Improving Maintenance with Technology

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Abstract. The paper will discuss the tremendous equipment improvements that electronic maintenance control programs and IoT can provide to owners. Tailoring maintenance provides optimum performance with minimal costs. An ideal program provides for contractual reimbursement when maintenance is not performed per contract, the financial benefits finally in favor of the building. Examples of documented 70% reduction of callbacks, reduction of unexpected equipment failure, elimination of incidents, preservation of capital equipment, and improved elevator personnel morale are possible. The current trends of overloading mechanics have swung too far to the detriment of owners.

1 INTRODUCTION: TECHNOLOGICAL EVOLUTION IN ELEVATOR MAINTENANCE

One can't be unaware that maintenance practices have changed in the last 30 years in the lift industry. Technological improvements have been applied, moving from relay logic to computer controllers, solid state motor control, and the use of sealed bearings. As these changes have occurred, maintenance demands have changed. Certainly, the need to meg and blow out the carbon dust in a motor-generator is no longer there; however, there still exists the ever-present degradation of mechanical components such as gibs and rollers in a dirty environment and rope stretch. Regular housekeeping maintenance remains unchanged. Older equipment is still in service, where much more maintenance is still required; it is critical not to apply a maintenance control program from a modern system to these older systems.

2 THE RISKS OF OVER-REDUCING PREVENTIVE MAINTENANCE

Reductions in maintenance time and frequency in the lift industry may have some legitimacy given technological improvements in the equipment. The question is, how much reduction in maintenance can a lift system endure before reduced performance and hazards are created? This must be examined objectively. In the US and Canada, the ASME A17.1/CSA B44 Code has a maintenance section that allows companies to determine intervals between maintenance visits. There is ample evidence that maintenance companies have stretched the interval limits hazardously, and without questioning these intervals, it will likely continue further.

3 KEY INDICATORS: CALLBACKS AND CUY

The first key performance indicator when determining if adequate preventive maintenance is being done is the number of equipment-related callbacks a lift or escalator has in a year. Six or more equipment-related callbacks in one year is direct evidence of a lack of adequate maintenance in a very busy building, such as a hospital or an extremely under-elevated building. For a correctly elevatored building of normal use with adequate maintenance, 4 equipment-related "Callbacks per Unit per Year" (CUY) is easily achieved. Injury incidents are typically associated with a high number of equipment-related callbacks, infrequent visits, short duration of maintenance visits, and insufficient training of mechanics on older equipment.

4 CASE STUDY: UNIVERSITY SYSTEM PERFORMANCE WITH LIFT EMCP

A real-world example is an account with 669 lifts at a large university in the United States using eMCP, now known as Lift eMCP after acquisition by LiftAI in late 2024. Before providing an enforceable contract with true transparency using Lift eMCP, the average callback rate was over 6.5 equipment-related CUY. After accountable maintenance was contractually imposed, the equipment-related callbacks plummeted to 1.5 equipment-related CUY, and after ten years, the average remains at 2.1 CUY consistently with no injury incidents reported. For a large University with primarily traction elevators, this is a stunning result.

	#	%	OSU MC	%	FOD	%	SL	%	BA	%	ATH	%	Out	%
Total OSU Units	651	100%	150	100%	294	100%	105	100%	24	100%	23	100%	50	100%
Units With Any Callbacks	469	72%	89	59.3%	176	59.9%	91	86.7%	12	50.0%	5	21.7%	4	8.0%
Total Callbacks	3,090	100%	548		1452		1043		32		5		9	
Equipment Related CBs	1,379	45%	248	45.3%	523	36.0%	581	55.7%	14	43.8%	2	40.0%	2	22.2%
Non-Equip Related CBs	1,711	55%	300	54.7%	929	64.0%	462	44.3%	18	56.3%	7	140.0%	7	77.8%
Units with 0 Callbacks	277	43%	61	40.7%	118	40.1%	14	13.3%	15	62.5%	23	100.0%	46	92.0%
Units with 1- 4 Callbacks	259	40%	70	46.7%	141	48.0%	35	33.3%	9	37.5%	0	0.0%	4	8.0%
Units with 5 - 8 Callbacks	80	12%	16	10.7%	28	9.5%	36	34.3%	0	0.0%	0	0.0%	0	0.0%
Units with 9 - 13 Callbacks	19	2.9%	2	1.3%	5	1.7%	12	11.4%	0	0.0%	0	0.0%	0	0.0%
Units with 14 - 18 Callbacks	6	0.9%	1	0.7%	2	0.7%	3	2.9%	0	0.0%	0	0.0%	0	0.0%
Units with 19 - 25 Callbacks	5	0.8%	0	0.0%	0	0.0%	5	4.8%	0	0.0%	0	0.0%	0	0.0%
Entrapment Callbacks	273	8.8%	75	14%	92	6%	105	10%	1	3%	0	0%	0	0%
Running on Arrival Callbacks	1,565	51%	236	43%	814	56%	493	47%	18	56%	3	60%	1	11%
Equip Related - C/U/Y	2.1		1.65		1.78		5.53		0.58		0.09		0.04	
All Callbacks - C/U/Y	4.7		3.65		4.94		9.93		1.33		0.22		0.18	

