



Systems Engineering and Photography? You Bet!

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Photography

A combination of **artistic vision** and **technical execution**. A form of art, but with a strong technical flair.

Question

Do serious photographers use Systems Engineering in their workflows, creative processes, planning & execution phases, etc.?

... Let's take a look!



Asking ChatGPT:

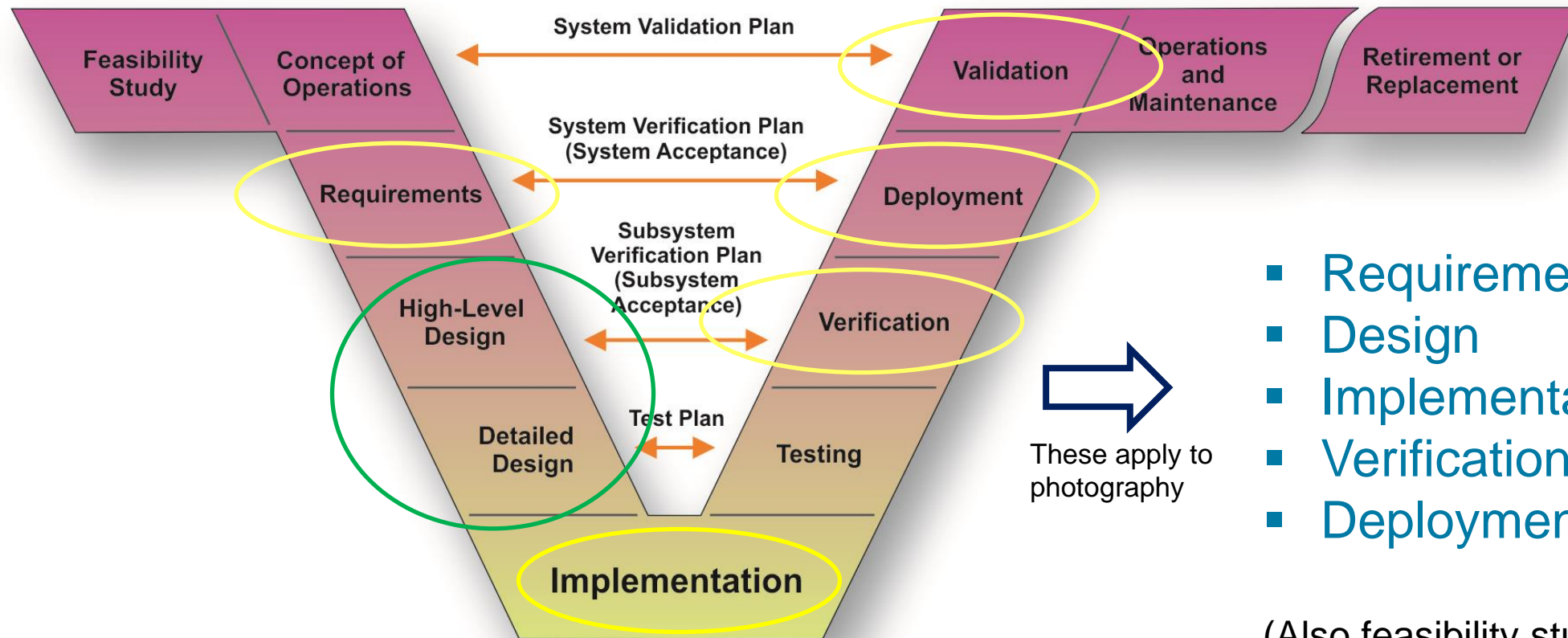
Q: **Can systems engineering be applied to photography?**

A: Systems engineering is an interdisciplinary approach to designing, analyzing, and managing complex systems. **While it is typically associated with engineering and technology fields, it can be applied to a wide range of domains and industries, including photography.**

...

