European BEST Engineering Competition

19th, 20th and 21st of march 2022

SaltPay

Team Design

ATM

INDEX

1. Introduction

An automated teller machine (ATM) is an electronic banking outlet that allows customers to complete transactions without the assistance of a teller. That way, anyone who has a credit or debit card can access cash and consult their card's data at most ATMs.

ATMs were first used in London in 1967 and today can be found all over the world. The first machine, which was invented by John Shepherd-Barron, allowed customers to withdraw a maximum of £10 GBP at a time. The first ATMs that were installed dispensed cash in plastic cartridges, rather than individual notes. Also, some customers used a metal or a plastic token that was inserted into the machine and was kept to be mailed back to the customer later and others even issued stacks of paper like checks.

Figure 1. First ATM mechanism [6]

Figure 2. First ATM in the world [5]

Banking wasn't tied to a branch or a human anymore and it could be done 24/7. In 1970, a concept of personal identification number (PIN) was proposed. This moment was a landmark moment in the growth of self-service banking. During the first decade of the 21st century we saw a rise in the number of the ATM's frauds through technologies such as skimming devices. Therefore, banks developed software that could detect these anomalies. Estimates place the number of the ATMs currently in use at 3 million units.

ATMs are now a part of our daily lives, and while we can perform some of their many functions using our laptops and smartphones, they are still the best option for withdrawing cash.

2. Main goal

The challenge is to create a functional ATM, capable of accepting SaltPay Bucks withdrawals.

The task

The amount of money must be selected through a numeric input (electronic or mechanical) which contains predetermined values. **Only after a card has been inserted into the ATM slot does the selected amount come out.**[1]

There are 2 types of SaltPay coins (1 and 2 SaltPay Bucks) and 3 types of SaltPay bank notes (10, 20 and 50 SaltPay Bucks). The following quantities must be able to be withdrawn from the ATM:

1, 2, 10, 20, 50

Bonus points will be provided for each additional withdrawable amount. For example, if your ATM is able to output 70 SaltPay Bucks **with only 1 interaction**[2], then it is deserving of the bonus points.

Each type of currency must be stored **in a separate container**, with a **maximum of 5 containers**. Each container must have more currency than the labeled amount. For example, if the labeled amount is 50 SaltPay Bucks, the deposit must contain more than 50 SaltPay Bucks.

Prototype operation rules

Since the prototype should be completely automated apart from the initial action, a participant can only interact with it if some of the mechanisms don't work, and the team will be penalized for this. If this were to happen, only one team member can operate it at a time.

[1] The order of operations is described in the Testing procedure
[2] Defined as the action to withdraw 1 amount (1 button press, 1 lever pull, etc)

3. Rules and general information

Breaking the following rules may result in your team's disqualification, loss of points, or loss of the deposit, according to the organization's or the jury's decision.

The competition will start on Saturday the 19th at 4:30 PM and will end on Sunday the 20th at 4:30 PM. Each team will receive an initial kit with a set of tools on Saturday the 19th at 4:30 PM. **All the tools must be returned undamaged at the end of the competition. You must leave the tools in your team's working area after the end of the competition**. Not following this procedure will lead to the loss of the deposit. These tools cannot be part of your prototype.

The testing equipment will be available for viewing in the shop from 4:30 PM on Saturday until 4:00 PM on Sunday. Each team will have the opportunity to test their prototype before the presentation, from 10:30 PM (Saturday) to 4:00 PM (Sunday). **Your team has a maximum of 3 opportunities to use the testing equipment during this period.** The scheduling will be made available at 19:30 PM (Saturday).

There will be a scheduling chart which the teams will have to fill with their name to schedule a test with their prototype during the competition. The Topic Group will bring the testing equipment to the team's desk to do the test. You will have a maximum of 3 minutes with the testing equipment, and you can schedule up to 3 tests at different times.

Each team can buy materials up to a maximum amount according to the table on page 14 to 15.

Keep in mind that there are certain materials that can be sold out at a certain time, even if your team hasn't had the opportunity to buy them. **All materials are limited to the existing stock**. Also note that materials, once bought, cannot be returned or exchanged between teams. Failing to follow the rules may result in a disqualification of the entire team.

You cannot use materials that were not obtained from the store. You cannot use materials from the initial kit in your prototype (unless specifically told otherwise).

The shop will open at 5:00 PM on Saturday and will close at 3:30 PM on Sunday. The workshop will open at 5:00 PM on Saturday and will close at 4:30 PM on Sunday.

Only 1 person per team is allowed to be in the shop line at the same time.

