POWER LINE
SYSTEMS
ENGINEERING
INC.

High Tech
Engineering Specialists

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel: (905) 294-5468 Fax: (905) 294-9754

SPINNING OUT OF CONTROL

By Patrick J. Lynch, P.Eng.

Presented to Electricity Today Forum - 1998

CASE STUDY #1

Metal spinning can be a very time consuming and exacting process. Our client begins with a flat metal disk, approximately 3′ to 4′ feet in diameter and through successive, gradual forming stages, transforms it into a perfect smooth metal sphere. It would generally take 2 to 3 days in forming this product. Each radius forming pass is a few thousandths of an inch greater than the previous pass. The precise control coding information is loaded into a computerized workstation, which controls all the drive systems and forming tools used in this process.

THE PROBLEM

This entire system would randomly crash 2 to 3 times per week. There were 6 of these metal spinning workstations and yes, all 6 would simultaneously crash and the partially finished products would have to be scrapped. Extra processing times were averaging over 500 hours per month and critical shipping deadlines were missed.

The hardware and software of each system was meticulously checked and found to be error free. The manufacturer of the metal spinning equipment claimed this was the only site of several 100 installed sites that was experiencing these types of problems. What was causing the problem? Were there any clues? Was there any telltale "DNA" left behind after each failure? Where was the black box recorder? Did anything occur within this manufacturing plant that may have precipitated this failure (ie. Operating overhead cranes, welding equipment, other metal stamping processings, etc.). Each area was carefully examined by the owner and no correlation to the event failures could be found.

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel:(905) 294-5468 Fax: (905) 294-9754

After several months of continuous manufacturing "turmoil", the only clue to emerge was a small beeping sound. This beeping sound occurred under the draftsman's desk in the main office, just before the metal spinning failures occurred in the plant. Where did this beeping sound come from?

The sound originated from a small 500 VA. U.P.S. connected to the office AUTOCAD computer workstation. The U.P.S. system would beep when it was automatically transferring from utility power to battery power due to a power problem. Finally at last, a breakthrough the owner thought, it now must be some sort of power problem. He pays his utility bills faithfully each month and therefore concludes, he should be getting "**clean power**" from this utility, not "**dirty power**".

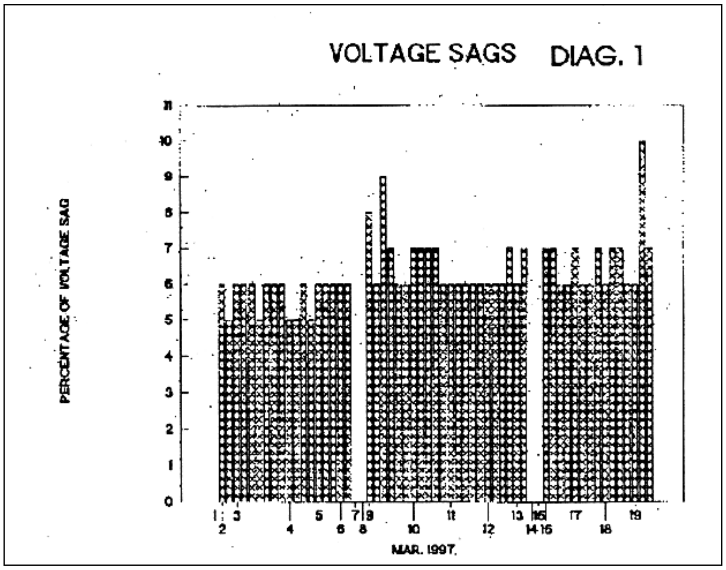
The owner contacted the newly appointed energy minister for Ontario, who also happened to be his local area M.P.P. There was lots of rhetoric, but the problem still remained. The owner at this point, was not only losing product and production time, but also was losing loyal customers because he simply could not produce the product and deliver the product on time. Power Line Systems Engineering Inc. was then hired by this very "frazzled" owner at this time to sort out the problem.

The first step was to perform a detailed electrical system analysis at this plant to determine if any electrical system abnormalities existed. The measured incoming 600 Volt voltage waveforms were sinusoidal and within acceptable voltage T.H.D. values. The phase load currents ranged from 150 to 200 Amps with all harmonics less than 30 dB. compared to the fundamental (ie. Within acceptable current T.H.D. levels). The plant's overall power factor was .8 to .83 lagging. Measured voltage sags were up to 10%, lasting up to ½ second in duration (Refer to Diagram 1).

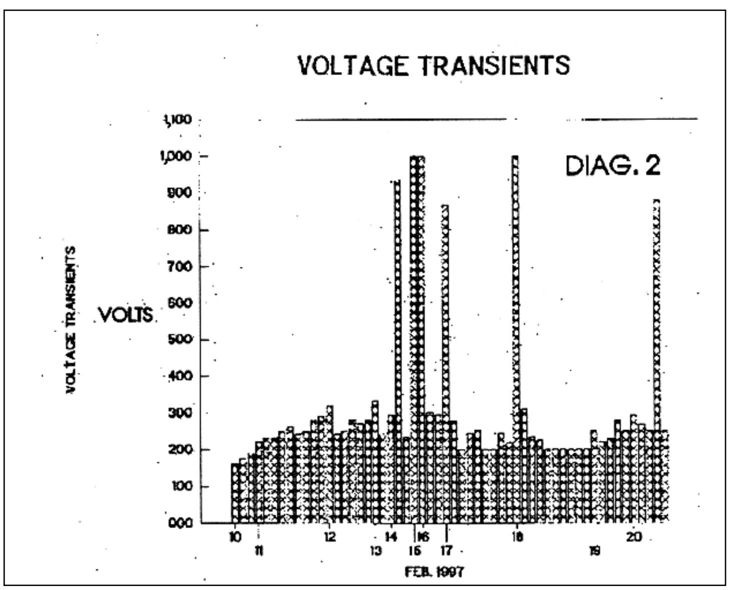
POWER LINE
SYSTEMS
ENGINEERING
INC.

