

Reverse Engineering Online Challenge 2022 - 2023:

Team: 5327X

Gael Force Robotics

Dublin, California, United States



Brand - *Nikon EM 35mm SLR (Single Lens Reflect) Film Camera



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“A deconstruction idea like no other...”

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Introduction -

Overview -

For VEX Robotics Spin Up 2022-2023, our team has decided to participate in the Reverse Engineering Challenge. For this challenge on backtracking and breaking down an electronic object, we have chosen a Film Camera to really dive deep and figure out:

What is behind the doors of a camera?

What is a Film Camera? -

A film camera that we are using to deconstruct, is a photo capturing device, which optimizes light and reflection to capture onto a film tape. A film camera will use a light - capturing tape stored inside of it, and use chemicals from the light and reflection to then paste onto the tape. This image will then be brought out from the top, and hold a clear display of capturing the details of the photo. And once a new photo is ready to be taken, the film rolls forward and resets.

Why did we decide on this? -

We decided on using such a complex, interesting device because of the different things it holds and stores inside of it, to take photos and print them out. We found it intriguing that such an item, that is a camera, has so much potential and usage to use for so many other things. Cameras have been popular and used widely for all sorts of things. We shall experiment this device and figure out how it really operates.

Clarifications:

This assignment process was approved by the parents and captain of 5327X. The batteries were taken out of the camera beforehand for safety. Goggles were worn by the members during the entire process for safety and preventing hazards.





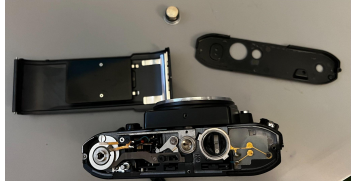
Deconstruction -

Tools/Instruments -

Tools which are important for taking apart this device, are definitely the smaller tools with the different screwdriver tips. From the hex sizes and the star sizes, taking apart a film camera will result in some effort. Using over 30+ of these tips will help crack open the camera and its different parts.



Deconstruction Process -

<p><u>Step 1 -</u> Working on taking off the battery (Figure 1.1) and then the tape covering (Figure 1.2) to understand how the camera functions.</p>	 <p><i>Figure 1.1: Battery which supplies the power for the camera to work. The voltage is set with two 1.55V silver battery rolls (LR44 type).</i></p>
<p><u>Step 2 -</u> The strap was detached and was able to show us some of the important functional portions. The film roller being widely important and the reflecting object to portray the image. The film roller brand is F55, or rather, the 35mm film.</p>	 <p><i>Figure 1.2: Back side of the camera, which had the film roller, the button to reset the film, and the mirror which would direct the light.</i></p>
<p><u>Step 3 -</u> We will detach the underside of the camera (Figure 1.3) and find all of the electronics in the bottom which make the camera operate.</p>	 <p><i>Figure 1.3: Underside of the camera was detached and displayed multiple gears for the tape, the battery holder, etc.</i></p>

Step 4 -

Use the screwdriver to remove all of the excess parts of the camera, including the lens holder (Figure 1.4) and others.



Figure 1.4: All of the lens caps and parts to the front side of the camera. All of these help stabilize the frame and the reflection position.

Step 5 -

Revealed the gear train (Figure 1.5) of the camera and disassembled the front of the camera lens and the flash (Figure 1.6).

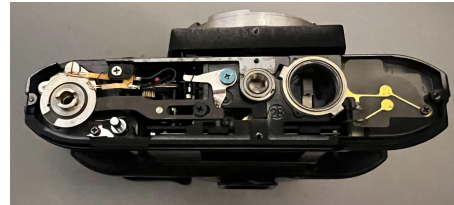


Figure 1.5: The gear train which turns the gears behind the camera. It has specific movements for every single working part.

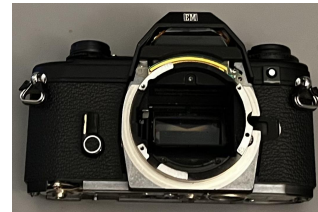


Figure 1.6: The camera was left with a mostly plain surface, but still held the circuits for the photo, and the lens portion.

Step 6 -

Disengage the powering system for the film roller (Figure 1.7) and get a more clear view of the inner electronics.

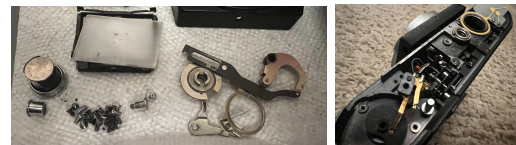


Figure 1.7: Side by side are the inner parts of the main power board, all operating things.

