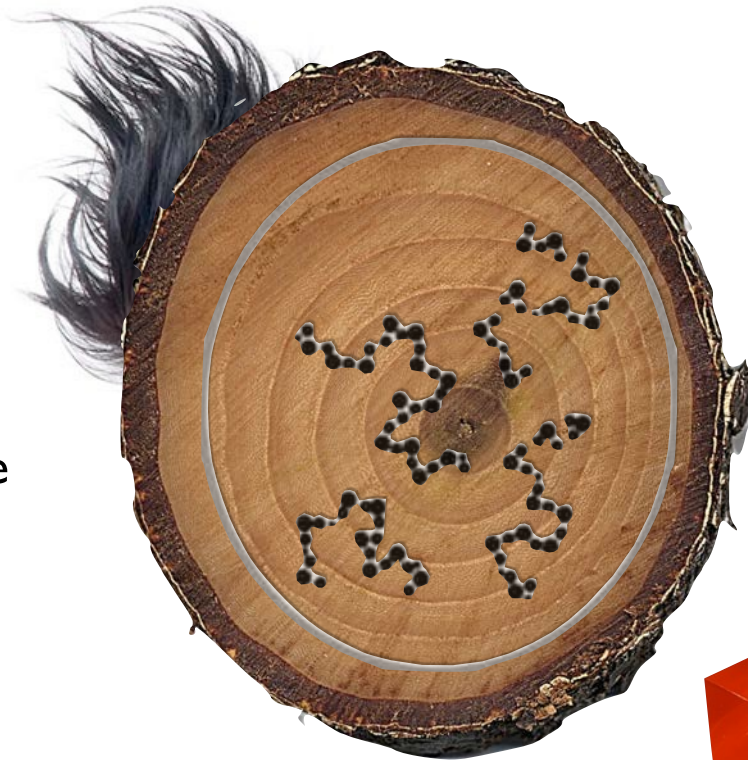
What are polymers?

Greek for many parts

long chains of repeating molecules (monomers)

natural polymers:
proteins, starch, cellulose

synthetic polymers...



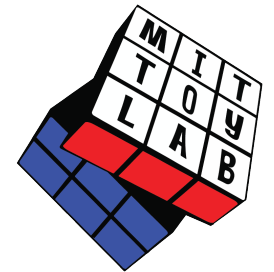
What is plastic?

synthetically polymerized material... typically from hydrocarbons

from crude



10 percent of U.S. oil consumption - approximately 12 million barrels a year in US for plastic bags alone!

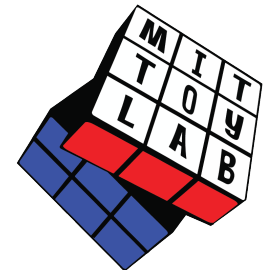


thermoplastic vs thermoset

THERMO (heat)
PLASTIC (deform)



THERMO (heat)
SET (permanent)



thermosets

permanent, chemical reaction

usually two-part exothermic, or heat-cured

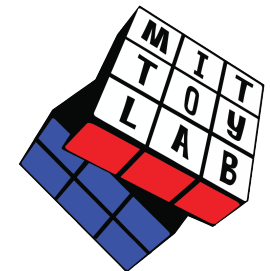
used in for high temp, high tolerance, or joining



← melamine



← phenolics



thermosets

permanent, chemical reaction

usually two-part exothermic, or heat-cured

used in for high temp, high tolerance, or joining

not recyclable



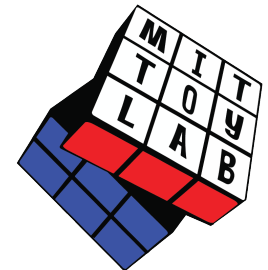
← melamine



← phenolics



→ vulcanized rubber



thermoplastics

easy to (re)shape with
different processes

mostly recyclable

8 very common
thermoplastics



Acrylonitrile Butadiene Styrene
(ABS)



PolyPropylene (PP)



PolyEthylene (PE)



PolyVinyl Chloride (PVC)



PolyStyrene (PS)



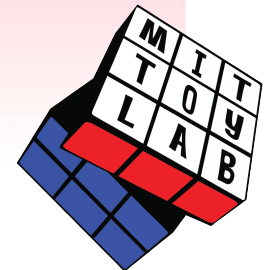
PolyMethylMethAcrylate (PMMA)
(Acrylic)



PolyCarbonate (PC)



PolyEsters (PET, PETE)



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



PMMA



PC



PET

Acrylonitrile Butadiene Styrene (ABS)

PolyPropylene (PP)

PolyEthylene (PE)

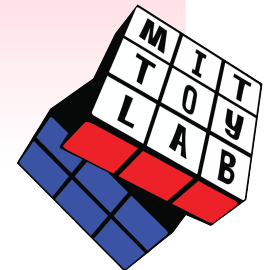
PolyVinyl Chloride (PVC)

PolyStyrene (PS)

PolyMethylMethAcrylate (PMMA)
(Acrylic)

PolyCarbonate (PC)

PolyEsters (PET, PETE)



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



PMMA



PC



PET

Physical Properties:

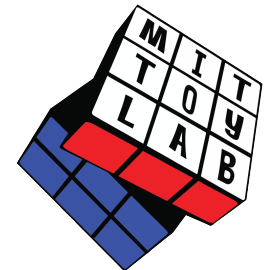
feel, look, smell
density, stiffness, opacity,
surface finish

Manufacturing Properties:

what are the processes
used with this plastic?
thickness, detail, size?