Overall, while photography may not be the first field that comes to mind when thinking of systems engineering, **the principles of systems thinking and analysis can be applied to many aspects of photography to help optimize and streamline processes and workflows.**

Traditional Systems Engineering V



- Requirements
- Design
- Implementation
- Verification/Validation
- Deployment

(Also feasibility studies and concept of operations, but let's ignore those for now)

SE & Photography

There are many TYPES of photography. E.g.,

- landscape
- studio
- event
- wildlife
- sports
- astro
- underwater
- night
- aerial
- portraiture
- family
- pet
- model
- macro
- advertisement
- & many more!

Each type has its **own degree and sort of planning**. Some, such as sports and landscape, are more about *read-and-react* and *discovery*, whereas others, like studio, are about *creating*.

E.g.: Landscape Photography

Requirements – What typically does one want in a landscape image, and how will this translate to **design, required photo gear, and planning?**

- **Whole scene** → Wide angle lens
- **Good depth of field** (everything in focus) → Smaller apertures/slower shutter speeds require camera stabilization, e.g., tripod
- **Agreeable lighting** → Time of year and daytime considerations, e.g., golden hour (sunrise/sunset) for warm light in desert, mid-day for foliage, etc.
- Also, **Accessibility** → Ability to reach the shooting area; will this require a permit, an SUV, hiking gear, an airline flight, etc.?

Example: (Specialized) Night Shot

Star Swirls: As the Earth rotates, the nighttime stars appear to circle around the North Star.

What **equipment, technique, and planning** is required to capture such an image?

Fun Note – Because it takes 24 hours for a star to fully rotate around the North Star, you can estimate in the photo how long the photographer left open the shutter. Here, ~ 1 hour.



Photo by [Reign Abarintos](#) on [Unsplash](#)

Star Swirl – Requirements

- A great photo (given)
 - Long swirl
 - Properly lit foreground object
 - Sufficient contrast
 - Distraction-free surrounding and scene

Star Swirl – Early Ideas on Implementation

- Camera with ability to **lock open its shutter** - the Bulb (b) setting and trigger
- Camera with enough **battery power** to remain open for at least several hours (note - noise reduction can double that requirement)
- Strong camera **stabilization** (tripod)
- **Dark** area and sky. Away from cities, a moonless night
- **Clear** sky (haze obscures light, clouds catch light from nearby cities)
- Non-flight path
- Ideally a **non-travelled area** (no car headlights or worrying about your camera disappearing)

Star Swirl – High Level Design

- **Foreground:** the best star swirl images have interesting foreground subjects, like an aesthetically-pleasing building, etc. (...pure star swirl images can be pretty boring)
- **Balancing the foreground and background light:** this is important, and can also be a significant challenge!
- **Lens focal length:** how wide should the scene be? Note that the wider it is, the more chance there is that the scene can be contaminated by unwanted light.
- **Exposure time:** how long should the exposure be? Winter has longer nights, but the longer the exposure the greater the chance of problems. Battery can go dead (note – best to use a FILM camera with mechanical B setting)
- **Access:** reaching the shoot location. Is it freely accessible, do you have the right vehicle, hiking/camping gear, etc.?

Star Swirl – Detailed Design

- **More Foreground** – Must ensure the scene isn't overly bright (if too bright, will burn out the detail on the image)
- **More Balancing foreground/background light** – Decide on, obtain, and prepare supplemental lighting (strobes, flashlight, etc.) If shooting film, bring digital camera to perform tests.
- **All technical considerations** – Decide ISO, aperture, protection from wind, trigger device (test!), supplemental battery pack(?), etc.
- **During-the-shoot considerations** – Keeping warm, protection from critters, camping equipment, chair, food, & keeping an eye on the camera, etc.
- **Ideal conditions** – What is the best time of the year to get the shot (temperature, lighting, crowds, etc.)?

Star Swirl – Implementation

- **Monitoring Weather** – Long and short-term forecasts. Delay trip as necessary
- **Making, using checklist** – A must! Helps avoid forgetting important steps or equipment (- think pre-flight checklist used by pilots)
- **Testing equipment beforehand** – All equipment must be tested before departure
- **Flexibility** – Be prepared to adjust the plan in the field
- **Transportation** – Reaching the shoot location
- **Performing small field tests** – Because will only have one chance to get the real image, best to do a few **short exposure experiments** in the field to verify calculations
- **Doing it – right!** – Time to execute. Avoid operator errors; check and double check all settings. Have fun.