When picking up the materials, make sure you have your nametag. You won't be able to collect them if you don't.

You can only use the tools and materials provided by the organization (pages 12 through 15). The use of any other tools or materials is forbidden and can lead to the disqualification of the team.

Participants may not leave the workshop area with the workshop tools.

The team is responsible for the transportation of the prototype from their room to the prototype storage room and from the prototype storage room to the presentation area the next day. The team is also responsible for operating and positioning the device in the test area.

The team cannot attempt to make any modifications to the prototype after the end of the 24h competition (includes transportation to the storage room, storage and transportation to the test area), otherwise the team will be disqualified.

Prototypes must have physical dimensions under 100x100x120cm (120cm is the maximum height of the prototype). Failure to meet these criteria will result in a disqualification of the prototype. **Note the doors are only around 80cm wide, so make sure your prototype fits through the door at the end of the 24h (you can do this by separating your prototype into different modules, for example).**

Please keep in mind that your prototype **will need to be relocated by the team** at the end of the 24 hours to a location where it will be stored overnight, so don't build anything that is attached to the table or other surrounding objects. **All Arduinos, electronic boards and breadboards must be returned** after the presentation, try your best not to damage them as you may lose your deposit.

A team is not allowed to go into another team's space without their consent.

4. Assessment Criteria

The evaluation will be based on different types of criteria. These will be evaluated according to the following parameters from 0 to 20:

A. **50% - Withdrawn currency (Wc)** - Your prototype has to be able to successfully withdraw the following:
   a. 60% - Basic amounts:
      i. Coins - 9% for the withdrawal of each coin;
      ii. Bank Notes - 14% for the withdrawal of each note.

$$C_i, BN_i \in \{0, 1\}^3$$
$$C = 0.09*C_1 + 0.09*C_2$$
$$BN = 0.14*BN_1 + 0.14*BN_2 + 0.14*BN_3$$

   b. 40% - Extra amounts:
      i. Combo of two different coins - 7.5%
      ii. Combo of two or three different bank notes - 10%
      iii. Combo of coins & bank notes - 12.5%
      iv. More than 1 coin of the same type - 15%
      v. More than 1 bank note of the same type - 20%

$$EA_k \in \{0, 1\}^3$$
$$EA = 0.075 * EA_i + 0.1 * EA_{ii} + 0.125 * EA_{iii} + 0.15 * EA_{iv} + 0.20 * EA_v$$
$$\sum_{k=1}^{5} EA_k \leq 2$$

$$Wc = C + BN + EA$$

B. **Attempts (At) -** Each different amount being withdrawn has a limit of 2 tries. If you use your second chance for a specific amount, your team will be given a score penalty. Be aware of the time.