Design Considerations:

which types of products use
this plastic? What is the cost
of these products?





ABS

Acrylonitrile Butadiene Styrene

hard with high
impact resistance

takes color well with
excellent surface finish.
Can be very shiny!

good chemical resistance

consumer product cases



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



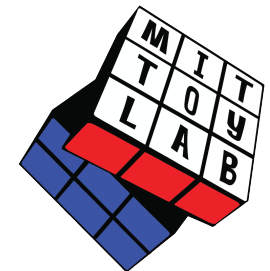
PMMA



PC



PET





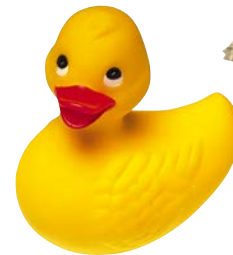
polyvinylchloride (PVC)

inexpensive, heavy, rigid,
durable but brittle
without plasticizers

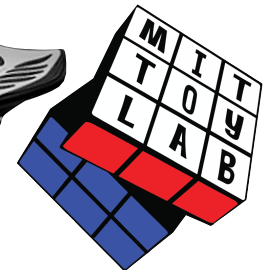


environment concerns

outdoor/water products



characteristic smell



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



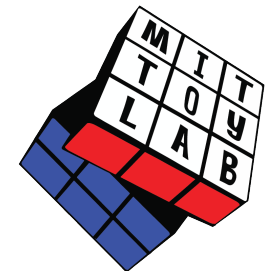
PMMA



PC



PET





polyethylene (PE)

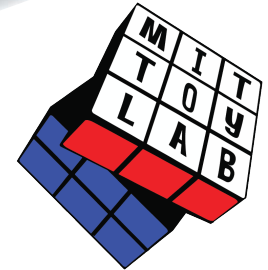
most common plastic

HDPE, LDPE

inexpensive, very flexible,
less dense than water

waxy feel, milky, slippery

highly resistant to food,
water, salt, chemicals



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



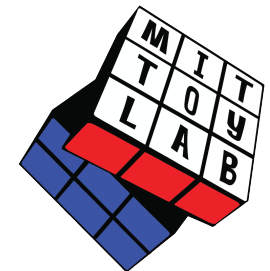
PMMA



PC



PET



Compare ABS, PVC, PP, PE



ABS

Hard
Colorful
Strong



PVC

Dense
Flexible*



PP

No Fatigue
Tough
Shiny Surface



PE

Flexible
Food/Chemical Safe
Waxy

stiff

\$\$\$\$

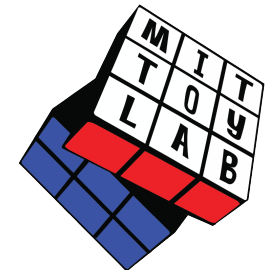
nicest finish



flexible

\$

worst finish



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



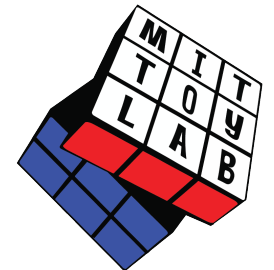
PMMA



PC



PET





polystyrene (PS)

clear, hard, inexpensive,
brittle, tinny sound

often foamed
into Styrofoam

good for lightweight
insulation

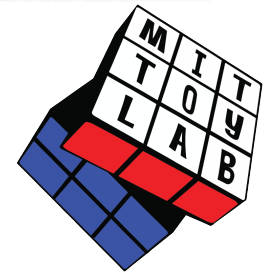
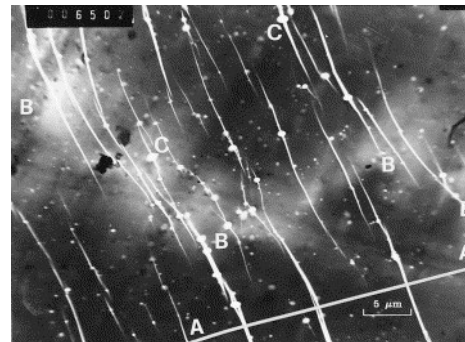
cracks and scratches
easily



crazing

strain whitening

network of small voids or cracks



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



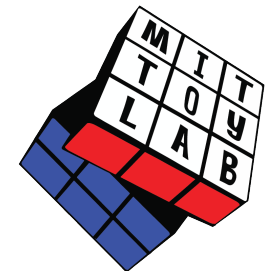
PMMA



PC



PET





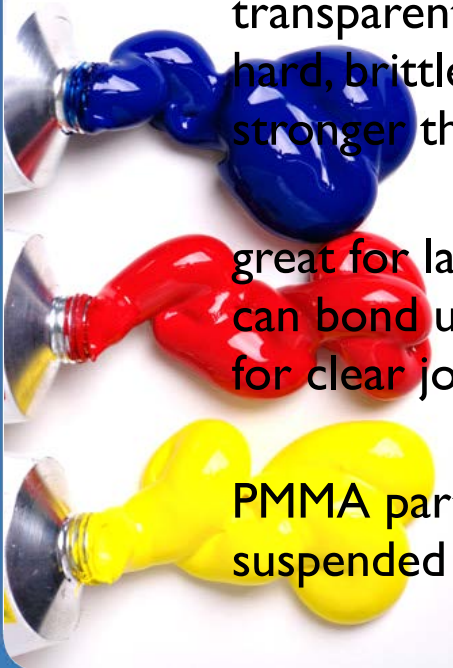
polymethylmethacrylate

Acrylic, Plexiglass, Lucite

transparent like glass,
hard, brittle, much
stronger than PS

great for laser cutting and
can bond using solvents
for clear joints

PMMA particles
suspended in water?



