PCBA Redesigns Done in the Right Way

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Abstract
Electronic component end-of-life (EOL) and declining prices are more problematic to industrial than consumer electronic products. Industrial electronic products typically have long product lifecycles. 10 years, 15 years and up to 20 years are common. Declining component prices make older products less competitive than newer ones. Component EOL causes production disruptions. The number of components announced for EOL has been on the rise (figure 1). Three options are often employed to mitigate the risks: making a last-time-buy (LTB), using new product introduction (NPI) to replace the old one, redesigning an existing PCBA with the EOL and high-cost components replaced. While none of these options are perfect, redesign provides a balance among development efforts, mitigating EOL impacts, and reducing the product cost[2]. In this paper, we will present a collaborative approach to redesign in an environment where the internal funding and resources are limited.

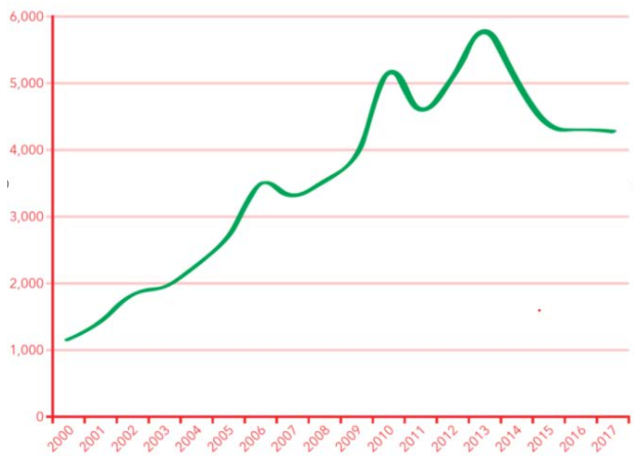


Figure 1 Component EOL Trend[1]

Background
OEM's internal engineering teams traditionally handle product redesigns. It is common for engineering teams to be stretched thin already with NPI, customer support, field issue resolutions, etc. Redesigning an old product is a significant undertaking. Resource constraint becomes the number one obstacle. The other constraint is funding shortage. Redesigning an old product requires upfront investments in the order of 100's of thousands of dollars in labor and materials over a period of many months to years. Given the resource and funding constraints, OEM often opts for LTB of EOL components and endures the associated sideeffects. We propose a collaborative approach to involve other stake holders to share the resource and financial burden.

EMS as a redesign partner
EMS (Electronic Manufacturing Service) companies see many good reasons to take on redesign projects with OEM. To increase profit margin and retain customers, many EMS have built up engineering service businesses. Major OEM built up substantial engineering department with hundreds to thousands of engineers with the capabilities to develop products from concept to production. We see it as a good fit to engage EMS for redesign projects. The immediate benefit is tapping into the EMS engineering resource pool to relief the resource constraint. Addressing the funding constraint requires a bit of creating problem solving. Luckily, OEM are often open to the idea of amortizing the NRE (non-recurring engineering) cost across the unit-cost of the redesigned product. For example, if the NRE is $200K, a $50 amortization adder can be added to the first 4000 redesigned production units. This arrangement works out well if, for example, the redesign achieves $100 reduction in unit cost, the annual volume is high enough, and the OEM has a broad, existing relationship with the EMS company.

A proper process is needed to make this kind of collaboration work well between the two companies. In the rest of this paper, we will illustrate the key features of a process and lessons learned with a real example.

This collaboration requires a systematic framework in order not to be bogged down by ambiguities. This framework is illustrated in the flow chart in figure 2. Only some of the PCBA meet the economical threshold for redesign. It is important to screen the candidate projects quickly to avoid wasting time and efforts. We perform an ROI (return on investment) analysis first. The inputs to the ROI analysis are unit cost, BOM with component costs, EAU (estimated annual units), estimated NRE, replacement NPI product plan, remaining product life, and other issues to be fixed such as field, manufacturing issues.