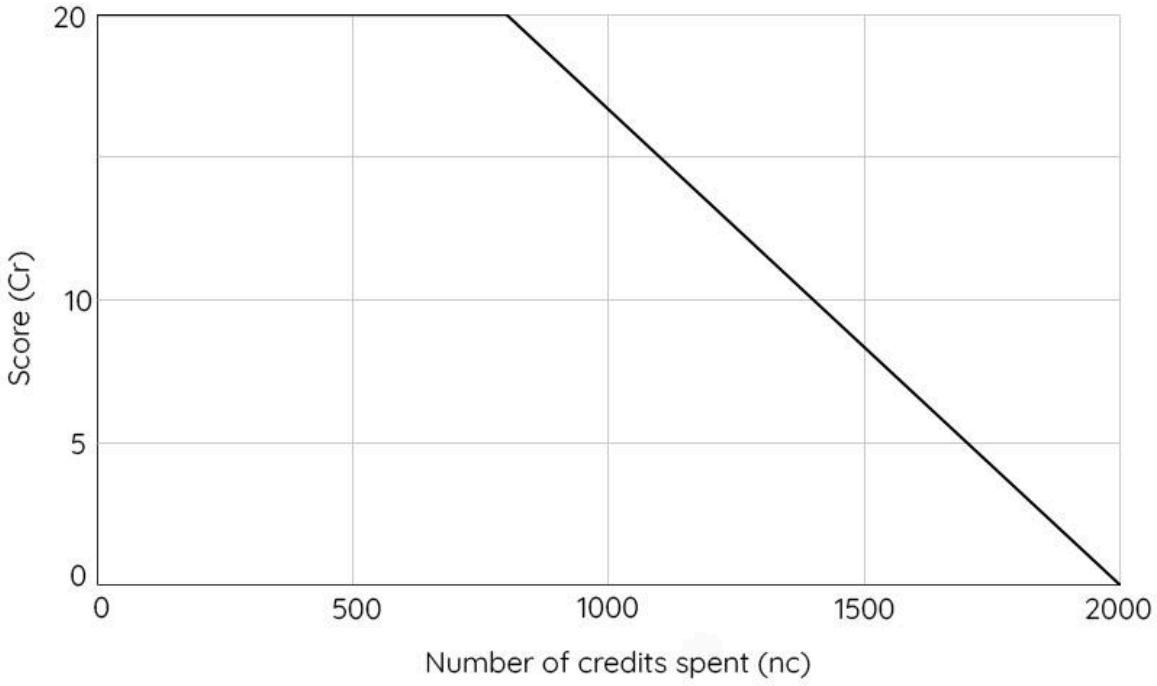
$$At = 1 - n/12,$$

[3] Variable equals to 1 if the objective is completed and 0 if not.

n = total number of second tries

C. **20% - Credits Spent (Cr) -** The lesser number of credits (nc) you spend, the more points you will get. The total number of credits available is 2000.

Cr = 20 , if 0 < nc < 800
Cr = 20 - (1/60) * (nc - 800) , if 800 < nc < 2000



D. **20% - Originality (Or) -** Original, out of the box prototypes will benefit from a higher score. This criterion will judge the originality on the specific mechanisms used.

E. **10% - Presentation (P) -** Each team must present their work and should include the following parameters in their presentation:
   - Strategy;
   - Prototype construction;
   - Technical references;
   - Engineering concepts;
   - Any relevant information that enhances your work.

This presentation must be in **English** and can be done while testing the prototype. The classifications will vary between 0 and 20 points and will be decided by the jury.

Final formula for the criteria:

Grade = 0.50 * **Wc** * **At** + 0.20 * **Cr** + 0.20 * **Or** + 0.10 * **P**

5. Prototype Testing Protocol

You must **be in the testing area**, with your prototype, **on Monday** the 21st. The order of the presentations and tests will be published Sunday morning. **If you're only available on a specific time**, please contact the **Participants Responsible** until **the end of the competition (the 24h)**.

You must be in the testing site at the time stated on the schedule that will be provided.

Test procedure

- Approach the test site and move to the table you're told.
- Place the prototype on the testing table and start preparing it. When told, **you have 5 minutes to:**
    - **Present your work to the jury:** This must be done in English.
    - **Test your prototype:** You have a maximum of two attempts per amount of operation of the prototype, and it will consist in:
        - Inserting the card into specified slot;
        - Selecting the desired amount to withdraw;
        - Removing the card from the slot;
        - Finally, the amount selected should come out of the machine.

- After the test, pick up your prototype and give your place to the next team **as quickly as possible**.

For logistic reasons, all presentations exceeding the 5 minutes will be stopped, so that the other presentations can continue on time.

The Testing Material

The sets of testing material will be composed of **2 types of coins**, **3 types of bank notes** and a **card**. The material will be available for viewing at the shop, along with its specific measurements.

As previously stated, each team will have the opportunity to test their prototype before the presentation, from 10:30 PM (Saturday) to 4:00 PM (Sunday). **Your team has a maximum of 3 opportunities to use the testing equipment during this period.** The scheduling will be made available at 19:30 PM (Saturday).

6. Disqualifications and penalties

Not complying with any number of the task regulations can lead to **penalties or disqualification**. An adequate penalty will be decided by the jury.

The **jury reserves the right to give extra penalties** if they think it's necessary. These penalties can have as consequence the disqualification of the team, the invalidation of the test or simply the reduction of points from the final classification.

The use of tools and materials **not provided by the organization** or that **weren't registered on the store as bought by your team** will lead to the disqualification of the team.

If at the end of the competition, the tools given by the organization are damaged, the team responsible for the damage has to pay the value of the damaged material, and will not get their deposit back. If the value of the damaged goods surpasses the value of the deposit, the team must pay the difference.

On Sunday, **after the end of the competition, the team has 30 minutes to clean their area and its surrounding area.** All the tools and unused materials must be **delivered to the store within 30 minutes after** the end of the competition. Not complying with this point, leads to the loss of the deposit.

You can't leave the competition site during the 24 hours. If you really need to do it, personally approach the Participants Responsible so that the situation can be evaluated.

7. Safety Equipment

The **safety equipment** available consists of:

- Gloves;
- Glasses.

Participants have to use the suggested safety equipment for whichever task they're performing. Teams should always have in mind the safety rules and regulations! If you need any help using and working with any tools, **ask an organizer for instructions at the workshop**.