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



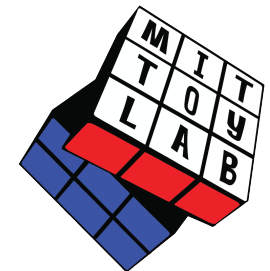
PMMA



PC



PET





polycarbonate

an “engineering” plastic

bullet proof

expensive, extremely
tough and rigid...

and optically very clear



thermoplastics

opaque and translucent plastics



ABS



PP



PE



PVC

clear plastics



PS



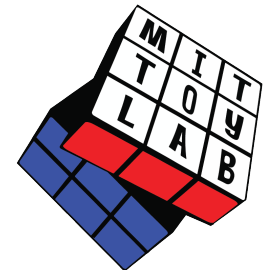
PMMA



PC



PET





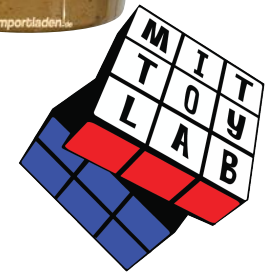
polyesters (PET)

inexpensive, transparent,
easy to mold

food products, barrier to
moisture

tough, able to withstand
high pressures

recyclable, requires less
energy than glass bottles



compare PC, PET, PMMA, Ps



PC

“bullet-proof” tough

Tough
\$\$\$\$



PET

low-permeability
tough



Acrylic

glass like
brittle
strong

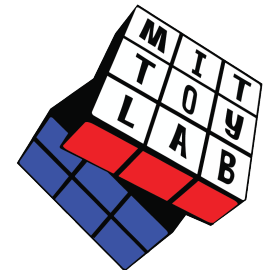


PS

tin sound
brittle
light weight



Brittle
\$



thermo-plastic forming

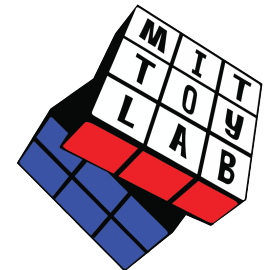
Extrusion

Injection Molding

Thermoforming

Blow Molding

Rotational Molding



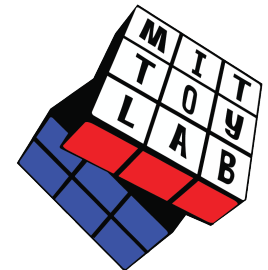
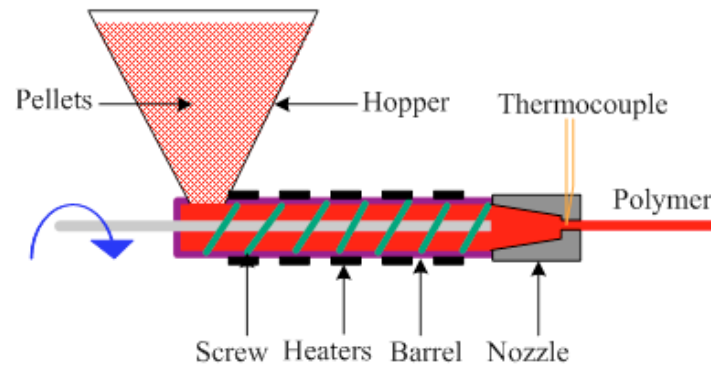
Extrusion

like a pasta extruder

constant profile extrusion
(rods, straws, etc.)

high volume

dies are expensive (sort of)

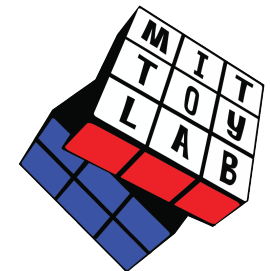
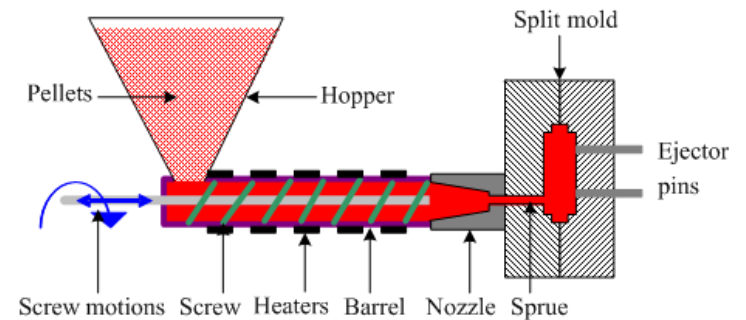