High Tech
Engineering Specialists

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel:(905) 294-5468 Fax: (905) 294-9754



These voltage sags were found to be generated by the owner's other equipment during start-up and did not cause the metal spinning equipment to crash. High speed voltage transients captured at this site, on the 600 Volt service, were up to 1000 Volts lasting 2 to 3 milliseconds in duration (Refer to Diagram 2).

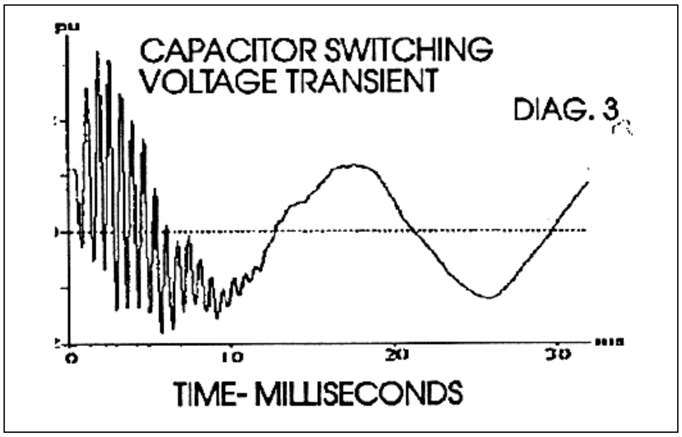


POWER LINE
SYSTEMS
ENGINEERING
INC.

High Tech
Engineering Specialists

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel:(905) 294-5468 Fax: (905) 294-9754

The occurrence of these voltage transients correlated exactly with the metal spinning equipment failures. The voltage waveform high frequency ringing oscillation was a typical "DNA" characteristic trace for utility capacitor grid switching (Refer to Diagram 3).



The utility was then contacted and confirmed capacitor switching had occurred at their substation at the exact same times of these voltage transients and subsequent metal spinning equipment failures. The source of the problem apparently had been found, but the arguments still remaining were:

1. The utility has to perform capacitor switching to maintain operating system voltage levels; it simply can not stop now because it was found to be causing operational problems with some metal spinning equipment.

2. The utility has been doing capacitor switching for years, why now is only some equipment affected at this plant?

3. Why are not other plants in the same general industrial park area complaining of similar equipment problems?

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel:(905) 294-5468 Fax: (905) 294-9754

It would appear further analysis is required at this plant to understand its "ultra-sensitivity" to this utility capacitor grid switching activity.

On closer examination within the plant, it was found the electrical contractor had installed a fixed power factor correction capacitor bank (to achieve plant overall power factor correction) on a plant subfeeder. According to the contractor, he installed the capacitor bank here because there was a spare disconnect at this location that he could use to feed this capacitor bank.

Question: It does not make any difference where the capacitor bank is actually installed, right? The plant's overall power factor, as mentioned earlier, was .8 to .83 lagging. Without the plant's capacitors turned on, the power factor dropped to .7 lagging, therefore, these capacitors seem to be doing the job, right? The correct answer is yes and no.

They are achieving the desired end result (ie. Increasing the power factor from .7 to .8 and reducing subsequent utility demand charges) but they are also overcorrecting the power factor on this subfeeder within the plant. With the plant's capacitor bank turned on, this subfeeder's power factor was **overcorrected to .3 leading**. This subfeeder just happens to be on the same electrical feeder supplying the metal spinning equipment. Is this a coincidence? It was then calculated the extra utility demand charges with this capacitor bank left turned off would be under $10 dollars per day. With the owner's permission, this capacitor bank was then turned off. Since that time, which is almost 2 years now, the metal spinning equipment has never crashed again due to this utility capacitor grid switching phenomena.

27 Sir Lancelot Drive, Markham, Ontario Canada, L3P 2J1. Tel:(905) 294-5468 Fax: (905) 294-9754

EXPLANATION:

The plant's power factor correction capacitor, located on this subfeeder as mentioned, was overcorrecting the power factor and actually amplifying the effect of this utility capacitor grid switching effect. The actual mathematical electrical analysis of this transient behaviour is beyond the scope of this present discussion.

CONCLUSION:

The owner is now paying up to an additional $10 dollars per day in extra electrical demand charges, but is saving over $2,000 dollars per day in recovered production and is slowly regaining back his customer base.

POWER LINE SYSTEMS ENGINEERING INC.
Patrick J. Lynch, P.Eng.
Principal

Phone: (905) 294-5468
Email: plynch@powerlinesystems.ca