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The Design and Development of a Professional Super-8 Movie Camera

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THE DESIGN AND DEVELOPMENT
OF A PROFESSIONAL
SUPER-8 MOVIE CAMERA

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INTRODUCTION

People in the business have made the claim that the Super-8 movie film of today, is the equivalent of 16mm film of ten years ago.

True or not, no one can deny the fact that in the eight years of its existence, the Super-8 format has expanded the scope of "home-movies" so vastly that the amateur can now do things which were limited to the professional (and the professional's format-16mm) until only recently.

My mention of "home-movies" was intentional. It seems that no matter what is done to this potentially useful format it's always referred to as an amateur's system, and with few exceptions, is frowned upon by the pros -- and quite unjustifiably.

As I have already mentioned, the image quality is excellent and quite comparable to today's 16mm film. Why then is it always relegated to the amateur?

The most likely reason, aside from the psychological stigma of being "non-professional," is the lack of professional capabilities (there are still some things which Super-8 cannot do); also lacking is the look and feel of professionalism in much of the equipment.

The purpose, then, of this thesis is to design and construct a mock prototype of a marketable, professional caliber Super-8 motion picture camera. The intended market would include educational and audio-visual departments of
schools, industry, social clubs, even small news stations. It would not be intended as a substitute for all aspects of film-making, especially those requiring extreme high quality, but it could supplement many film-making situations, and even carry the ball alone in some.

Many companies are already manufacturing the necessary accessories and supplemental equipment needed to match the Super-8 system with 16mm.

The main advantage for such a system would be enormous lessening of equipment cost, size, and weight; increased availability of film and equipment (just about any department store could stock the equipment and fixtures, and film is available in any drugstore), simpler maintenance, and easier repair.

The camera which I am designing would incorporate most features already found on existing advanced Super-8 cameras, plus many which are not: single and double system sound capabilities; 100 or 200 ft. bias-reel double S-8 magazines (plus the regular 50' S-8 cartridge), built-in battery charger, self-contained power supply for all camera functions, and semi-automatic focusing are the major features. Many lesser features are also incorporated.

The package itself would be designed for ultra-simplicity, and operating efficiency, as well as creature comforts. All operating functions and controls would be accessible from the dual handgrips; the camera itself would be lightweight enough (8-10 lbs.) and balanced to enable long periods of
hand-held operation, while still providing a stable image -- especially with the detachable shoulder brace.

In the following sections I will explain my research and the camera itself in further detail.
RESEARCH

My research began with a thorough review of existing Super-8 and 16mm cameras, noting their assets and deficiencies -- there were many on both counts. I found most Super-8's to be lacking in any true functional design, with the possible exception of the Pathe D S-8. All S-8 cameras use a single pistol-grip type of handle, of varying design. This is adequate for most amateur situations, but not the best means for hand holding a camera. Also, many of the controls are not easily accessible while filming, leastwise, not without upsetting the camera's stability. On the other hand, several S-8 cameras are making a noble effort to raise the stature of their cameras by giving them some professional features, such as long-ratio zoom lenses, variable speed motors, variable shutter controls, reflex focusing, built-in intervalometers, etc. Yet many important features are still lacking, in the S-8's.

The world of 16mm is a separate entity. This is the true professional format. Complete sound capability, large capacity film magazines, varieties of lenses, specialized job accessories, all make the 16mm format the most desirable of the two sizes. Many are fairly well designed and definitely "user" oriented in the design department. Still, ideally, some of these aren't the best. They are often too big, awkward to handle, and excruciatingly expensive.
2.

But now, why the gap between these formats. Surely there's a need for an intermediary type camera, which would incorporate the best features of the two.

To further research the possibilities of such a unit, I consulted with several people who were representatives of certain facets of my thesis.

I first went to Eastman Kodak, where I spoke with Mr. Bruce Elle, the head of their motion picture industrial design dept. (Mr. Elle designed the special camera used by the Apollo 11 astronauts to take close-up photos of the moon's surface). He agreed that the market for such a camera was definitely lacking, and almost wide open. He was also quite enthusiastic about the prospects of such a unit, and in particular about my design. He went on to give me some very valuable pointers about production costs, the inclusion and deletion of certain features, as well as information about types of motors, drive components, etc. (this will be dealt with in more detail later.)