Injection moulding

for thin, constant thickness parts

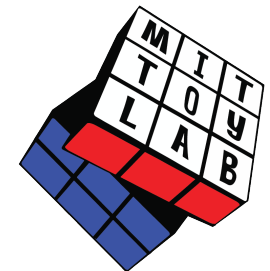
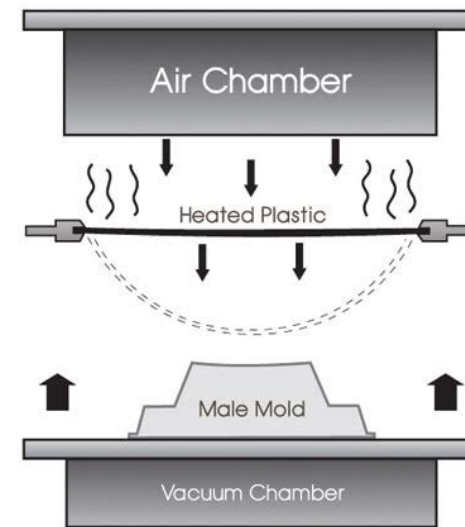
gate, parting lines, ejector pins

mass production, molds are expensive



thermoforming

for thin sheets, simple one sided forms

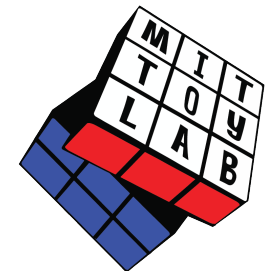
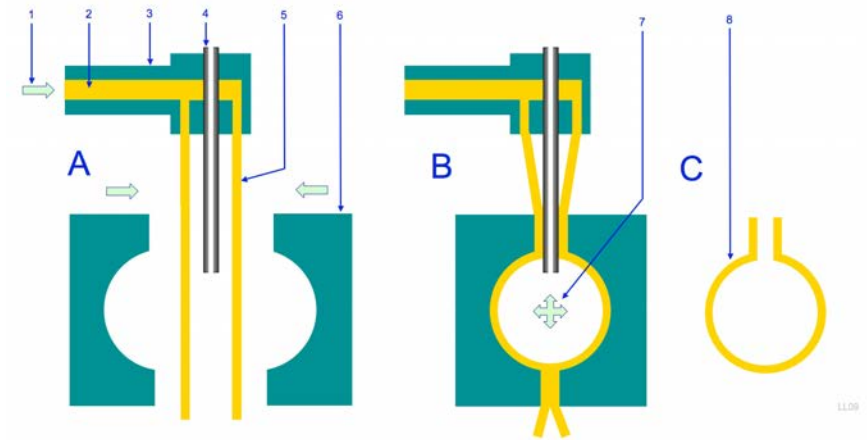


blow molding

for open thin walled hollow, large parts

milk jugs, most bottles

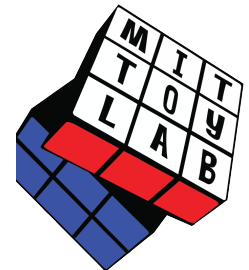
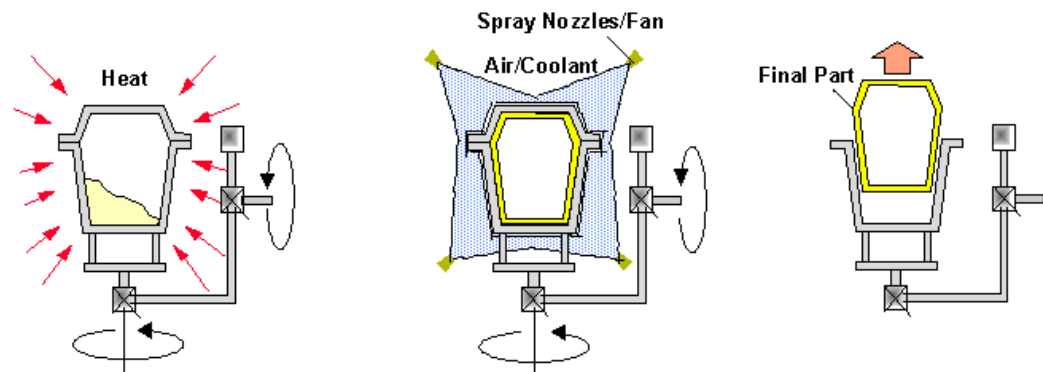
pinched look on bottom