Step 7 -

Release all of the straps and the screws for the top portion of the camera to find the main microprocessor (Figure 1.8). Clear up all of the other wires in the way to simply finish with just the main board at the top.

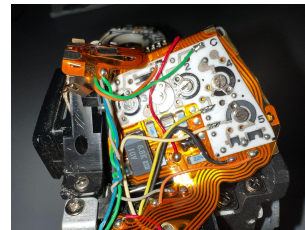


Figure 1.8: The microprocessor lies right on top of the camera to connect to all the other parts.

Step 8 -

Unveil the cover behind the film rewriter to access the other part of the microprocessor. This part being labeled as a second 'processor' (Figure 1.9) because of it being hugely connected to the main microprocessor itself.

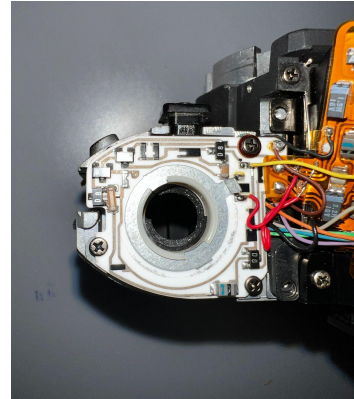


Figure 1.9: The processor being placed right next to the main microprocessor or even the 'mother brain'. The processor places its own role of operating with the microprocessor with taking in information and distributing it.

Step 9 -

We needed to finalize the sequence and gears which help operate the camera on the inside. Thus, we unscrewed the entire gear train (Figure 1.10) inside of the camera to observe it.

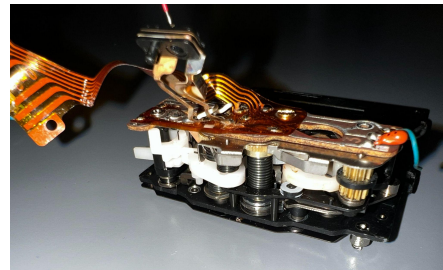


Figure 1.10: The gear train system has provided a good foundation when trying to take pictures of moving film.

Step 10 -

Being the last step of deconstructing the rest of the camera, we had to make sure to break down the camera to its last parts. We had broken down all the parts until we reached just the frame (Figure 1.11) of the entire camera with nothing inside.



Figure 1.11: The frame of the camera once all of the components and parts of the camera were taken out. It is now a hollow piece with nothing inside.

Videos -

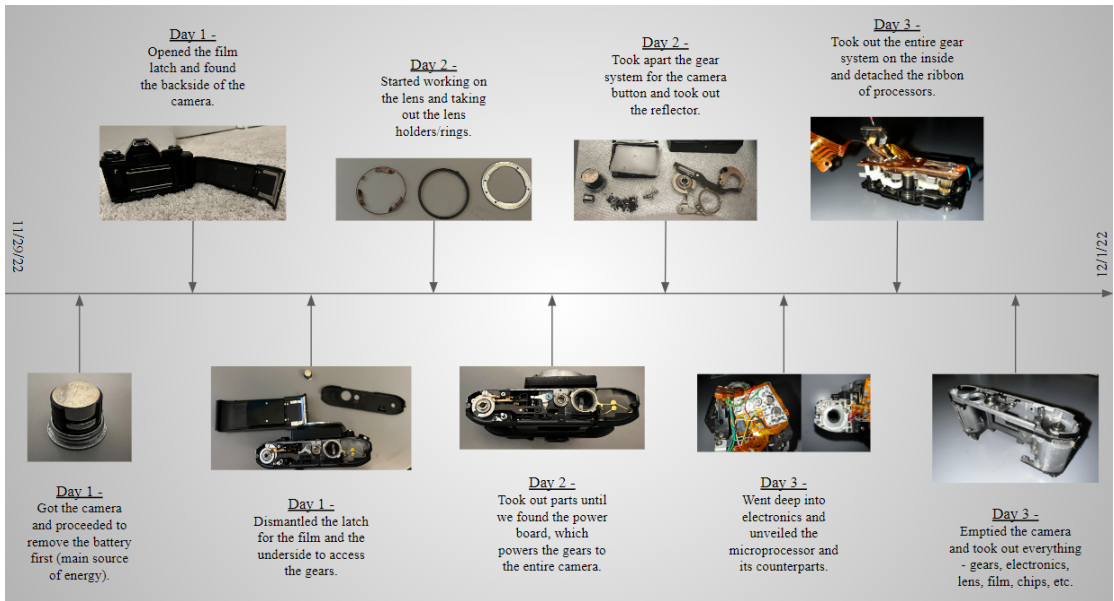
Gear Movement and Inner Camera (Open Links in New Tab):

