BIRKET ENGINEERING NEWS

Electrical & Software Control Systems for Safe Rides & Shows Since 1984

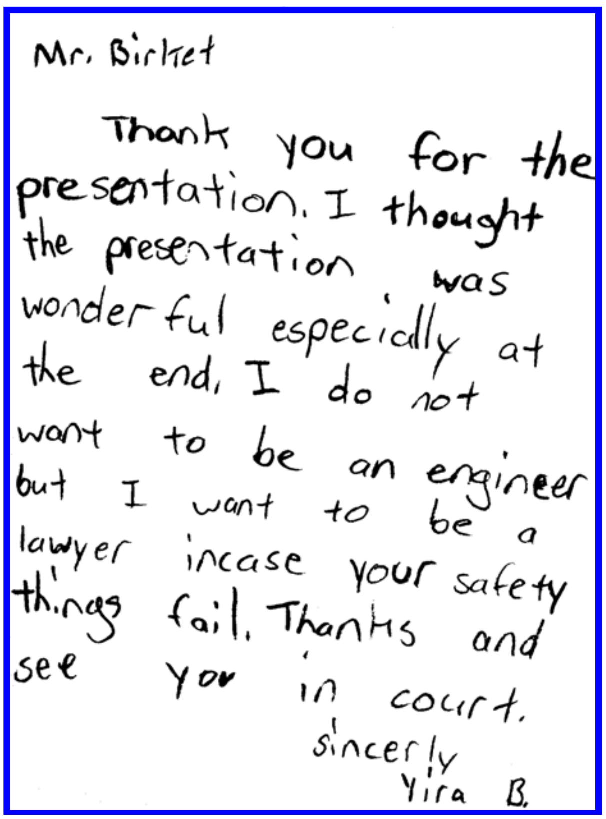
Spring 2003

ATTRACTION SAFETY

A Fifth-Grader Sums It All Up For Birket Engineering, Inc.

In case there is any confusion as to our focus, we have been provided with a reminder.

The card pictured arrived with a stack of about a hundred traditional hand-made 'thank-you' cards following a presentation we gave to the fifth-graders at MetroWest Elementary School. It points out that there are always a few people out there who see it as their job to backstop your conscience.



Mr. Birket

Thank you for the presentation. I thought the presentation was wonderful especially at the end, I do not want to be an engineer but I want to be a lawyer incase your safety things fail. Thanks and see you in court.

Sincerly
Yira B.

May we always remember that we not only have a duty to do our best to protect the public, but we also have a duty to ourselves to be prepared to defend our designs. Take good notes, document well, file everything, and consider not only what is real, but what it will look like to Yira in about twelve years.

Protecting Against Undetected Failures

Undetected failures permit us to blindly trust safety systems that no longer work and can lead to situations that we thought couldn't happen. The following explores strategies to identify and prevent Silent Failure through automatic and manual validation.

Silent Failure is the undetected failure of a device that we rely upon to ensure safety. The device may be anything: sensor, brake, motor, mechanical interlock, etc. that protects us against some risk. If a device fails without anyone noticing it, it has an *undetected failure*.

Why is Undetected Failure Important?

If the thing stops working and nobody can tell the difference – why do we need it?

Remember that the device was put there to guard against some significant risk. A significant risk *will* eventually become very significant reality. Ask Murphy. But now the gadget that should have handled the problem didn't work when we needed it… and we didn't have a clue. We didn't even think the resulting mess was possible. *Unsuspected* Failure might be a better description.

A Silent Failure Scenario

Imagine a simple ride system that starts using an electric motor and stops using a pneumatic brake. Bad things could happen if we can't stop the ride promptly, so we want to be sure that we have air pressure at the brake before we run the motor. Simple: put a pressure switch on the air supply line and interlock it with the motor. Now we can't start the ride unless there is enough air pressure to stop it again. We can stop worrying about air pressure.

Not really. Now we have to worry about the pressure switch – and we *still* have to worry about air pressure.