rotational molding

for simple hollow shapes

good for large, durable parts

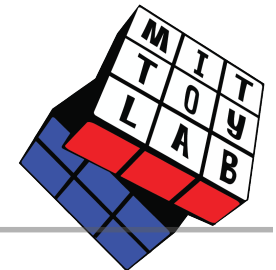


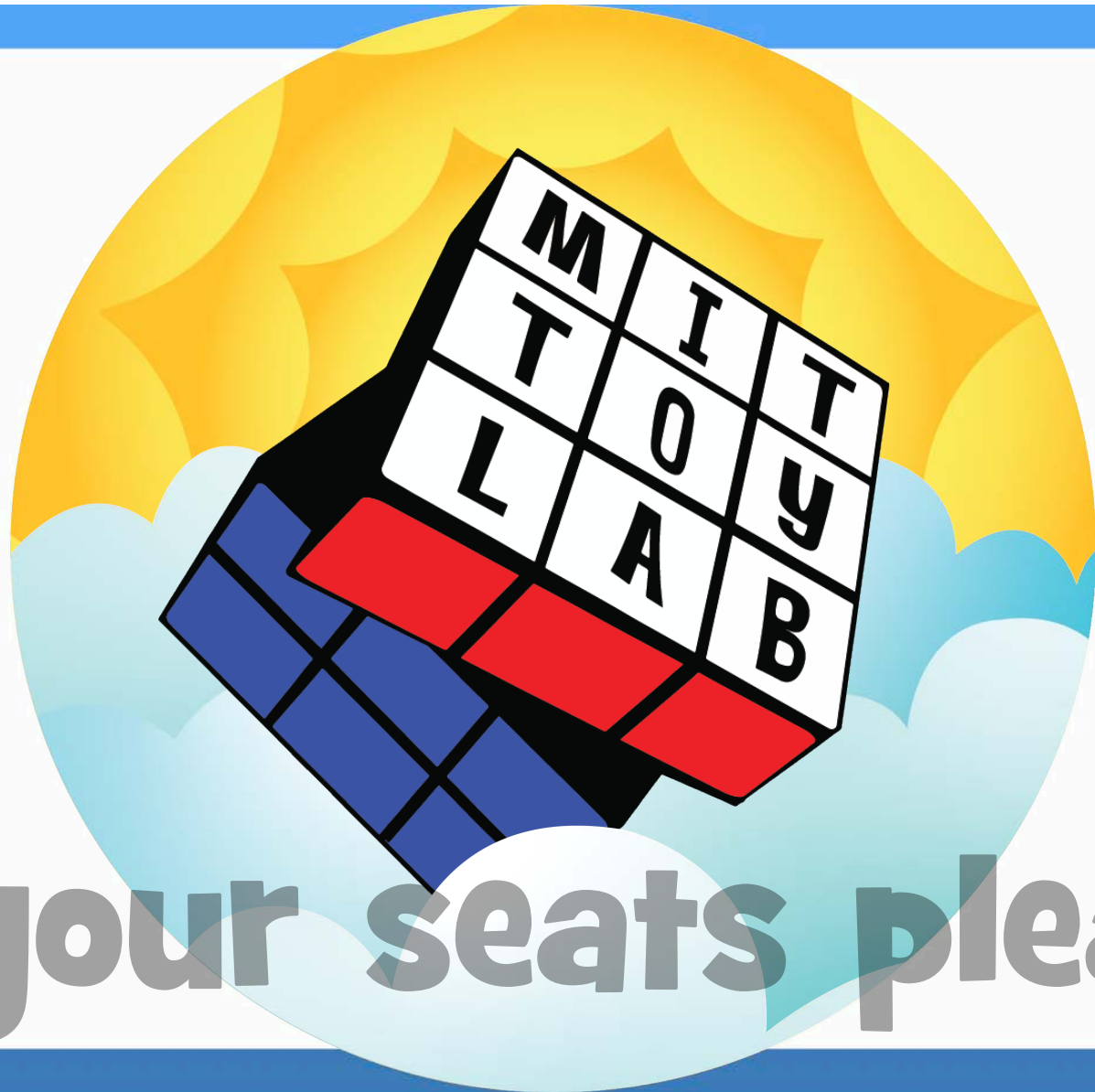
team quiz! until 4:34

we are in here!



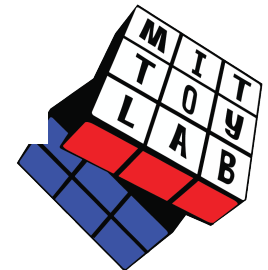
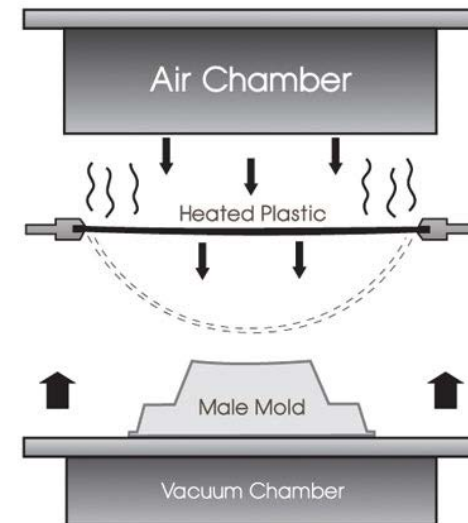
4:35





to your seats please!

polystyrene (PS)

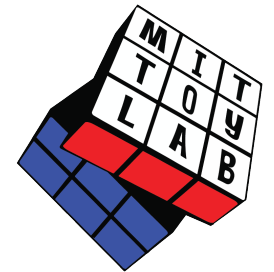
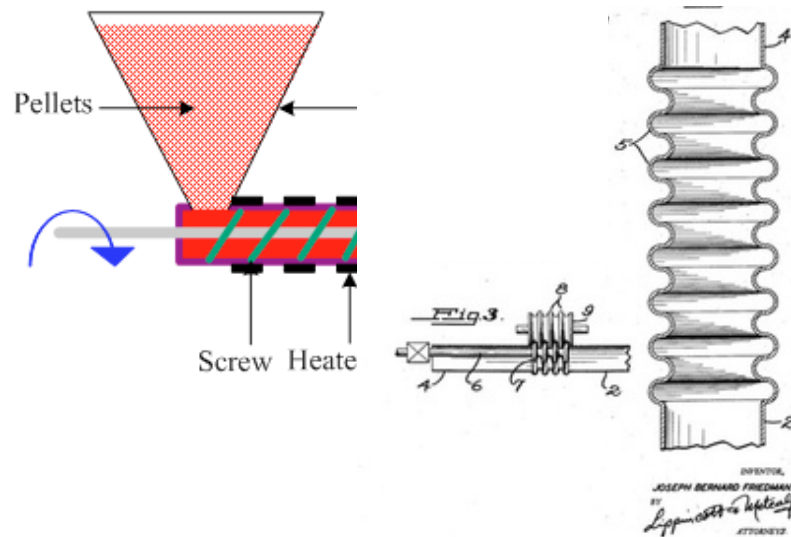