I next went to Bausch & Lomb and spoke with Mr. Paul Hoogesteger, the manager of the industrial design department there. He assisted me in determining how the optical system could work (in this area I already knew what I wanted, but how was another matter), and some possible methods and materials on the construction of the final product (likewise, this will be dealt with in more detail).
I made a quick visit to the Ilex Company, lens and shutter manufacturers. They also assisted me in determining the best possible type of shutter and lens arrangement for my design. I should also mention that although I had my design nearly finalized at the time of these visits, these men were very instrumental in helping me to change and/or improve my design wherever possible.

My last consultations were with the Motion Picture Department at RIT; namely Dick Floberg, and Bob Osborn, both of whom are, or have been, working motion picture photographers for some years, and are well qualified to judge my design as far as its "in the field" use. They assured me, quite excitedly, that it was a good working design, with tremendous possibilities.

With my swollen ego, and my little model camera, I left to begin the project in earnest.
DESIGN AND DESCRIPTION

I settled on my final design, after about fifteen sketches of possible designs. I was fairly certain of what I wanted it to look like, but my main problem was whether or not the necessary features and components could be incorporated. After my consultations, I made the few revisions necessary to the drawings.

At first when I set out on this project I was more involved with the outward appearance of the camera, envisioning a sleek, projectile-like unit, which may have looked sexy, but wouldn't have been very functional. That approach was quickly squashed, in favor of a slightly more conventional but much more functional design.

I had made a set of finished drawings showing all aspects of the camera. It was these drawings which I brought with me to the various consultants, and it was these drawings on which I made the necessary revisions. That done, I made a prototype (full-size) out of styrofoam which served as a guide for future consultations. It was handled by a number of people in the business to see if they thought it had the right "feel." They thought it definitely did. Certain areas still needed to be modified however; the viewfinder location, and the shape and angles of the hand-grips.

A. HAND-GRIPS: The twin hand-grips created a small problem. I wanted them cantilevered, one on either side of the camera body.
This is the most desirable position for the hands when manipulating a camera of this type. To offer some latitude of comfort for the hands, the grips would be designed to swivel 45° inward along their own axis.

The grips themselves would have certain vital controls built into them: camera run switch, zoom controls, and focus controls.

This would negate having any lateral movement to the grips, as such a pivoting joint would be a needless, and costly luxury. At any rate, since the grips were also control
surfaces, they had to be designed for efficiency also. The end portion is raised and indented to accommodate the thumb, which would activate the operating button on both grips, and both grips would be contoured to accommodate the four fingers of each hand. The right grip will have a socket in it's forward end to accommodate a remote control operating unit. The socket itself would also be used for single frame operation, by inserting a cable release. The operating button on each grip would be of a 2 position type -- the first detent would be spring loaded, and operated by finger pressure. Push in further, and the buttons would lock in position, for continuous running. It would be released by pushing in again slightly.

Both grips would have a dual button setup on their inside edges, for zooming in and out, and for focusing in and out.
Note: The following features and components are all invisible as far as the mock-up is concerned. However, every aspect mentioned in the following pages has been considered, and planned out in advance, and the design has been formulated to specifically include all these aspects and features.

This thesis, being a design project rather than an engineering project, has limited the model stage to an exterior aspect only. References to internal components have been made as lucidly as were possible, and can be seen in the set of drawings. Again this project was not merely a styling exercise to give a camera an attractive outer shell. It was an in-depth study on how the inner workings of the camera could relate to its exterior, design and yet have both function very efficiently. Please keep this in mind as you read on and note the sketches.

B. THE LENS: The glass up front, being one of the most important components of any camera, would be of the highest
quality, yet extremely fast -- preferably F 1.4 - 1.6, and to be enticing enough for the pro, should have a 2-speed zoom with a ratio of at least 10:1 (some S-8 cameras do go this high); but the kicker would be the fact that the lens would be a MACRO lens -- that is, one that could focus down to two inches or less. (I was assured at Bausch & Lomb that all this would be possible, and very desirable -- also that it would not be overly weighty or bulky). Another feature of the lens would be its semi-automatic focusing, activated by the two buttons on the right hand-grip. It could also be manually focused by the conventional method of turning the knurled ring on the lens. (No design problems here either, according to Bausch & Lomb). The lens would be non-interchangeable, but then again this wouldn't be necessary since the zoom ratio covers most wide-angle and telephoto situations and the macro arrangement would negate the use of close-up lenses or bellows in most cases. Besides, having the provisions for interchanging a lens of this type (the one built in), would be much too expensive -- especially since the zoom and focus motors are directly attached to the inside of the lens barrel. The lens would feature an automatic diaphragm, as all modern camera lenses do, and would accept standard size 52mm (series VII) filters and attachments.
C. THE OPTICAL PATH:  The optical path of such a camera, is definitely one of the most complex to deal with, design-wise. This is the area in which you view, focus, expose the film, and determine the light exposure. Needless to say, that while I did research this area, with the help of Bausch & Lomb and Ilex Co., and I did make provisions for all its features in my design, it was beyond the scope of this project to determine precise components, alignments, glass characteristics, etc. That would be a thesis in itself. However, I was told that what I wanted could be manufactured reasonably. I will briefly explain the basic components of the optical system:

1. the shutter would be of the adjustable rotating disc type with a slot on one side. This is the most efficient type for this price-range camera. Also not expensive to manufacture.
2. the **prism**, which deflects a percentage of the light (app. 90%) to the film, and the remainder to the view-finder, is the main component of any reflex viewing system (other reflex systems are much too expensive for this camera). Reflex viewing enables the viewer to see the exact image the film "sees."

3. the **mirror** is what reflects the portion of light from the prism to the viewfinder. This is mounted at a 45° angle to the prism.

4. the **focus screen** is a small (app. 1 x 1 1/2") piece of ground glass located between the prism and mirror, thru which the viewer can focus his image while still looking thru his viewfinder. It should be located as equidistant from the prism as the film plane is.

5. the **behind the lens meter** (BTL) is another piece of glass coated with light-sensitive selenium, which when light-struck, sends a minute electrical current to a motor which activates the lens diaphragm -- thus giving you automatic exposure control. There also would be a manual over-ride slide switch, located along the lower left side, and operable while the user's hands were still on the hand-grips. This control would have an **auto** mode setting, and a continuous sliding motion, for
11. manually setting the lens F-stops. It could also be used for fade-ins and fade-outs, by completely opening and closing the lens diaphragm.

6. the viewfinder lens components are several small lenses along the viewing path, which brighten, magnify, and rectify the image before it reaches your eye.

7. the viewfinder is located in a direct line with the optical path, and is the actual piece thru which one views and focuses his image. Three features of the eyepiece are: an iris diaphragm to close off any light coming into the optical system from the viewfinder (only in off-beat situations would this be necessary to use -- eg. PHOTO-MICROGRAPHY); a diopter adjustment to enable viewers with different eyesight to view comfortably; and a swiveling eye-cup to accommodate right and left eyed viewers.
D. MOTORS: There are three motors which operate the film drive, the zoom lens, and the focusing.

1. filmdrive: located in the center of the camera body, this motor would drive the sprocket advance for the film as it passes thru the shutter, as well as supply the main drive for the 50' cartridge. It would also drive the 400 ft. film magazine atop the camera when its being used. It would do this by means of a gear assembly. The motor itself would be of variable speed from 8-54 frames per second (true slow motion), and would have a declutching devise, to disengage the motor from the magazine. This would enable the user to rewind the film partially, allowing him to make superimpositions, or dissolves (using the fade control simultaneously).
2. **zoom motor:** this small servo-motor would be a 2-speed reversible type to allow the lens to be zoomed in and out. It would be located in the lower left corner at the front of the camera body, where it could line up with the lens barrel.