Figure 1 2023 Callbacks

	#	%	OSU MC	%	FOD	%	SL	%	BA	%	ATH	%	Out	%
Total OSU Units	669	100%	154	100%	305	100%	115	100%	22	100%	23	100%	50	100%
Units With Any Callbacks	463	69%	107	69.5%	219	71.8%	107	93.0%	11	50.0%	4	17.4%	15	30.0%
Total Callbacks	2,851	100%	689		967		1,096		63		9		27	
Equipment Related CBs	1,407	49%	327	47.5%	396	41.0%	590	53.8%	42	66.7%	1	11.1%	16	59.3%
Non-Equip Related CBs	1,444	51%	362	52.5%	571	59.0%	506	46.2%	21	33.3%	8	88.9%	11	40.7%
Units with 0 Callbacks	190	28%	38	24.7%	80	26.2%	9	7.8%	11	50.0%	18	78.3%	35	70.0%
Units with 1- 4 Callbacks	242	36%	57	37.0%	142	46.6%	24	20.9%	4	18.2%	4	17.4%	15	30.0%
Units with 5 - 8 Callbacks	124	19%	24	15.6%	54	17.7%	35	30.4%	4	18.2%	0	0.0%	0	0.0%
Units with 9 - 13 Callbacks	39	5.8%	10	6.5%	11	3.6%	15	13.0%	3	13.6%	0	0.0%	0	0.0%
Units with 14 - 18 Callbacks	33	4.9%	8	5.2%	8	2.6%	14	12.2%	0	0.0%	0	0.0%	0	0.0%
Units with > 18 Callbacks	26	3.9%	7	4.5%	4	1.3%	18	15.7%	0	0.0%	0	0.0%	0	0.0%
Entrapment Callbacks	308	10.8%	103	15%	92	10%	105	10%	7	11%	1	11%	0	0%
Running on Arrival Callbacks	1,620	57%	277	40%	814	84%	493	45%	21	33%	9	100%	6	22%
Equip Related - C/U/Y	2.1		2.12		1.30		5.13		1.91		0.04		0.32	
All Callbacks - C/U/Y	4.3		4.47		3.17		9.53		2.86		0.39		0.54	

Figure 2 - 2024 Callbacks

The numbers shown in Figures 1 and 2 illustrate how monthly site visits improve performance and prove the obvious point: maintenance frequencies and durations are critical to keep even the oldest equipment operating hazard-free and operating with maximum uptime. The University is clearly elated, and additionally, the total cost of vertical transportation maintenance did not increase, with the exception of inflation and labour rate escalation. Even in this ideal environment, the number of "Running on Arrival" (ROA) callbacks remains over

50% of the total callbacks. Some of these callbacks required repairing a component. Because the lift was running, there was still a corrective action to some component. Most records, however, had no corrective action at all, just “Checked Operation” without finding any problems requiring a corrective action.

5 UNDERSTANDING ROA CALLBACKS AND TELEMETRY OPPORTUNITY

ROA callbacks are a waste of labour, they interrupt maintenance to answer a phantom call, and are a nuisance to the University. From researching ROA callbacks, the evidence suggests that very conservative behaviour by the owner is partially responsible. They respond to the general public perceiving a problem, and they request the maintenance company check out the lift, typically without their own review of the lift by someone onsite. If there is a place for utilising IoT telemetry systems that can provide enough data to determine if the lift is operating correctly and safely, it is in this area, where there is an actual financial return on investment for the telemetry equipment. If the telemetry system can safely determine the elevator is operating correctly, then the response to the callback is logged: “Telemetry shows all is OK, call again if the problem returns.” When this information is available on the mechanic's smart device, he can continue with his maintenance tasks without interruption. This concept is valid with intelligent telemetry, the kind of intelligence available with many systems today.

6 IOT: FROM REACTIVE TO INTELLIGENT MAINTENANCE

For example, in this implementation, the telemetry can detect accelerations known to be hazardous, such as an emergency stop, the lift not getting to full speed, or overspeeding. Vibration analysis can determine if door cycle times are substantially increased, indicating debris in the sills or impacted doors with bent gibs. When using IoT devices to simply notify the maintenance company that a failure has occurred, in lieu of the maintenance company actually regularly visiting the unit and observing a developing failure, it allows the failure to occur. It is reactive maintenance, otherwise known as “callback maintenance”, when scheduled maintenance visits are three, four, or six months apart, a failure is detected, and that is what brings repair personnel to correct the issue.