Star Swirl – Verification & Validation

After the shoot,

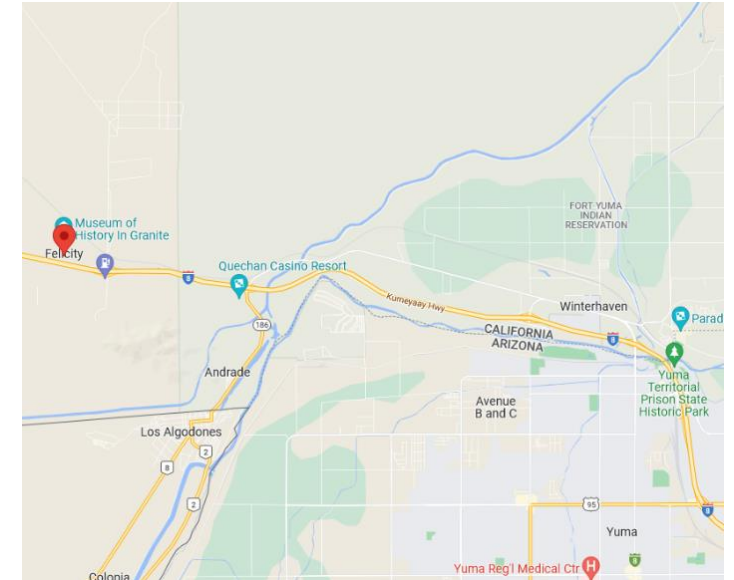
- **Inspect results, choose best** photo(s)
- Perform **post processing** ('post') as necessary
- Get **feedback**, make adjustments

Actual Star Swirl PHOTOSHOOT

Night Swirl - Felicity, California, 2014

Star Swirl – Real World Example

High Level Design



- **Foreground subject:** interesting church on hill at Felicity, CA, the Museum of History In Granite.
- **Location:** CA/AZ border. Near Yuma, but far enough away for sufficient darkness.
- **Isolated but accessible:** mostly isolated, only slightly violating official visitation hours.
- ✓ **Bonus:** church façade faces south, so North Star aligns directly behind it.

Star Swirl – Real World Example

Detailed Design

▪ Choice of equipment:

- Mamiya 645 Medium Format film camera with **mechanical Bulb** (b) setting
- Wired remote **trigger with locking capability**
- 45mm MF Lens (28mm equivalent)
- Fuji Velvia 100 ISO **film** (120mm medium format)
- Slik 212 **tripod**
- Nikon D700 digital camera, for lighting experiments beforehand
- Nikon SB-700 detachable **flash** (92 Guide number) for lighting foreground

▪ Other details:

- Flashlight to work at night, avoiding rattlesnakes in dark, etc.
- Tape to block the Mamiya's back viewport (to avoid fogging film)
- Alarm clock