3. **focus motor:** this servo-motor would be even smaller than the zoom motor and would be tucked up in front of the body just behind the lens, where it too could line up with the lens barrel, which it has to turn. It would likewise be reversible to allow focusing both in and out.
E. **POWER SUPPLY**: Power would be supplied thru 10-12 "C" cell cadmium sulfide batteries. These would power all camera functions except the sound amplifier (which has its own battery). The batteries would be re-chargeable while in the camera, and would be removeable from a tray on the bottom rear of the camera body. A mode switch located at the rear end of the camera would control the operating mode -- battery run -- A.C. run -- recharge -- and main power-off switch. A red and green pilot light would signal if the camera were running or charging, and a receptacle would accomodate an A.C. current line for A.C. operation or battery charge. In addition, there would be a built-in ammeter for checking battery status.
F. FILM SUPPLY: There would be two types of film supplies -- the usual 50 ft. S-8 cartridge which would simply fit into its own compartment on the right side of the camera body in the conventional way (the cartridge itself is designed to preset the A.S.A. film speed for itself when inserted into the camera). And there would also be a detachable 400 ft. (or 200 ft. whichever you chose) double S-8 magazine which would have to be loaded by the user. The film from this magazine would pass thru the same compartment and film gate as is occupied by the 50 ft. cartridge when in use, however, only one supply can be used at a given time. Both the cartridge and the magazine on top would be driven by the same main drive motor mentioned earlier. Since the 50 ft. cartridge is self-contained with its own rollers and pressure plate built-in, the film coming into the chamber from the magazine above, would require a system of collapsible rollers and a spring loaded film pressure plate, all of which would pop inside when the 50' cartridge was being used, and would pop out for use with the magazine film. The A.S.A. film speed would have to be set manually when the magazine was in use.
G. **SOUND SYSTEMS:** Two sound systems could be incorporated in my design -- **SINGLE SYSTEM** and **DOUBLE SYSTEM.** Either one would operate off of the same amplifier on the bottom of the camera. **Single system sound is** when the camera is also the tape recorder, and the film itself has a magnetic track along its edge which acts as the tape. In this way, the user can conveniently record the sounds of an event simultaneously with the picture, and without the need for a separate recorder. This system only can work with the magazine film supply, since the 50 ft. cartridges are not available with a magnetic stripe. However, both film supplies can be used with the double system, as a separate tape recorder is required. The recorder is connected via a synch-pulse cable to the amplifier, and a beep signal is periodically transmitted from the camera to the recorder, thus keeping them synchronized with each other. The advantages of the double system are capability for easily editing the sound separate from the picture, and also better sound reproduction. Both systems can use the same microphone outlet on the camera. There would also be an external speaker jack, for using earphones or playback thru an external speaker. The entire sound system is powered by a 9 volt NI-CAD battery located in the front portion of the sound amp. A white pilot light on the right side of the amp., and inside the viewfinder, would signal if the sound
system were in use. The on-off switch for the amp. is also located along the right side, and can be activated while the user's hands are on the grips. When using SINGLE-system sound, a sound recording head is necessary. This posed a problem, since the sound head must be placed 26 frames ahead of the photographed frame (remember, this system can only be used with the magazine film supply). This would place the sound head in the same chamber as would be occupied by the 50 ft. cartridge. Therefore, the sound head and roller assembly must be removable and out of the way when the cartridge is used, and inserted again when the cartridge is removed, and only the film from the magazine is passing thru the chamber. Behind the film chamber, would be a flywheel and spindle assembly, powered by the main drive motor. This flywheel is necessary for single-system sound, providing a stable transport for the film passing thru the sound head assembly.

H. MISC. FEATURES:

1. **shoulder brace:** the detachable shoulder brace would attach behind the sound amplifier; via a locking universal type joint. This would enable the user to move the camera about slightly in relation to his body, while still giving a third point of support (along with the two grips). In addition it would telescope in and out several inches, and could lock at any point along its travel. This would give still more latitude to the user. The
part which rests against the shoulder, is contoured enough to accomodate any physique, and can be twisted around to fit more comfortably. It would be padded, and have a built-in strap by which the user could release the camera from his hands and let it hang by his side by means of the shoulder strap.

**SHOULDER BRACKET**

2. **carrying handles**: There would be two carrying straps designed into the camera. One would be built into the top of the 400 ft. (or 200 ft.) magazine attached. This strap would spring back when not in use, and as not to disrupt the lines of the design.
The other strap would be for carrying the camera itself with the magazine detached. This strap or handle would attach to the camera body, at the same place as the magazine would attach. In other words, this handle would be a separate piece, and when in use, would also act as a seal to prevent light from entering the camera through the cavities on top, where the film from the magazine would enter.

3. **Footage and frame counters:** The footage counter would be located on the exterior of the left side of the camera body, adjacent to the main drive motor. It would be calibrated for use with both the 50' cartridge and the 100' or 200' magazine, and would be self-resetting.

A frame counter also located on the left side of the camera body, would enable the user to accurately determine how much of a back-wind to use for super-imposing or dissolving.
The final stages of my project will be a solid wood and metal mock-up (full-size), which would approximate the target weight of 6-8 lbs. The magazine portion will be removable, as will the shoulder brace. The twin hand-grips will be molded solid out of polyester resin, and most likely painted black like most of the rest of the camera. Also the balance of the unit should likewise approximate what the real piece would feel like, with the center of gravity being towards the rear of the hand-grips.