Outer View: <https://drive.google.com/file/d/1-hb-nc3vIWAOK2gxjKXWykSJ3o0Dx-ec/view>

Inner View: <https://drive.google.com/file/d/1xCv4CtDABvAvfsVHK9UUkRUEA20SH0OI/usp/view>

Revision and Timeline -

What was done in the deconstruction portion had taken a span of 2-3 days to make sure that every single portion of the camera was taken apart and ready to be fully analyzed. Regarding this, we have made a timeline for the amount of work we had finished at the end of every day.



Before (11/29/22) -



After (12/1/22) -

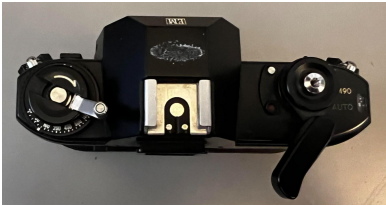


Nikon Film Camera Analysis/Explanation:

Exterior Overlay/General Parts -

Buttons and Adjusters -

The top portion of the camera consists of the button to take the photo (the button on the right side), and the latch which then rolls the tape to print a new image (black latch at the bottom right). These two parts help synchronize the photo taking process. On the left side is the latch to rewind all the tape to then take it out (silver latch on the left side). Lastly, the adjusting numbers on the left side of the camera under the silver latch which help change the values of the power for the mirrors on the inside to reflect the light.



**Numbers located on under the latch*

Lens Fixing -

The lens of the camera can be altered, as usual, to zoom in and out of the camera to find the perfectly toned photo. The lens can reach a far distance and has a clear result at the end. An extra source to see is the entire list of lenses which can be used to take photos on the Nikon EM (Figure 2.1).



**Lens to adjust the viewpoint of the picture*

Nikon and Nikkor Lenses for the Nikon EM	
(Wideangle)	(Telephoto)
Nikkor 13mm f/5.6	Nikkor 1200mm f/11 IF ED
Nikkor 15mm f/5.6	(Reflex)
Nikkor 18mm f/4	Reflex-Nikkor 500mm f/8
Nikkor 20mm f/3.5	Reflex-Nikkor 1000mm f/11
Nikkor 24mm f/2	Reflex-Nikkor 2000mm f/11
Nikkor 24mm f/2.8	(Zoom)
Nikkor 28mm f/2	Zoom-Nikkor 28-45mm f/4.5
Nikkor 28mm f/2.8	Zoom-Nikkor 35-70mm f/3.5
Nikkor 28mm f/3.5	Zoom Nikkor 43-86mm f/3.5
Nikkor 35mm f/1.4	Zoom Nikkor 80-200mm f/4.5
Nikkor 35mm f/2	Zoom-Nikkor 50-300mm f/4.5 ED
Nikkor 35mm f/2.8	Zoom-Nikkor 50-300mm f/4.5
(Normal)	(Fisheye)
Nikkor 50mm f/1.2	Fisheye-Nikkor 6mm f/2.8
Nikkor 50mm f/1.4	Fisheye-Nikkor 8mm f/2.8
Nikkor 50mm f/1.8	Fisheye-Nikkor 16mm f/3.5
Nikkor 50mm f/2	(Special)

Figure 2.1: Different possible lens for the camera

Film Portion -

The back side of the camera has a latch which needs to be opened to see the film portion of the entire camera. This part itself is mandatory to add the film roller, and then reflect the picture onto the film. The rollers on the far right side help with putting the film in its correct place after every photo. The far right holds the film rewind to put back all the tape where it normally was.



**Back side holds the main part to make the 'film' in the film camera*

Mirrors and Reflectors -

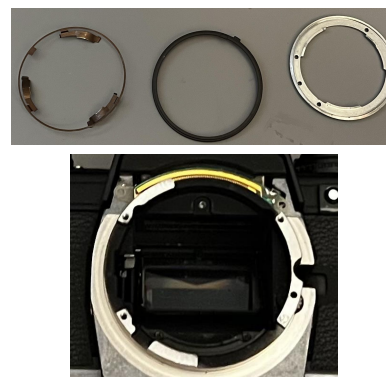
The mirrors on the camera, like other devices too, have the property of reflecting light onto chemicals to cause photos and color on the film tape. The reflector, which is another way to indicate the screen on the back, helps secure the information onto the film and doesn't let out any excess light.