Star Swirl – Real World Example

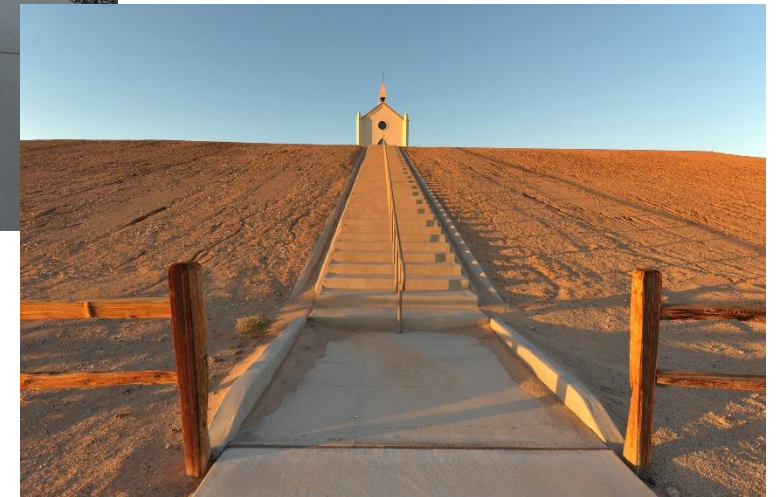
Implementation

Overall Details and Logistics

- **Drive:** 2.5 hours (~ 165 miles)
- **Weather:** warm evening (Oct), moonless & mostly clear. Completely dark by 9pm
- **Isolation:** very few visitors
- **Human factors:** parked near entrance, slept in back of SUV
- **Exposure:** ~ 7 hours. Ended exposure at ~ 4:15 am (well before dawn)

Star Swirl – Real World Example

Location

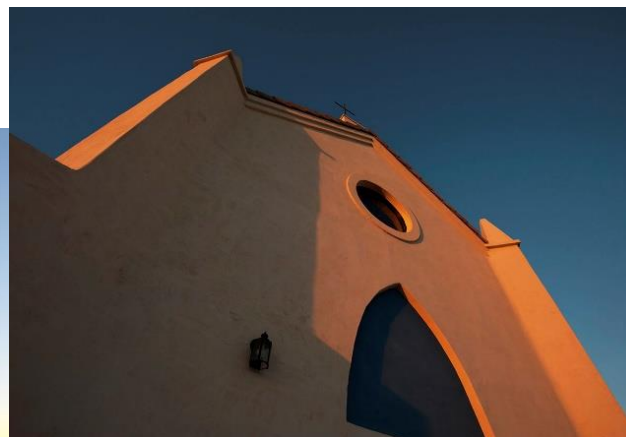


Museum of History
in Granite.
Felicity, California

Star Swirl – Real World Example

Subject

(All images should have a subject)



Risk! Church had flood lights that, if powered, would completely burn out the church in the image.

Workaround: None, as there was no way to safely (and legally) disconnect them. Luckily, they did not illuminate.

Star Swirl – Real World Example

Implementation

Like a space launch, only one chance to get it right.

Implementation Steps

- Determine the **best camera angle**
- Emplace **tripod**
- Determine **correct amount of foreground lighting**: experiment flashing the façade with strobe and digital camera. Check image to estimate correct exposure
- Replace digital camera on the tripod with **film camera**. Block rear viewport
- Set correct aperture, manually focus (not super easy in the dark), attach remote trigger
- **Lock open shutter** on film camera using B setting and locking remote trigger
- **Flash the foreground**. Slightly underexpose, as ambient starlight will add slightly more exposure overnight

Then, hope for the best!

Star Swirl – Real World Example

- **Foreground Lighting Experiments** (using digital camera)



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Star Swirl – Real World Example

Verification & Validation

Examining the Captured Image on Film

- Film scanned into a digital image
- Is this an acceptable base image?

Notice the flash head illuminations in the photo. These must be eliminated in post processing.



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Star Swirl – Real World Example