polypropylene

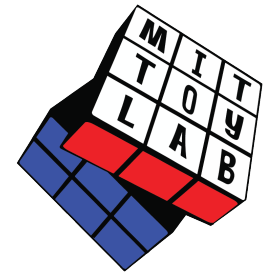
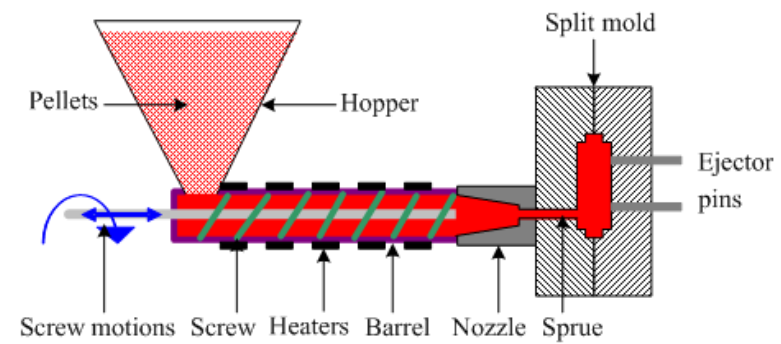
Sept. 28, 1937.

J. B. FRIEDMAN
DRINKING TUBE

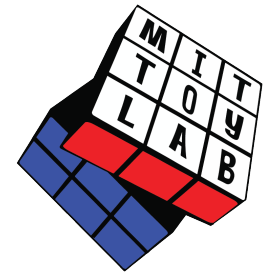
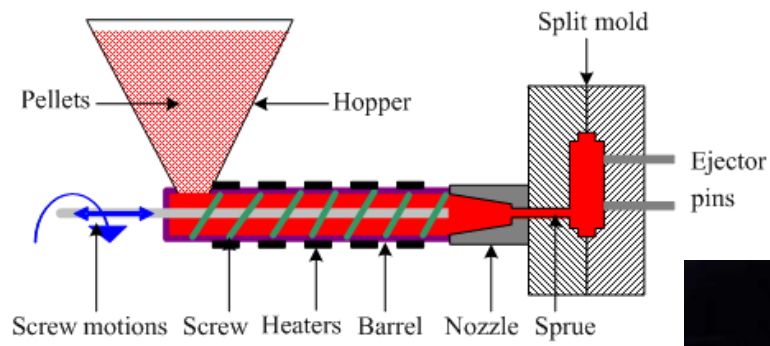
2,094,268



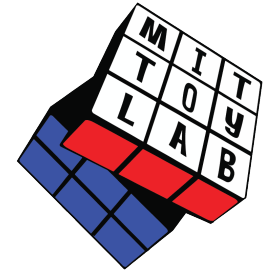
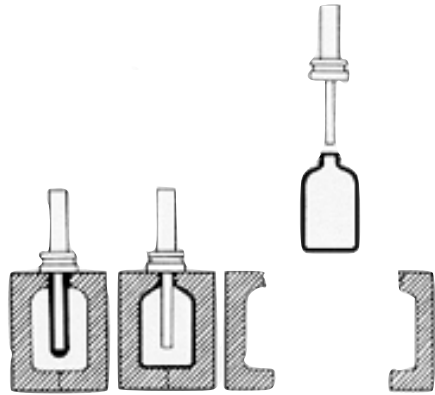
polypropylene (PP)



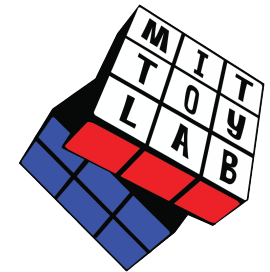
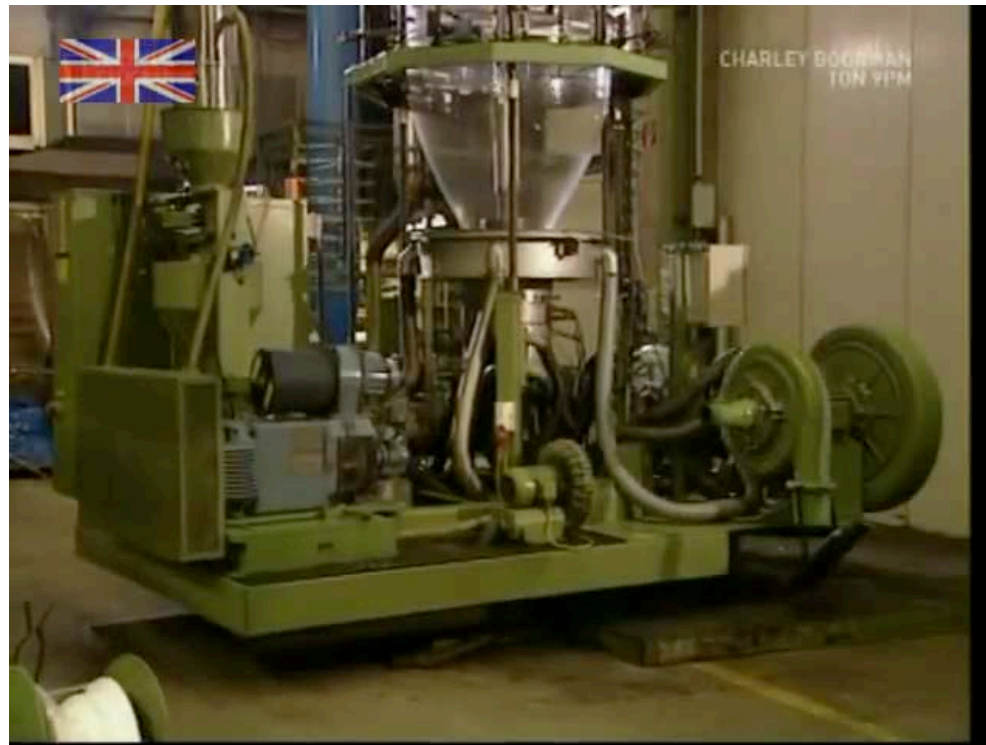
PET