**Mirror (Left) is polycarbonate plastic which reflects light. Reflector (Right) forbids any excess light from hitting the film and its chemicals*

Interior Overlay/General Parts -Lens Adjusters -

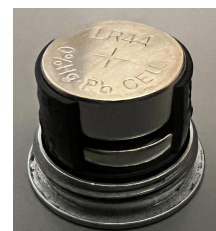
The lens caps/adjusters are hidden behind 4 screws in the front of the camera which stabilize the lens and the mirrored view of the final product. An important part of the lens in general, is the yellow/green chip which lies on the top of the holder. It has an important job of processing the information once the button is clicked and the chemicals are brought onto the new image.



**The rings (Top) have helped secure the front of the camera to make the lens stay in place. The green chip on the outline (Bottom) helps indicate what the image will look like*

Battery and Processors -

The battery and battery processor, the important sources of power which help operate the entire camera in the first place. The battery, being set at a battery voltage of 1.55. The processor helps send quick messages to each of the parts, to make all of the components work at once to give an output.



**The battery synches its work with the entire camera to help with a power source, etc.*

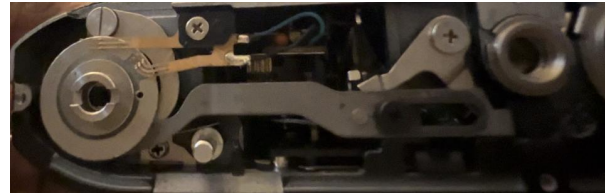
Current Parts Understanding -

All of the components so far have their own reason for why they are placed there and what their uses are. Going from just the supporting strands all the way to the battery and its processors, everything has a reason for why it's there. Going a little bit further into the rest of the camera will prove to have even smaller parts and even more reasons why everything is there. Things including the smaller gears, the wires, and the chains which make everything work together.

Gears and Trains -

Film Reset:

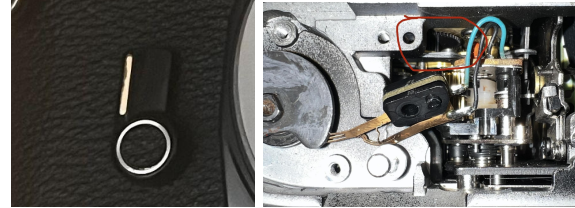
As from the button and the latch shown for the exterior parts, taking apart the bottom will reveal the gears to how the film really resets and how it works. The picture shows the latch pulling the film and then the button setting everything back to square 1.



**Gears are used to make the roller move on an axis from side to side and locking in/out of place*

Self Timer:

The self-timer is a component which helps the photo taker track a certain amount of time before taking a framed shot or waiting for a perfect photo indication. This is operated through multiple tiny gears which can be seen in the bottom part of the camera.

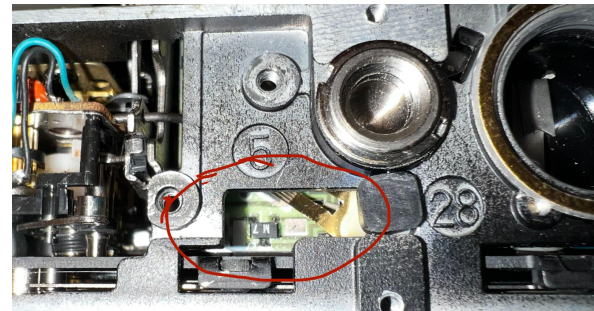


**Self timer is used personally for taking photos and estimating the captured shots. The red, circled spot is the exact location of the gear that moves*

Wired Portions (Underside) -

Power Board:

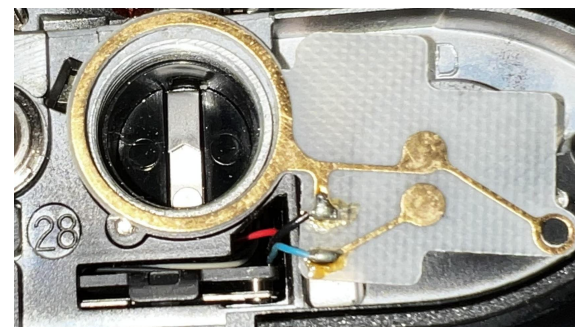
The power board in the circle is the placeholder in the middle of all of the other gears, wires, etc. The main answer is proved to show that this is one of the main sources, or even the brain, to all of the other components. Having this board will give power and energy to the other parts of the camera.