Intelligent use of IoT telemetry systems must be an adjunct to preventive maintenance, not replace preventive maintenance. For example, the telemetry should provide notice of a new vibration in a roller indicating a deleterious change in its condition, an irregular vibration in the floor open and close cycle indicating debris in the sill. Such events should be evaluated, a degree of importance assigned, and levels based on the customer's ability to sense the failure and schedule a new task to immediately generate a maintenance request, regardless of the next scheduled maintenance visit. These things should be noticed before the guide roller material shredding off and allowing a full speed clipping of an interlock, causing injury or rope stretch, which trips a buffer or compensation sheave switch, causing an injury. These conditions should be observed by an on-site mechanic who should visit the lift more than 3 times a year.

7 MAINTENANCE FREQUENCY STANDARDS – THEN AND NOW

In the 1980s, traditional maintenance in the United States and Canada was monthly, with some exceptions. Very low-use lifts could be quarterly, for example, in a church or a water treatment plant, where the usage is very low. Very high-use lifts in critical areas sometimes have every two-week visitation requirements in their contract, for example, international airports. In practice today, many large companies have what seems to be a one-size-fits-all schedule, regardless of the price, and claim that one major reason is due to a shortage of labour. One has

to ask if you own a business and take on too many clients to the point they all suffer a reduction in service, wouldn't it be better to not take the job on until it could be properly manned, so the existing customers don't suffer?

8 INDEPENDENT VS. MAJOR FIRMS: INCIDENT DISPARITY

Juxtaposed with this is the practice of independent maintenance companies that do monthly maintenance. Since 2008, when I began doing forensic analysis of incidents, the major companies have had a significantly higher number of incidents than independent companies. Out of over 200 incidents, only 12 were independent company incidents, while the major companies had over 180 incidents. In my experience with the University, requiring monthly site visits bears this out, and there have been no incidents in over 10 years. Major companies have 60% to 65% of the estimated total of 1.2 M units in the US and Canada. One would expect a similar ratio of incidents, but this is not the case. There is no reason my cases should statistically bias against independent company incidents. This was confirmed by my consulting peers - all had similar percentages.

9 CONTRACT ENFORCEMENT: LEGAL AND OPERATIONAL IMPACT

There seems to be no limit to how little maintenance a company can do, with only the injuries bringing the inadequate maintenance to light. This is what appears to be the driver in the marketplace today. When the bar is as low as reducing preventive maintenance to the point of occasional injury incidents, this practice should not be allowed to continue. The purpose of Codes and Standards is to assure that there are few injuries, to protect life and limb, where act-of-God-type failures are the only acceptable types of incidents. This should be the lowest bar, and mandates to reduce preventive maintenance should be left to technical engineers and former mechanics, not to financiers and shareholder interests.

10 LIFTAI AND LIFT EMCP: FULL TRANSPARENCY IN ACTION

This kind of oversight is the purpose of LiftAI and Lift eMCP: to provide transparency to contractually enforceable duties. For example, if a contract requires monthly maintenance, without some oversight, most customers don't know if they actually received maintenance in the last month. Lift eMCP provides a monthly completion report that is used to illustrate maintenance completion when combined with contractual language to use this reporting system. This excludes all company boilerplate contracts that typically just require "systematic and periodic" visits to the unit. When a contract requiring the use of Lift eMCP is signed, maintenance companies must rationalise why the tasks were not completed. There may be valid reasons, for example, a fire in a building that has left the building unoccupied, or the lifts are being modernised. This leaves either doing 100% of the tasks or rationalising why it wasn't achieved, so owners have full visibility of their maintenance costs and results.

Lift eMCP provides a tool for seeing contract compliance. Our findings after 10 years of successful use at the University include improved morale when the mechanics are told to leave their jobs, as they can report that they are not finished with all the maintenance tasks. When the tasks are left incomplete, the company has money withheld for not completing all the tasks. The net result is that when a mechanic is asked to work off-site, they are now also asked if all the tasks are completed or if they are on track to complete them. If the mechanic says no, the company instructs them to stay and finish the maintenance tasks. This is what regularly occurs at the University, and the condition of the equipment is much improved. Reverting back to the

1980s when the mechanic was much more autonomous and when routes were not so heavily populated with excessive numbers of units.

