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Maintenance
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Newsletter

Geaslin's Inverse-Square Rule for Deferred Maintenance

Proof of Exponential Breakdown Cost Escalations

By David Tod Geaslin
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When an organization attempts to reduce maintenance costs by reducing maintenance spending, maintenance costs will be reduced until spending falls below the minimum needs of the machines.

When maintenance spending falls below the minimum level of funding required and the machines are operated to failure, the results will be an exponential cost increase that is **INVERSE** to the expected savings.

If a part is known to be failing but operated to failure (OTF), the resultant energy required to overcome the breakdown event to the entire organization will be the square of the cost of the primary failure part.

If the breakdown event escalates, the energy required to recover from the breakdown event will continue to square at each successive level of failure.

I discovered this rule when trying to find a method that would predict the difference between Breakdown Costs and Early Intervention Costs. I had some good numbers from a client that had been well documented for a very expensive truck breakdown event that caused an accident.

From my past experience I knew there had to be a relationship that explained the dramatic increase in expenses when an asset is operated to failure (OTF). I had long ago discarded arithmetic and geometric progressions, these tools simply did not prove to be accurate at all scales. After all my years working in the maintenance arena, I knew the cost increase had to be exponential but I had never been able to find a predictable base number from which to start the exponential progression.

One night, after staring at the numbers for too long, I threw down my pencil, turned on the TV in my office and there was a program about gravity running. The program talked about the force of gravity diminishing by the square of the distance…

"Ding", a small bell went off in my head. Having been a Marine Corps Aviator with nuclear weapons training I remembered that the blast effect energy of a thermonuclear weapon diminishes by the square of the distance…

"Ding… Ding…", I remembered that the chemical blast effect energy of a 2,000 pound bomb diminishes by the square of the distance…

"Ding… Ding… Ding…", I then remembered something my father once told me. He told me that money was just stored energy. He said that he would work all day as a mechanic and all that energy he expended working on cars was handed to him in his paycheck. He said that he could then take the

stored energy in that paycheck and give it to a plumber to fix a drain, or the electric company to change his stored energy into electrical energy, or a seamstress to make a dress for my mother.

“DING!” I thought, “If money is stored energy, will that energy behave like gravitational, nuclear and chemical energy?”

Having some very good numbers in front of me, I grabbed my calculator, entered the total direct maintenance cost (Work Order $1,600) for the breakdown event and took the square root.

“DING… DING…!” I looked at the number and knew what that number represented. That number was the cost of the $40 brake shoe block that had failed and caused the accident.

“DING… DING… DING…!” I then squared the WO cost of $1,600 and got $2,500,000 which is what the company had set aside against profits to settle the personal injury lawsuit.

Value		√ Value	
$2,500,000	√	$1,600	Mechanical and towing costs.
$1,600	√	$40	The cost of the brake block.

I started examining every set of reliable cost numbers I could find from past breakdown events and when I thought I had all the direct maintenance costs, indirect breakdown costs, and intangible breakdown costs totaled, I took the square root. It took me many years to get an understanding of how to get all the costs but the method worked.

In my seminars where my clients computed their total breakdown event costs to their company and took the square root, their number was within 10% of the cost of the primary failure part… But not always.

Often the number was too large so I had them take the square root of that number until they got to the cost of the primary failure part. Doing this, having to take the square root more than once, troubled me because only the lowest square root produced a recognizable part value.

After years of examination I realized that if I started with the cost of the primary failure part and initiated a succession of squared values that each successive value represented the escalating energy state required to recover from the breakdown event at that level of failure.

The more examples I studied the more I realized that each of the escalating energy states were in fact plateaus where management had the opportunity to intervene to stop the progression but failed to act and the exponential costs continued. I often had people tell me, *“It can’t be the square because the numbers get too big, too quick.”*

I agreed but the progressions worked at everyday operating levels so I continued to use the rule to document breakdown events until I came across a really big breakdown event number. A refinery explosion had wrecked the facility, stopped production for years, and killed about eighteen people. I came across a statement that the company, in its annual report many years after the explosion, had closed the accident file with a write down of $2.13 billion. I examined the accident investigation by the US Chemical Safety Board and found that during startup after maintenance that a high level indicator gauge in a vessel was known to be bad but the startup process was not halted. I began my calculations backwards from the total write down cost and came up with these numbers:

Value		√ Value	Energy State Decision Point
$2,130,000,000	√	$46,152	The cost to halt the startup and fix the gauge?
$46,152	√	$215	The cost of the gauge?
$215	√	$15	The cost of the mechanism in the gauge?

The Inverse-Square Rule is not a physical law but using the primary failure part as a base number from which to compute the exponential total breakdown cost to the organization works very well as a rule when choosing between deferring maintenance and executing an early intervention effort.

If your maintenance people tell you that a $15 wheel bearing is failing on a light utility trailer you can predict that the next energy state to recover from a breakdown event will be about $225 in direct maintenance costs to replace the whole axle if operated to failure. You can also predict that if the bearing failure causes an accident on the road that the next escalating energy state level to the whole organization could be about $50,000.

The real benefit here is that sales, managerial and financial people do not have to understand any of the technical information associated with the mechanical knowledge about bearing failures and collateral damage to the axle. All they need to know is what the escalating worse case risk to the company will be in lost productivity, lost sales, and legal fees will be if they choose to defer maintenance and allow the trailer to be operated to failure.

Not every maintenance event that is deferred will progress to a breakdown event, but those that do will create exponential costs so dramatic that the effects can be threatening to the very existence of the organization. The *Inverse-Square Rule for Deferred Maintenance* computation gives the executive without extensive mechanical experience a very good preliminary tool to use in their decision to defer or repair.