**The green board in the red circle shows the main source where the camera gets its power*

Battery Processor:

The processor, as mentioned earlier, is a clear sight of the battery's link to energy and outputting it into the camera. The red and blue wires are connected to the green board and then have all of its outcomes after that



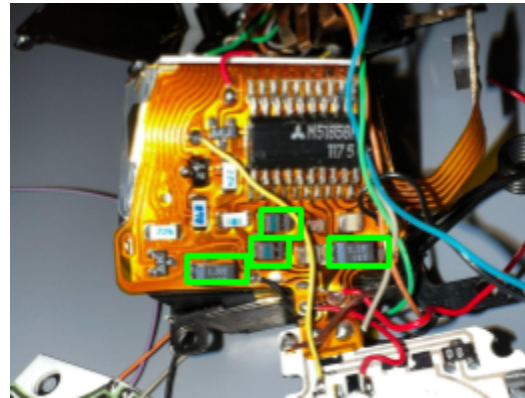
**The processor has its wires and database surrounding the battery and operating all of the main sources of power*

Microprocessor + Components:

The microprocessor, or rather, M51858P, is a Mitsubishi Integrated Circuit used for the main communication and portion for the entire camera. It is like the mother brain; sending signals to all the camera portions, having a power distribution circuit and overall being the more significant part of the film camera. It holds inductors, resistors, transistors, specific electrical nodes, the tape which outputs code to the camera, etc. This processor is dated back from electronics and tech of over **20-30** years ago.

Transistor -

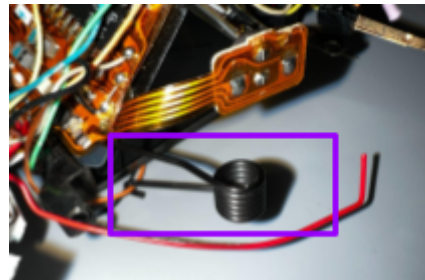
All of the different green boxes in the photo are transistors which are used on the microprocessor. However, there are no dated back clues to figure out the direct code number for the transmitters. There are 2 of the main transmitters that were observed, and all of them have specific coded numbers and voltages. The green box on the far left holds the values of 1.5m and 16V, as the far right box holds the values of 2.2M and 10V. The voltage and the size conversions will have direct effects and power limitations. The direct signals from the microprocessor will interact with the transistor as it is implanted directly inside.



The 4 green transistor boxes will all help in electrical signals and maneuvering power.

Inductor -

The purple box holds the viable component, the inductor. The inductor is a coil which helps direct electrical energy through a magnetic field for power. This picture holds the disassembled portion of the inductor and the remainder of the coil. Nonetheless, it plays a role of directing power, just like the transistor. However, the inductor differs since it advances in its performance for interaction with magnetics and the field.



The deconstructed coil has the ability to achieve the magnetic power in the camera.

Resistor -

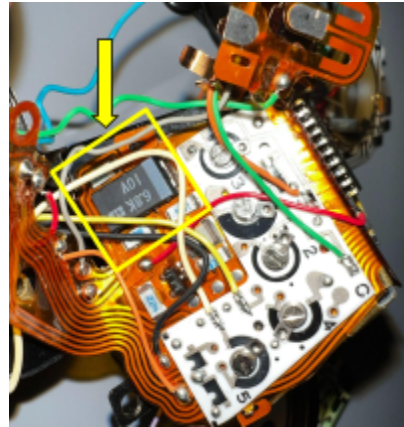
The shiny resistor is an impactful part which holds a big responsibility for the camera. It is directly linked to the microprocessor and placed right above the camera lens. For code numbers, there is an unknown stamp which labels the resistor - 137. Overall, the job of the resistor is to limit the light and reflection inputs and outputs and limit how far the lens can extend.



The resistor is the part which helps in the foundation of limits and is hugely beneficial.