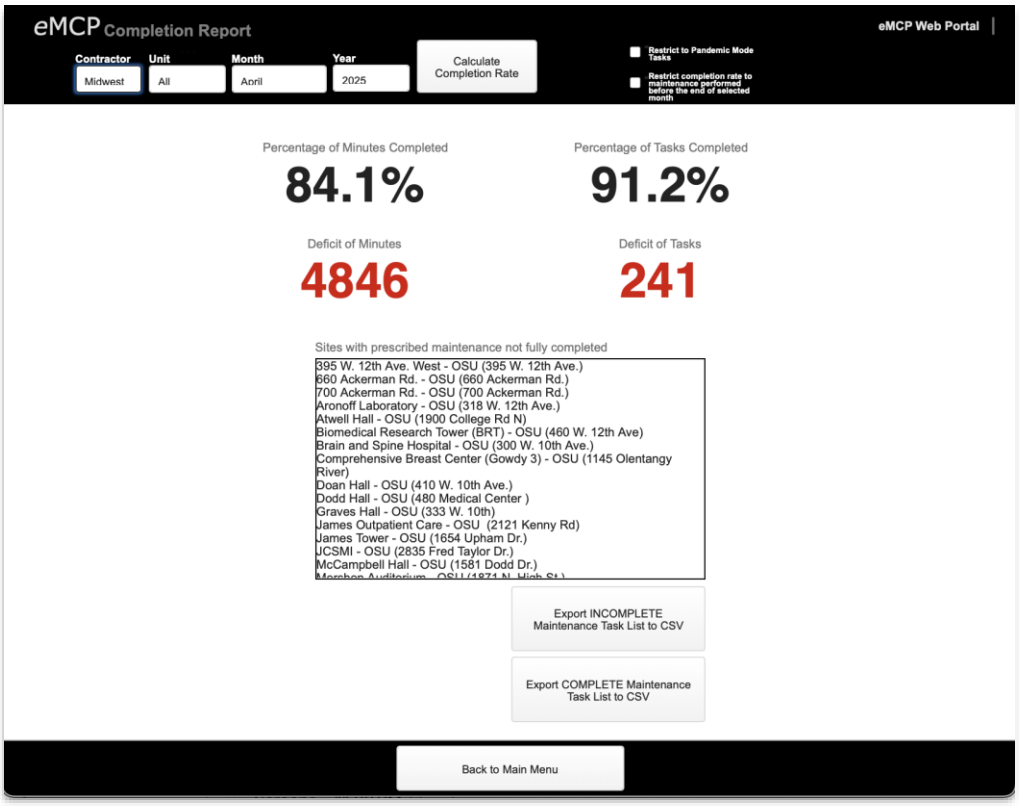

Figure 3 - Completion Report

When the tasks are completely identified and a reasonable time is associated with each task, the time can be tallied and the monies recovered by reducing the next payment from the maintenance company in breach of the contract. The refusal to pay was challenged in year two, and the University won when undergoing a legal challenge. The company did not perform, and the lack of maintenance monies was credited back to the university. This was a seminal ruling and has been recognised and adhered to subsequently. One can get what you pay for with systems and contracts in place.

LiftAI has the business of monitoring and auditing all communications: proposals, invoices, parts orders, and verification of pricing per the contract. By acquiring eMCP, rebranding to Lift eMCP, a complete maintenance system allows for total transparency. Their auditing function can be managed by the building or by a consultant who may have many building owners in their business. Errors in billing, unjustifiable proposal amounts, and not following contractual site visits are regularly discovered with this type of auditing. Providing experienced oversight to building managers and owners is commonly done by consultants. LiftAI provides systems for this function so owners and managers can manage their maintenance contracts effectively. By partnering with eMCP, LiftAI has revolutionised lift maintenance, changing the premise of little say because of the complexities of the lift products, by monitoring the money, the value of the spend, and demanding to get what they pay for with systems that illustrate all aspects of their equipment.

11 CONCLUSION

Utilising transparent, accountable maintenance systems such as LiftAI and Lift eMCP improves safety, capital preservation, and uptime of lift equipment. Using Lift eMCP has produced optimum performance with minimal costs. Combined with a contract which binds the maintenance company to actually perform to the terms, with control of the maintenance fees at risk to the maintenance company, the owner now controls his equipment in ways not seen in the past. Equipment life, in-service uptime, reduction of callbacks, elimination of incidents, and mechanics who are given the time necessary to actually perform maintenance, which improves morale.

12 REFERENCES

BIOGRAPHICAL DETAILS

John Koshak has worked in the elevator industry since 1980, beginning as an adjuster with major companies before moving into product design, code compliance, and consulting. He patented the LifeJacket safety device, founded Elevator Safety Solutions, LLC in 2008, and later co-founded eMCP LLC to deliver code-compliant Maintenance Control Programs. An author of books, Certified Elevator Technician courses, and numerous technical articles, he also teaches code education for licensing. Koshak has served on the ASME A17 Standards Committee since 2005 and holds leadership roles including President of the International Association of Elevator Consultants (IAEC) and Board Member of Elevator World Magazine.