Finally, the proposed construction of the production model, would consist of two main sections forming the shell of the main body, with the left side and both ends forming one section -- "C" shaped, and a flat piece forming the right side.

![Diagram of camera components](image)

The bottom section would consist of the sound amplifier encasement, and the bottom of the battery tray. The top would be a single flat piece with openings to admit the film from the magazine. Two possible materials have been proposed for the marketed camera -- aluminum, which would give a better
"feel" to the unit, would be just as durable as the aluminum, and less expensive, but would lack the solid feel of metal.

In either case, the inner structure of the camera would consist of several partitions upon which all inner components would be attached (see drawing below).
CONCLUSION

I would just like to reiterate what I mentioned before about the intent of this project.

It was, to put forth a definite workable solution to an existing situation -- that situation being the lack of a really adequate camera to bridge the gap between the amateur and professional status, while maintaining the best of both worlds. I believe I have succeeded, judging from the reactions the camera has received to date.

And again I'd like to restate the fact that, while not all the engineering problems were completely worked out, they were all dealt with and considered, and they did affect the final design -- which, ultimately, could be marketable, with only a minimum of possible changes.

This is the designer’s role -- he’s not merely a stylist, neither is he an engineer -- but he is the go-between for the two. He must consider the engineer's problems, and cope with them in relation to his design.

I feel that I have fulfilled my role as a designer. All inner workings and features are feasible as I have mentioned them, and I have provided for all of them in my design. Although the model only shows exterior, I feel that the design of the camera body itself is an accomplishment, as it solves many of the problems existing in today's cameras.
Currently, the design is in the process of being submitted to Bell and Howell for future examination.

I had chosen this project because of my interest in the motion picture field and photography in general. It has taken nearly six months to complete, but it's been a labor of love.
ADDENDUM

Since the inception of this design, in December, 1969, there have been several new and beneficial developments in the field of Super-8 photography. Most notably; Eastman Kodak has recently announced that they will be manufacturing a line of DOUBLE S-8 films -- this is 16mm film, with S-8 perforations on both sides, and would place images in two rows. In other words, a 100' roll of DBL. S-8, would yield 200' of regular S-8, after it has been slit. After the first 100' were exposed, then it would be flipped over, and the other side would be exposed, yielding the second 100 feet. (Corrections relating to this new film have been incorporated into the text of this thesis).

This format of DBL. S-8 applies only to the magazine load, not to the conventional 50' S-8 cartridge. This will always remain single strand.

While my design was not drawn up specifically to incorporate DBL. S-8, I did leave enough room in the film chamber to accommodate the larger width of DBL. S-8 --mainly
because it seemed inevitable that it would be manufactured.

At any rate, this means a wider magazine will have to be made, however, the diameter can now be nearly halved.

Other new developments: The new DBL. S-8 film will be available with a built-in soundtrack for single-system sound recording (I have provided for this in the design).

Also many new accessories and products, of professional calibre, are being manufactured for the professional S-8 user.

And finally, it has been rumored within appropriate circles, that many TV news stations will begin shooting their news footage on S-8 film rather than 16mm.

All this just confirms my original proposal, and makes my efforts even more worthwhile.
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Eastman Kodak Co., Rochester, N.Y.; Mr. B. Elle, Mgr. Industrial Design.

Ilex Lens \& Shutter Co., Rochester, N.Y.

Rochester Institute of Technology, Rochester, N.Y.
Messrs. Richard Floberg, Robert Osborn, and Reid Ray, Instructors in Motion Picture Dept.

LITERATURE:


Guide to Filmmaking, Edward Pincus, 1969

Movie Maker, April, May, 1970.


Plus various literature and informational brochures on numerous makes of S-8 and 16mm cameras and accessories.
TOP ASPECT (app. 3/4 size)
REAR ASPECT

- Twin Hand Grips
- Batteries
- Focus Buttons
- Dual Operating Buttons
- Manual Exposure Over-Ride (Super-Switch)
- Flywheel
- Magazine Drive-Cog
- Magazine Clutch
- Take-Up Reel
- Supply Reel
- Reel Hub

- Cartridge Compartment
- Cartridge Drive-Hub
- Main Drive Motor
- Flywheel Drive Cog
- Battery Charger
- Battery Holder
- Battery Holder Connecting Meshes
- Sound Head Connecting Meshes
- Operation Light
- Red Light
- Take-Up Reel
- Supply Reel
- Reel Hub

- Amplifier on-Off Switch
- Amplifier

(1/8 Size)