Capacitor-

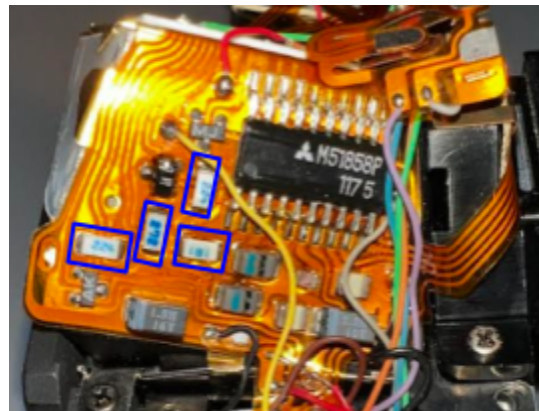
The yellow arrow pointing to the yellow box holds the capacitor. Alongside some of the other microprocessor components, it also holds electrical energy and can distribute it amongst the camera parts. The capacitor is embedded into the processor itself and works directly as a main part of it. The capacitor has a big play since its terms of 'electrical energy' can power the wires and everything that they are involved with. Going off specific numerical details, the capacitor results with the values of 6.8K and 10V. Results like these tell us the capacitor is stored at 10 voltage units and includes 6.8 Kelvin units. Thus, results in the entire camera benefiting from the capacitor.



The capacitor in the microprocessor holds the main electric charge. Similarly like an insulator.

Electrical Nodes -

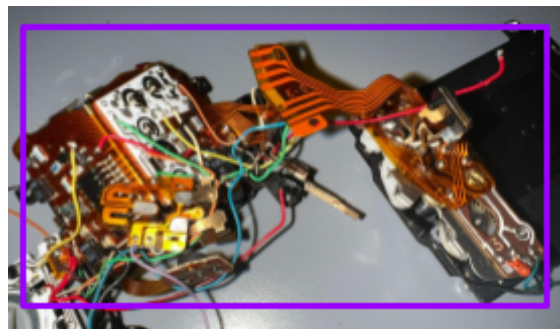
Every blue box amongst the microprocessor is a node which sends power and information amongst the other parts of the camera. The label numbers for the 4 nodes are - 224, 272, 181 and 224. These numbers are all lists for the different assigned variables given to them to work along the other electronics. Whether it be the film rewinder or pressing the camera button, the nodes will have their part on the microprocessor to get a specific quota finished.



The nodes have their uses when it is needed for maximum quality performance for the camera.

Orange Ribbon Cable -

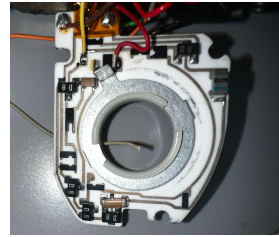
The ribbon which wraps around all the parts connects everything from high to low. It all is mainly directed from the microprocessor and then leads its way till the bottom gear trains just with the flick of a switch. The ribbon itself derives multiple coded instructions and will also use voltage and resistors to fulfill Ohm's Law equation, which was another new thing that we learned about.



The orange ribbon cable connects every single portion through the camera to send messages.

Secondary Processor -

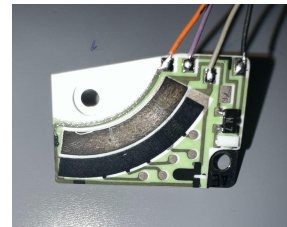
The 2nd processor is directly wired and almost combined to the microprocessor and then concludes its traits of similarly spreading data and command to the film related components. The brand of the processor is named on the back of the board with the word, Alps. This is an offspring of the Alps Alpine Circuit Board. The processor also holds multiple of its own transistors with the labels, D8. At the end of the day, the processor plays its role as the co-lead with generating and deriving info.



The 2nd processor is near the top of the camera (microprocessor) and also relays messages.

Unknown Data Chip -

The last interesting component which we speculated about was this data chip that was wired right under the battery and the power board. This is a data chip which was most likely placed as to specific commands for power distribution and lens adjusting. The 'unknown' in the title results in the fact that there is no information whatsoever on this specific data chip. Nonetheless, the data chip will process data and execute it.