Over a season or two, the pressure switch quietly rusts in place, freezing the switch contacts where they are - ON. Nothing visibly changes. Nobody notices. The ride works fine and the switch even agrees with the actual pressure in the air line. Everything is fine

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This Issue

This newsletter is provided by Birket Engineering, Inc. as a communications device to current and future customers and friends.

Every control system must be evaluated and designed with consider-ation for the details of the specific application.

Information in this newsletter is not meant to be an engineering or professional opinion.

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until one day when a backhoe hits the air line, or maybe the compressor's circuit breaker trips.

Now the air pressure for our brakes is gone, but we don't know it because the pressure switch rusted shut last winter. Even worse, we're *sure* that we're protected from that problem – so go ahead and press the [Start] button. We can always trust the system to keep us out of trouble… Hey! Why won't this thing stop?

Expect the Unexpected

The first step in solving any problem is to realize that we have one. In order to eliminate possible undetected failures we must first identify where they may occur. This can be a big task because just about everything fails eventually. We can trim the job a bit if we only worry about things that might impact safety.

One accepted system for finding out what can go wrong is an F.M.E.A.: Failure Mode & Effects Analysis. (Not F.E.M.A.; they clean up after disasters. F.M.E.A. prevents them.) Although this subject can get very technical, it is still useful in its basic form. Even a casual safety analysis is better than none – just don't assume that you'll find all the problems by yourself.

This kind of safety analysis starts with making a list of the components in our system and sitting down with a pencil to think about each piece. The questions to ask about each component are:

1. **How might this thing fail (Failure Mode)?** Our pressure switch above might fail stuck in the ON or OFF position.
2. **What will happen when it fails in each mode (Effect)?** It's very helpful to categorize these by severity: "possible injury", "safety loss", "downtime", "expensive", or "complaint". Effects of "bad appearance" or "no effect" don't need the same attention. Our stuck ON pressure switch above goes in the "safety loss" category because it no longer protects us against an air pressure failure. If it were stuck OFF, we'd use the "downtime" category because the ride wouldn't start.
3. **How likely is it to fail?** This can be tough to figure out, but categories will help again. We can count on Human Error. (Don't forget the human "component" of the system.) Factory Defect and Fatigue will nail us regularly. Murphy defined the criteria: "Anything that can go wrong, will." If we can think of a way it can break without an absurd concatenation of improbable events, we should consider it.
4. **How do we detect the failure?** Here is our first chance to make a difference. If we choose a good way to detect the failure, we'll know when we need to do something. See below.
5. **How do we correct the failure?** The simple (and usual) way to keep our system safe is to "correct" the failure by shutting everything down: E-Stop. If we want to enhance reliability too, we must find a way to safely continue without the component until we can fix it.

Do you have a controls question on a specific ride or show application? Birket Engineering, Inc. invites inquiries. We are fortunate to have a wealth of experience and talent from which to draw to address your need.

This component-by-component analysis of our system may turn up a variety of interesting things that we had not realized before. But, since our subject is undetected failure, our interest now is any failure with an effect of Safety Loss and a detection type of Undetected.

Solve Silent Failure

Now that we know where to expect undetected failures, what can we do about them? There are just two ways to eliminate undetected failures: *detect* the failure or *prevent* the failure.

Prevent the Failure

There is a hard way and an easy way to prevent the failure of a component: The hard way is to make the component 100.0 % reliable. This is *really* tough and most designs settle for a one-in-a-billion chance. Even if we use two components, there is still the chance that a shared event will wipe out both components. Lightning. Corrosion. Power Failure. Redundancy doesn't solve everything and it always introduces new and more complex problems.

The easy way is to *eliminate the component*. Simplify the system. The biggest problem with undetected failure is that we think we're protected when we're not. If we can do without the gadget, we won't depend on something that will let us down. The guy in the rental car with the broken gas gauge will run out of gas. The guy on the motorcycle without a gas gauge will never let his tank go dry – he'll unscrew the cap and look.

Detect the Undetected

There are two major ways to detect a failure: Automatically, using a sensor (and maybe a control computer) or manually, using our hands and eyes. Automatic detection has the advantage of saving us from trying to watch everything at once, but brings complexity that is itself susceptible to failure. The problem of detecting the failure of the sensor that we installed to detect a failure is *validation*. Our pressure switch above got us into trouble because we didn't confirm that it was still *valid* – that is, still reporting meaningful information.