A first aid kit is available at the workshop. If there is an injury, go to the workshop or contact any organizer. **Safety above everything!**

8. Tools

A tool kit is given to each team at the beginning of the competition, containing:

- 1 Hot Glue Gun
- 2 Hot Glue Sticks[4]
- Pen
- A4 Sheets of Paper
- 1 Acrylic Board
- 1 Utility knife
- 1 Hammer
- 1 Ruler
- 1 Measuring Tape
- Adhesive Tape
- 1 Scissors

These tools and the remaining materials must be returned to the organization at the end of the competition.

There will also be some tools in the workshop:

- Utility knives
- Universal Pliers
- Level
- Saw
- Hacksaw
- Set of Screwdrivers
- Small Rasp File
- Pachymeter
- Drill
- Automatic Screwdriver
- Hard Rubber Head Hammer
- Electric Soldering Iron
- Solder wire
- Bench vice
- Jigsaw
- Ruler

[4] These materials can be used in the construction of the prototype.

- Set-Square
- Grinding Wheel
- Self-locking Pliers
- Oscillating Tool
- Cutting Pliers
- Rotating Tool

9. Available material

Category	Code	Materials	Measurements	Max Quantity	Credits
Cardboard	C1	Miscellaneous cardboard		4	25
Duct Tape/Glue	G1	Hot Glue Stick		3	30
Duct Tape/Glue	G2	Various Tape Rolls		3	10
Electrical	E1	Micro USB Breakout Board		1	30
Electrical	E2	AA Battery	Pack of 4	2	40
Electrical	E3	AAA Battery	Pack of 4	2	40
Electrical	E4	Arduino Uno		1	50
Electrical	E5	Arduino Nano		1	50
Electrical	E6	Breadboard		1	30
Electrical	E7	DC Motor		3	35
Electrical	E8	DC Motor Driver		1	20
Electrical	E9	Electric Wires	200mm	10	10
Electrical	E10	Jumper wires F-F	Pack of 2	5	10
Electrical	E11	Jumper wires M-F	Pack of 2	5	10
Electrical	E12	Jumper wires M-M	Pack of 2	5	10
Electrical	E13	Resistor	Sum up to 2kΩ	3	30
Electrical	E14	Servo Motor MG94R		1	60
Electrical	E15	Servo Motor SG90		1	40
Electrical	E16	Push Button		5	10
Electrical	E17	2 State Switch		5	20
Foam	F1	‚m Foam Rectangle	550x550mm	1	25
Foam	F2	Small Sticky Foam Squares in a Roll	500mm	2	15
Foam	F3	Foam Tube	100x25mm	5	15
Metal	M1	Small Door Hinge		3	25
Metal	M2	Big Door Hinge		1	30

Metal	M3	Nails	pack of 3	6	10
Metal	M4	Screws	pack of 3	10	10
Metal	M5	Compression Springs	Pack of 2	3	30
Metal	M6	Traction Springs	Pack of 2	3	35
Metal	M7	Nuts	pack of 3	5	10
Metal	M8	Washers	pack of 3	5	20
Metal	M9	Hanging Hooks		3	20
Metal	M10	Steel Wire	300mm	3	40
Other	O1	Mouse Traps		1	50
Other	O2	Pulleys		2	40
Other	O3	Pins		3	15
Other	O4	Bearing		2	15
Other	O5	Cork Disks	5xØ25mm	5	10
Other	O6	Cork	45xØ25mm	5	30
Plastic	P1	Small Cable Ties	pack of 3	3	20
Plastic	P2	Big Cable Ties	pack of 3	3	25
Plastic	P3	Straws	pack of 5	3	15
Plastic	P4	Green Plastic Ribbon	10x300mm	3	25
Plastic	P5	Plastic Tube	Ø10x300mm	3	25
Plastic	P6	Various Cut Tubes	30x30mm	2	40
String/Rope	S1	Rope	500mm	2	40
String/Rope	S2	Rubber Bands	Pack of 5	10	10
String/Rope	S3	Twine	1000mm	4	60
Wood	W1	MDF	600x400x3mm	2	60
Wood	W2	Toothpicks	pack of 5	2	15
Wood	W3	Wooden Piece	500x400x18mm	3	50
Wood	W4	Wood Clothespins	Pack of 3	3	20
Wood	W5	Jenga Pieces	Pack of 3	5	25
Wood	W6	Wooden Lath	300x7x7mm	3	30
Wood	W7	Wooden Lath	400x13x27mm	3	40
Wood	W8	Wooden Dowel	250xØ10mm	3	30

Wood	W9	Skewers	Pack of 3	3	20

10. Bibliography

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