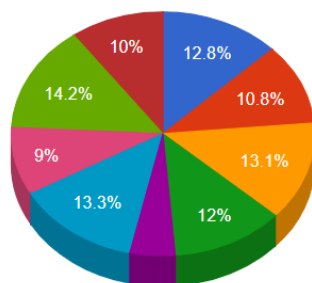


The data chip, which is embedded into the tape rewinder, has its own processes to capture film data

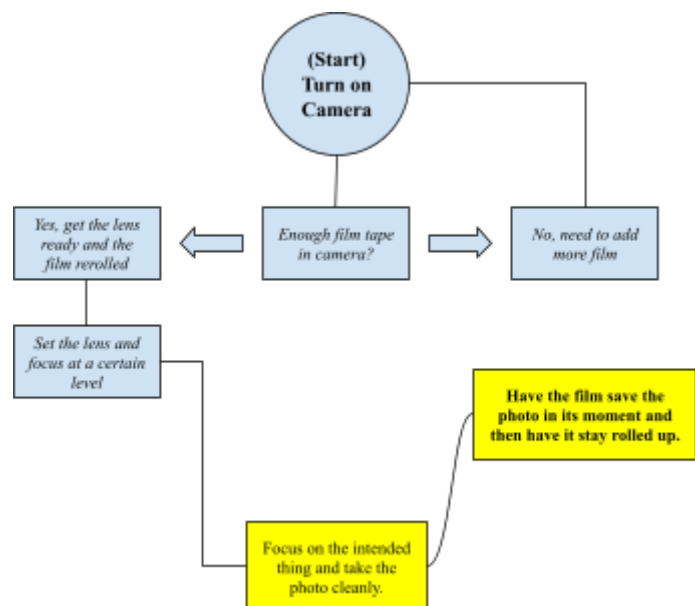
Components Chart and Control Flow Chart-

Electronics in the Film Camera (Close Estimate)

- Transistors 1
- Capacitors 2
- Resistors 3
- Nodes 4
- Inductors 5
- DataChips 6
- Processors 7
- CableRibbon 8
- Unknown 9



*Both of these charts indicate the operating system and process of the Nikon Camera. They both are good ways to understand what functions in the camera and how the process around the film camera itself works (Film, Lens, etc.)