There are three major ways to automatically validate a sensor (or other component), plus manual validation makes four.

1. **Continuous Automatic Validation:** This is the best form of validation and usually involves buying two sensors instead of one. By comparing the two sensors we will know instantly when one has failed. But like a man with two watches, we generally won't know which one is right.
2. **Cyclic Automatic Validation**: The next best way to check our sensor is every time (or *cycle*) that

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BIRKET NAMED TO TEA SUBCOMMITTEE

Orlando, FL – Birket Engineering, Inc. has been named to the Themed Entertainment Association's "Managing Technical Risk" subcommittee. The TEA is developing a process tool for attraction owners/developers to use on technically difficult projects. The TEA subcommittee intends to put on paper a size-invariant process to manage the risks inherent in the development of a technically complex project. A final draft is planned for public comment later this year.

Birket is also a member of the National Fire Protection Agency's committee responsible for the 'Fire Before A Proximate Audience' language in the NFPA's National Electric Code.

See steve.birket@birket.com for more information.

FRANK MIFKOVIC

Orlando, 1988. Frank begins work as the fifth employee at a newly formed company with the task of creating an electrical assembly and installation facility from the ground up. In a shop with no employees, no equipment, and 5,000 sq.ft. of empty space, the ride control installation of Epcot's Norway Pavilion would begin in six months. Frank was immediately cast to wear all the production hats of hiring, procurement, assembly, quality control, installation supervision, and field test & adjust. Norway opened as scheduled, as have the following 100+ Birket projects with Frank's production leadership.

The Stats on Frank

US Navy Submarine Service, 6 years
Fire Control Technician
Polaris Missile

Walt Disney Productions, CA, 11 years
Production Supervisor
MAPO

Walt Disney World Central Shops, 4 years
Production Supervisor
EPCOT, Tokyo Disneyland

Birket Engineering, 14 years and building
Production and Installation
Norway Pavilion, EPCOT
SuperStar Theater, Disney-MGM Studios
Epic Stunt Show, Disney-MGM Studios
JAWS, Universal Studios Florida
Earthquake, Universal Studios Florida
Turbo Tour Theater, Ridewerks
Backdraft, Universal Studios Hollywood
Wild Wild Wild West Stunt Show, Universal Studios Florida & Japan
Buccaneer Bay Stunt Show, Treasure Island at the Mirage
Demon, Paramount's Great Adventure
Palm Beach County Judicial Center, West Palm Beach Florida
WaterWorld-A Live Sea War Spectacular, Universal Studios Hollywood & Japan
EFX, MGM Grand Hotel & Casino
Escape From Pompeii, Busch Gardens Williamsburg
Nautilus Theater, Sea World Orlando
E.T. Adventure, Universal Studios Florida, Hollywood, & Japan
The Outer Limits: Flight of Fear, Paramount's Kings Island & Kings Dominion
Western Stunt Show, Six Flags Great America
Phuket FantaSea, Phuket, Thailand
Mr. Hyde's Nasty Fall, Geauga Lake
Mad Cobra, Suzuka Circuitland
The Amazing Adventures of Spiderman, Universal's Islands of Adventure
Popeye & Bluto's Bilge Rat Barges, Universal's Islands of Adventure
Speed: The Ride, Sahara Hotel & Casino
Illuminations 2000: Reflections of Earth, EPCOT
Universal Monsters Live Rock and Roll Show, Universal Studios Japan
Snoopy's Sound Stage Adventure, Universal Studios Japan
Hollywood Magic, Universal Studios Japan
Animal Actors Stage, Universal Studios Japan
Lethal Weapon Stunt Show, Warner Brothers MovieWorld Madrid
DMX Multi-Strobe development & production, various

Prior to Birket Engineering, Frank worked for eleven years with then Walt Disney Production's MAPO in California. The following four years were as Production Supervisor for Electronic/Electrical Manufacturing at Walt Disney World's Central Shops where Frank was responsible for 110 employees and the work that would open EPCOT Center and Tokyo Disneyland. Later contract work for Disney included eight months in Paris during the EuroDisney installation.