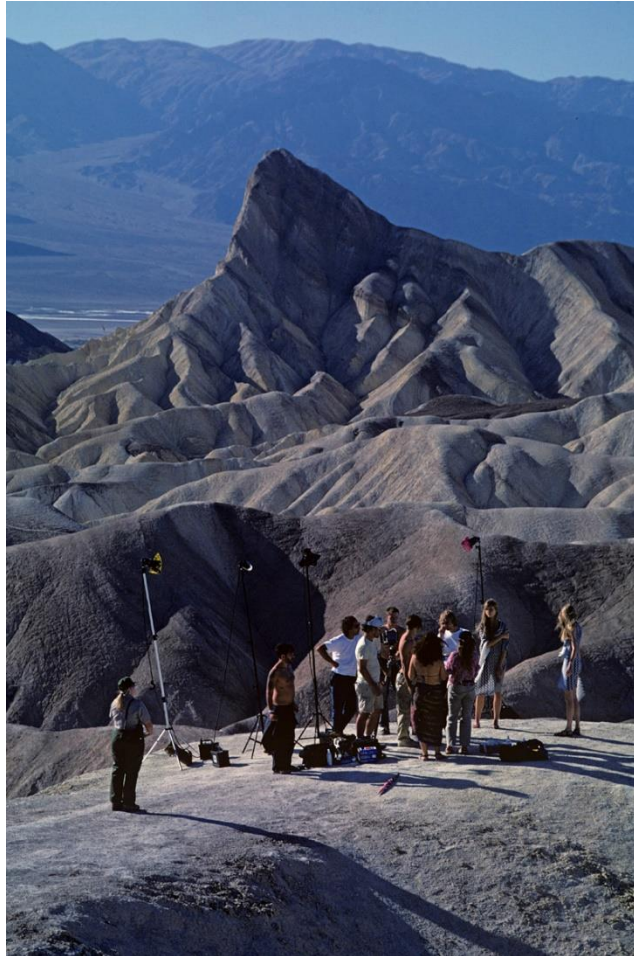
Verification & Validation

Post processing:

- Eliminate distractions
- Straighten image
- Adjust colors, density
- **Success or Failure?** This is where you determine whether you need to do a reshoot



Other Situations

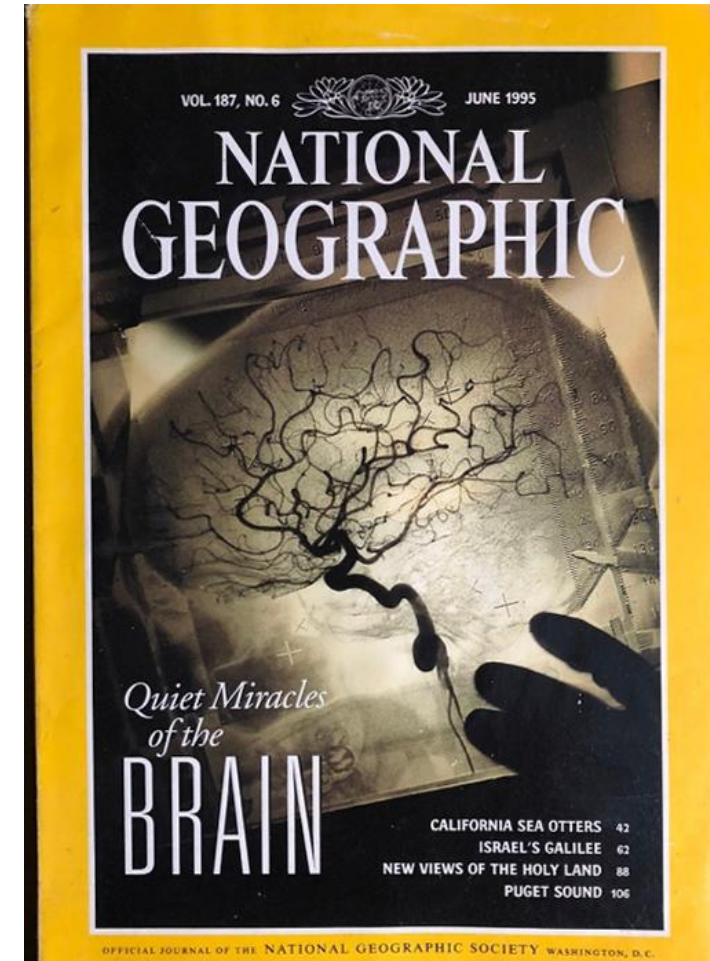


Challenging Assignments:

The Brain, by
Joe McNally

Productions:

Death Valley,
California



Conclusion

- For **serious** results, photographers can benefit from organized consideration of image requirements, design, and implementation.
- This **can** be considered **systems engineering**.
- Post processing is now a given. However, similar to engineering, photographers **try to get things as right as possible from the start** (in design and implementation) to minimize post-work.

THANK YOU