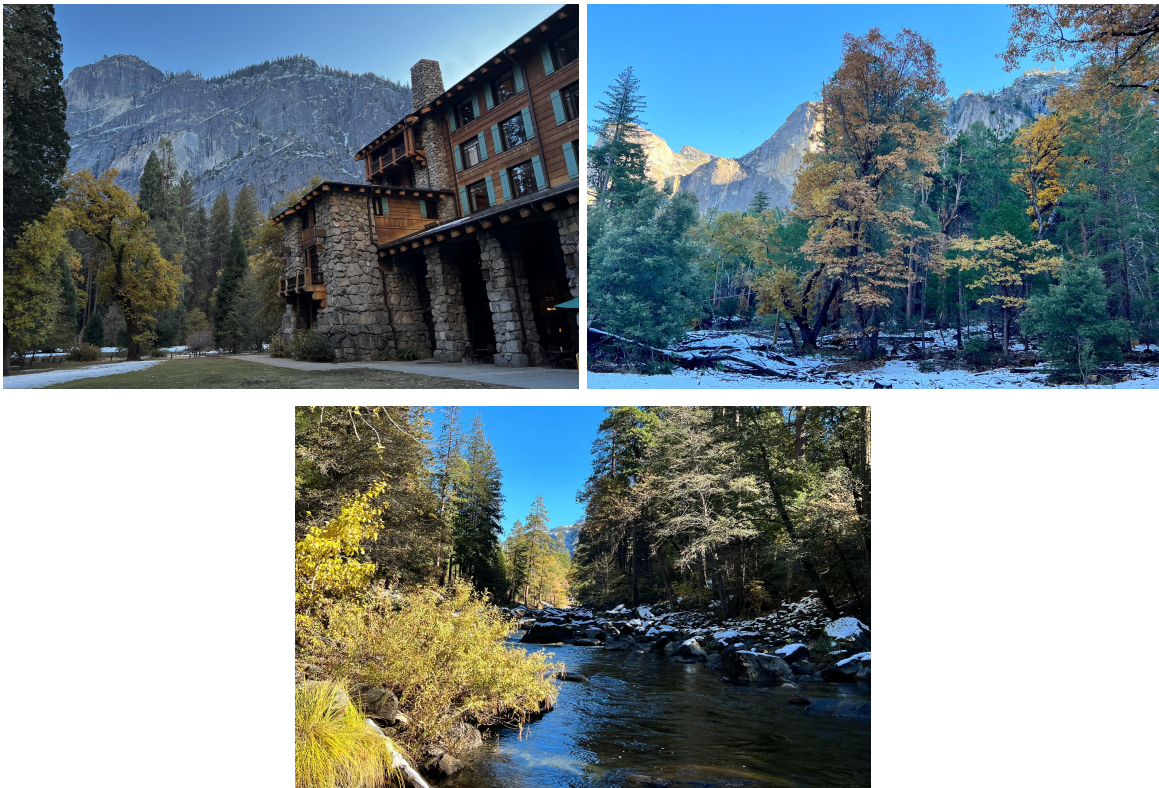


Specifications -

1. Camera Type: Nikon 35mm Single Lens Reflex (SLR) (*Only sold in Black Body finish)
2. Picture Size: 24 mm x 36 mm
3. Lens Types: Types consist of - Wide Angle, Telephoto, Reflex, Zoom, Normal, Special, etc.
4. Lens Mounting: Nikon type (Bayonet)
5. Shutter Operation Speed: 1/90 seconds when set to the label M90 on the focus change
6. Exposure (Light): The amount the camera takes in at a time is 1 silicon photodiode (SPD)
7. Signals: There are periodic beeps and sounds when the photo is in a focus mode, etc.
8. Power Source: Two of the 1.5V silver-oxide batteries at the bottom of the camera
9. Power Mode: Lights from sensors are sent to indicate the amount of charge remaining
10. Motor Drive Coupling: Interior Electrical Contact and built in operation for MD - E
11. Frame Reset: The camera will reset its frames once the back of the camera is opened
12. Film Rewinder: Can be manually altered on the left side of the camera button to reset the film
13. Camera Back: The backside of the camera opens once the film rewinder resets and is pushed up
14. Final Dimensions: 135mm (W) x 86mm (H) x 54 mm (D)
15. Weight: Total weight adds up at 460 grams for the body of the camera only

Photos taken with the Camera -

(*Taken from the memory and the film itself)



Overall Summary -

After taking apart the entire film camera till what we observed, we all were able to make a few concluding statements without knowledge. Devices aren't simply as they seem from the outside, rather, the inside which pulls all the strings. We all observed the multiple portions of how the power can shift through all the components and that the device isn't limited to just one thing. What can be for sure, is that this was a fun experience to take apart something to sprout new knowledge which was hidden before.

As a result of taking the camera apart, we reached deeper conclusions than simply pushing a button and ending up with a result. Digging deeper into how the process fully works, helps with understanding about things in life as well and that everything has more meaning.

Observing what every component and part does, gave us better knowledge on the functionality of a camera.

At the end of this project and taking apart all of the camera parts, we could understand how a lens really operates, how the gears for the film tape could be distributed, etc. Going even deeper, we understood how the main power board could operate and the battery processor helps support the entire foundation of the camera. The essential parts of the camera, which includes the lens, reflectors, and the tape, have all been made to synchronize and work based on each others' portions. A device works because of the components which let it do so, and with its flexible parts, can accomplish multiple feats.

A very peculiar and interesting part which we observed and will mention, is the microprocessor and its functions on the top of the camera. This component holds immense power over the film camera and drives so many questions and interesting things to learn with this part. We learned about new things like the transmitter, inductor, capacitor, resistor, etc. with only one part. It even helped us understand, 'Ohm's Law' equation, and kept us interested till the end.

The final statement to make for this project, we have learned so much and understood enough to know that our skills gained with experimenting on the film camera can be used in the real world. As a final message, learning all of this from a simple device, but a very interesting one, this project was worthwhile for the 2 weeks that we spent and we would be willing to do it again to gain more knowledge and learn more about the camera.

Citations -

Links:

1. *Nikon EM Manual and Guide.*" eugigufo.net, N.d,
<http://eugigufo.net/NikonEMManualAndGuide.html>
2. *Nikon EM - Specifications*, [Nikon Hardware/Specifications/Parts](#)
3. "Nikon Em SLR 35mm Film Camera Tutorial | Forward Cameras Vintage Film Camera Channel." YouTube, YouTube, 8 Dec. 2016, [Tutorial Video: Nikon EM 35mm SLR](#)
4. e34ish. "S2: Nikon EM, 35mm SLR, 1979-1982." YouTube, YouTube, 8 Apr. 2021,
[#2 - Overview of the Nikon Film Camera](#)
5. DazCaz1. "Nikon F100 | the Best 35mm Film Camera for Beginners | 4K." YouTube, YouTube, 10 June 2019, [Film Camera for Beginners - General Understandings](#)