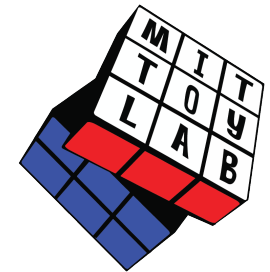
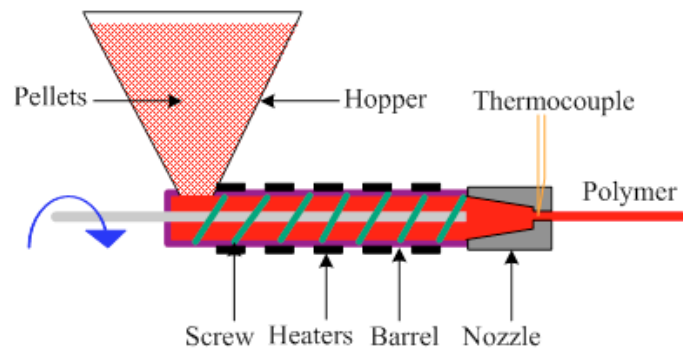
PET preform



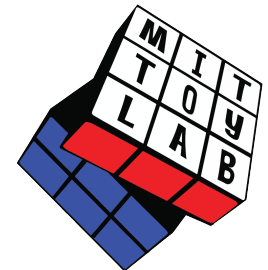
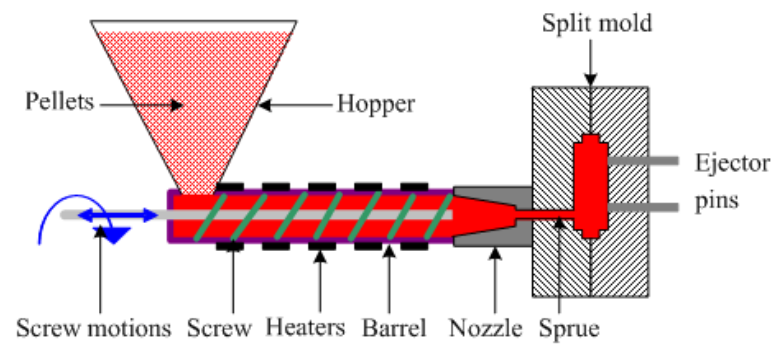
polyethylene (PE)



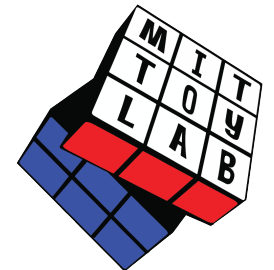
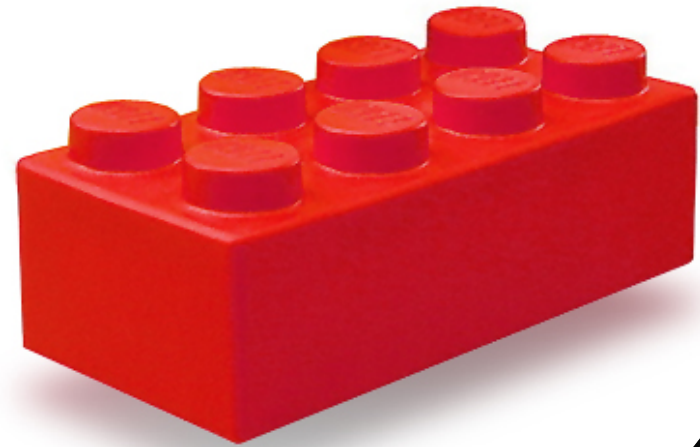
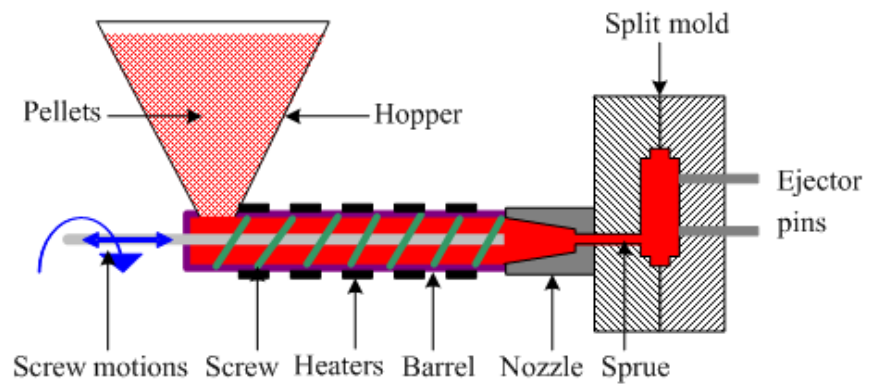
polyethylene (PE)