If the organization's leadership has evaluated decisions that have led to breakdown events in the past, computed the total cost to the organization, and verified that the *Inverse-Square Rule for Deferred Maintenance* applies to their process, then the decision to repair or defer maintenance becomes very easy. Early detection and early intervention will produce the lowest maintenance cost per unit of production possible. All other maintenance decisions will produce a higher cost.

Evaluating the Inverse-Square Rule's effect on the whole company, not just work order costs for a breakdown event, will offer leadership a tool to act quickly and decisively when faced with highly technical and mechanical decisions. All the leadership needs to know is the cost of the part that is failing and square it to see the energy needed to overcome a breakdown event at the first level of failure.

If they then square the energy needed at the first level, they will see the total energy needed by the whole organization to overcome a second level of failure. This number is usually big enough to make the decision to defer or repair quickly and decisively because the consequences are obvious.

In making decisions to repair or defer, management has never had such a simple and accurate tool.

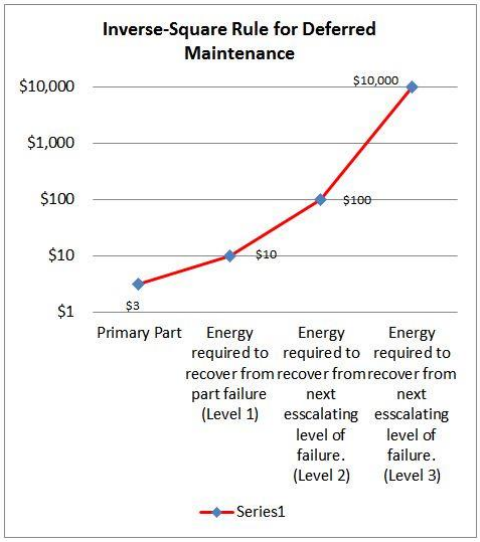
1. Verify that the Inverse-Square Rule is valid for your process by working historical breakdown events.
2. Know the cost of the primary part that is failing today.
3. Square the cost of the part to see the energy needed to recover from a breakdown at the first level.
4. Square the first level number to know how much energy will be needed to overcome the second level escalation of the breakdown event.
5. Square that number to know how much energy will be needed to overcome the third level of the breakdown event.

By this time in the evaluation, the decision will be obvious and early intervention actions can be planned and executed before the breakdown.

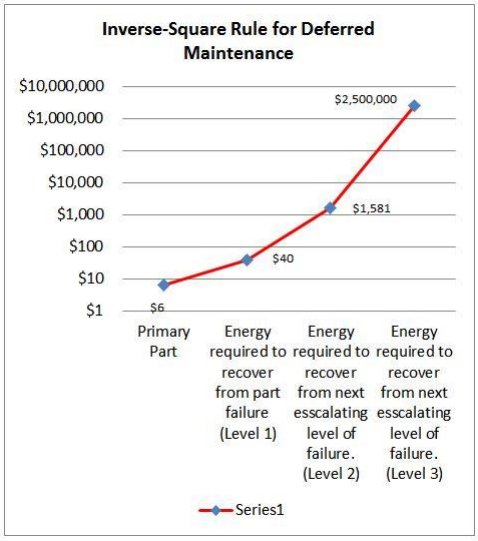
The Exponential Universality of the Rule

This rule seems to have a universal application that is not effected by the type of business, organization, or process. I have seen the rule upheld in all kinds of operations including university building, school bus, barge, jet fighter, helicopter, power generation, fracking, road paving, warehouse, forklift, truck, steel mill, food processing, general manufacturing, and mine maintenance.

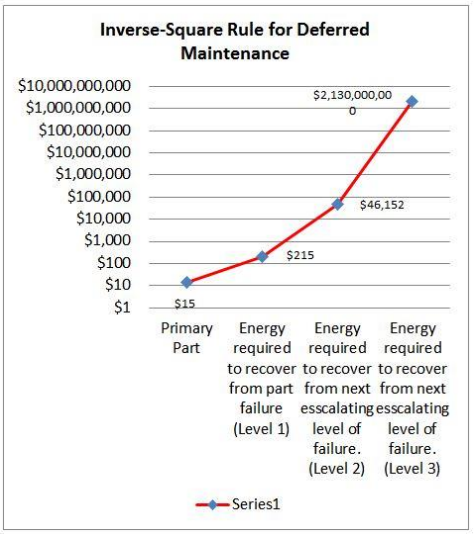
Electric Motor Bearing



Brake Shoe



Refinery Gauge



I have not seen this rule to fail where an organization has been able to identify all the costs associated with the breakdown event. If the primary failure part cannot be identified for some reason, my clients have been able to use the Total Breakdown Event Costs they have generated and divide those cost by the early intervention cost that could have avoided the breakdown to derive the *True Risk/Reward Ratio for Deferred Maintenance* as a complementary tool. This ratio is often easier to work with for financial people.

There seems to be a recognizable exponential energy relationship with individual component costs and the added value of manufacturing also, but that is another discussion.

The author:

David Geaslin is the owner of The Geaslin Group (www.geaslin.com) and a graduate of The University of Texas at Austin with degrees in Industrial Management & Marketing; a former Marine Corps Aviator and Aircraft Maintenance Officer; the CEO of his maintenance service company for 15 years; and has consulted offering coaching and seminars in the management of maintenance since 1990. He lives in Gonzales, TX and travels offering his services wherever needed.