More recently Frank spent six months in Osaka installing six attractions for Universal Studios Japan, followed by two months in Spain preparing the Lethal Weapon Stunt Show for opening at Warner Brothers MovieWorld Madrid, returning to Birket as Production Manager.

A Baltimore native, Frank has resided in Florida for the past 20 years. He is responsible for Birket Engineering's Production Quality Control and administers the company's ETL compliance requirements for the UL-508 panel assembly standard.

In production now are show control equipment racks for a new attraction at a major Orlando-area theme park and strobe systems for national and international installations.

See frankm@birket.com for more information.

'Judging by data, roller coasters are remarkably safe--certainly safer than driving to the park.'

Thursday May 30, 2002 *Wall Street Journal* Editorial

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we use it. If we have a sensor to detect when the load gates are ajar, we should check that the sensor notices each time we open and close the gates. (Note: it can be important to detect a failure *prior* to each cycle of operation instead of *during*; otherwise we may be too late to correct it.)

3. **Periodic Automatic Validation:** The remaining automatic means of validating a sensor is simply to check it on some regular schedule: daily, weekly, etc. We could have automatically checked our pressure switch above by cutting off the air each morning.
4. **Periodic Manual Validation (Inspection):** Here's the method so familiar to ride maintenance people – open it up and look – every day or month or season. This is as good a method as the people, time, and money we devote to it.

If we have to resort to manual inspection to validate the pressure switch we installed to detect a failure of air pressure, we might be better off without the sensor. It may be no more difficult to manually check the air pressure directly than it is to check that the pressure switch is still working. At least we won't have a false sense of safety.

Conclusion

Adding sensors and interlocks to a system may not make it any safer and will always add complexity and new problems. The solution is to design the system so that it naturally validates its own operation. A poorly designed system will at best require a lot of time-consuming inspection and at worst may give a false appearance of safety. A well-designed system will use the intrinsic characteristics of the equipment, crosschecks between components, and feedback to ensure that nothing fails undetected.

See Dan at danielb@birket.com for more information.

DMX MULTI-STROBE CONTROLLERS™
installed in Orlando park

Orlando, FL – Controllers for the sparkling exterior lighting of an Orlando-area park's centerpiece icon recently underwent transplant surgery. Without interruption of the nightly show, existing strobe controllers were replaced with fourteen of Birket's **DMX MULTI-STROBE CONTROLLER™** Brik-32S systems.

Paul Leone configures strobe controllers at an Orlando site.

The installation transparently replaced the controllers, preserving the original DMX programming. The new system provides diagnostics previously unavailable to the 448 strobe channels. Enhanced features include channel specific indicators for strobe failures, ground faults, and mis-wires, and allow lighting designers the freedom to program individual flash events and intensities as required.

The **DMX MULTI-STROBE SYSTEM™** was designed to provide precise and robust control of hundreds of strobes in all-weather applications. Programmed with any DMX lighting console, the system fills the need for large, constant duty displays and attractions.

Additional systems have shipped to a major Japanese theme park and are planned for a domestic casino and a Canadian attraction.

Complete **DMX MULTI-STROBE SYSTEM™** *information is available at (407) 290-2000 or www.birket/strobes/default.htm.*

Glenn McNair with strobe controller power supplies during installation.

BIRKET ENGINEERING, INC., IN PROGRESS

Projects

- Life-safety design of Linear Induction Motor-launched roller coaster ride control system, domestic
- Show control production for a new Orlando-area theme park attraction

Products

- *PYRO CONDUCTOR ™* system upgrade, a major Japanese theme park
- 520-strobe **DMX MULTI-STROBE SYSTEM™**, a major Japanese theme park
- 40-strobe **DMX MULTI-STROBE SYSTEM™**, an Orlando lighting designer

Proposed

- Design for attraction safety upgrades, an Orlando-area theme park
- Software game design for children's museum, domestic
- 840-strobe **DMX MULTI-STROBE SYSTEM™**, casino display, domestic