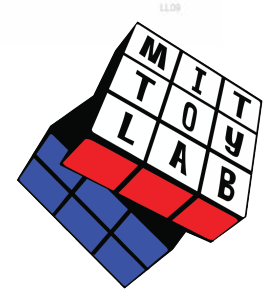
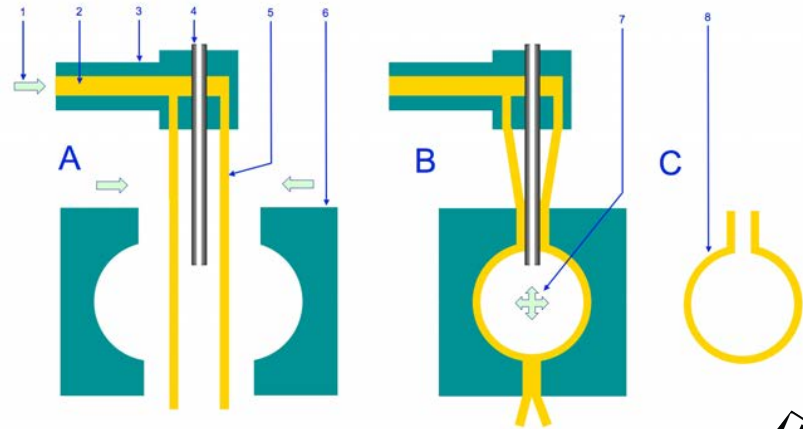
PVC (polyvinylchloride)



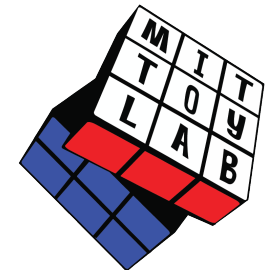
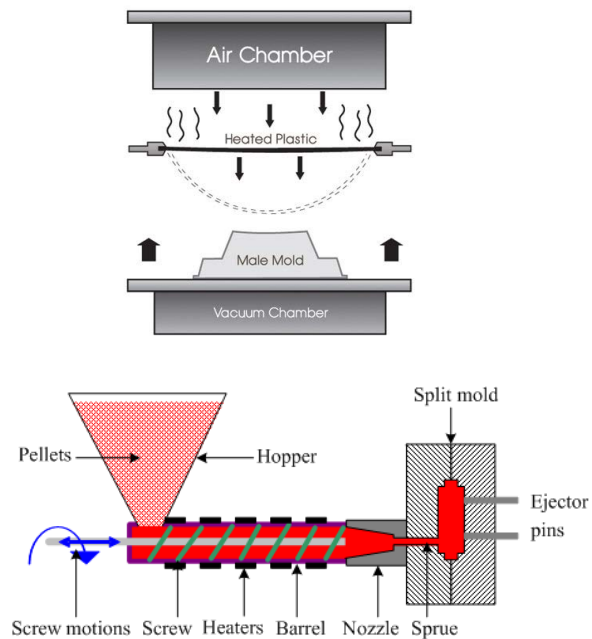
ABS



polyethylene (PE) low density



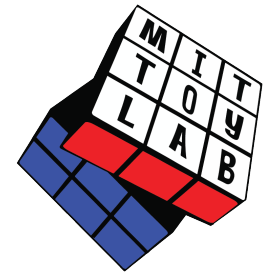
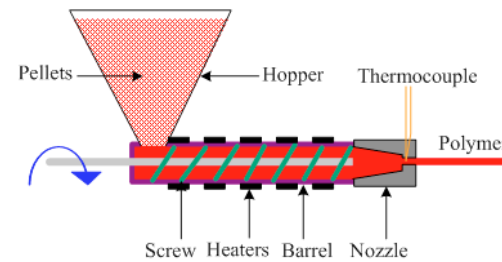
polystyrene (Ps) two ways!



PLA (polylactic acid)



lower melting temperature than ABS



plastic recycling

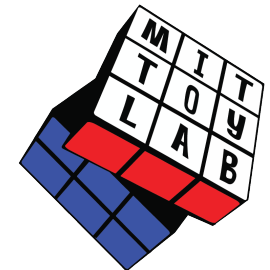
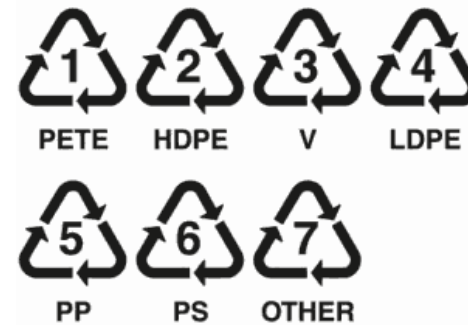
not everything gets recycled
(even if it's recyclable)

sorting, shredding, cleaning
processing

30% of PET bottles recycled

130 million water bottles are
discarded per day, in the US
alone! 1500 per second!

10% of all plastics are recycled,
15% is burned



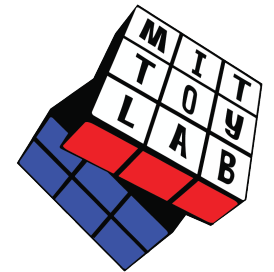
energy in plastic

5 lbs
of plastic



~

gallon
of gasoline



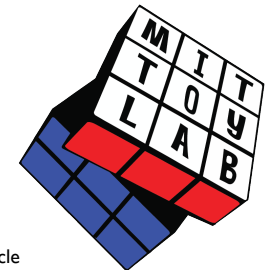
paper vs plastic



two plastic bags use ~10% less energy to make than one paper bag

and produce ~70% less pollutants than one paper bag

plastic doesn't degrade, comes from a non renewable resource, and is horrible for wildlife



* institute for lifecycle environmental assessment



M	I	T
T	O	T
L	A	B



2.00p



2.00p



plastic

is a design flav

word