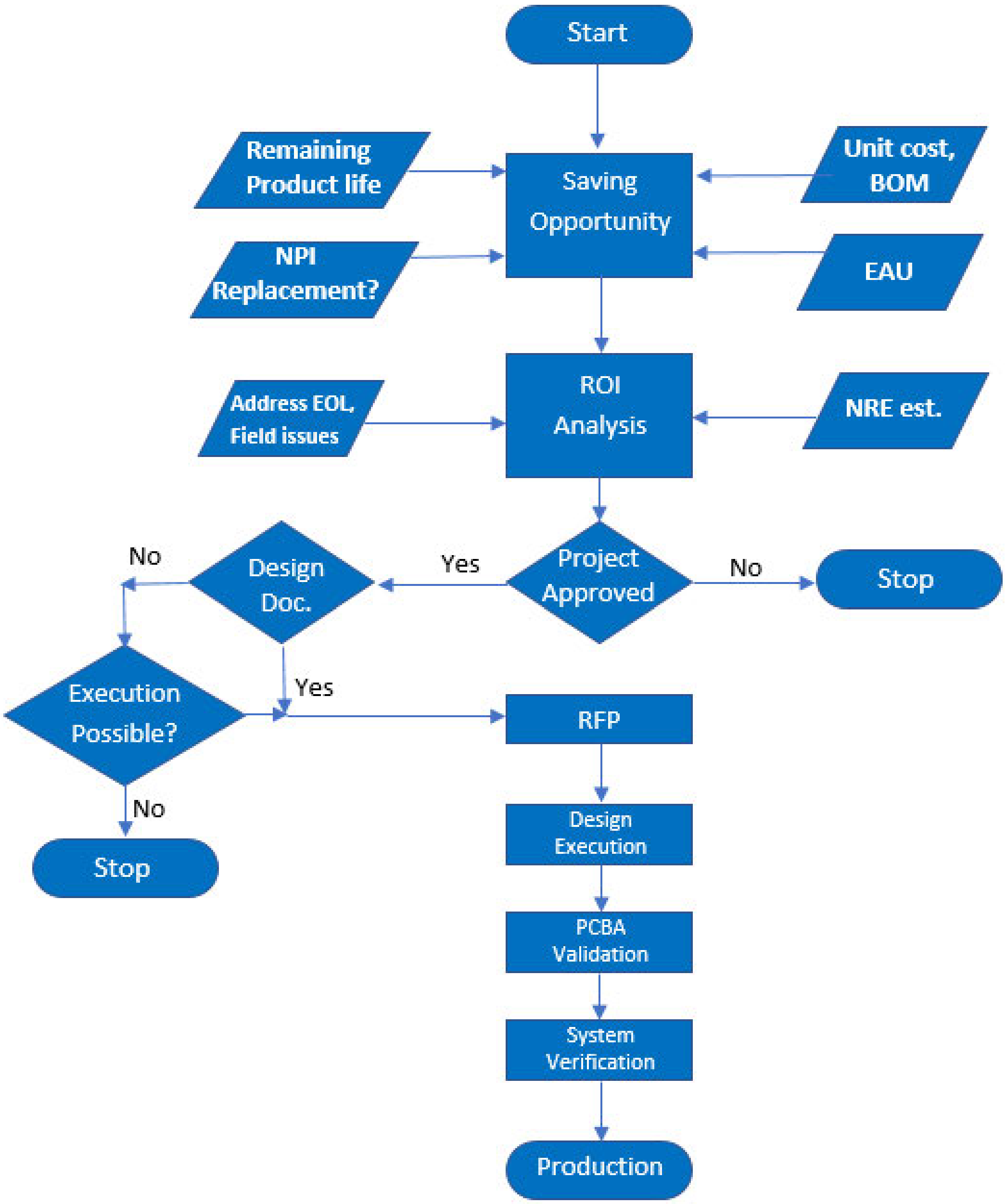
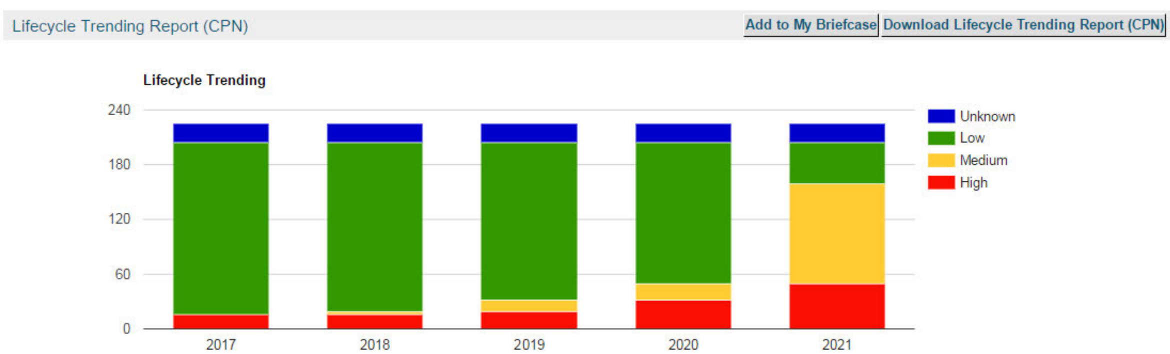


Figure 2 Redesign Framework

The first thing to check is if the product will be replaced by a NPI soon. If it is, there is no need to proceed further. The potential savings can be estimated with product unit cost, EAU, BOM, and EOL information. By analyzing the BOM, we can tell which components should be replaced, the replacement components and their costs. We calculate the annual saving with the EAU, old and new product cost estimates. In many cases, the cost saving by fixing known manufacturing and field issues, if any, can also be estimated. The investment is the estimated NRE. Given the quantified investment and return (savings), we can calculate the ROI to judge if redesigning the product is a profitable activity.

We will illustrate this process with a fictitious example shown in figure 3. This is a digital control board in a medical device. First, we verified that there is not replacement NPI on the horizon. The main component to be replaced is the FPGA near the lower left corner. To be thorough, we scanned all the components and obtained a report in figure 4.

Figure 3 Photo of digital control board example



	Lifecycle High Risk Parts	Lifecycle Medium Risk Parts	Lifecycle Low Risk Parts	Unknown
2017	16	0	188	21
2018	16	3	185	21
2019	19	13	172	21
2020	32	17	155	21
2021	49	110	45	21

Figure 4 Component Lifecycle Scan Report

This report shows components at various risk levels. The high-risk components are facing issues with EOL, LTB and NRND (not recommended for new design). The follow table is an example summary of the old and replacement components. Other essential estimates are also listed.

Component	Old device unit cost	Replacement device unit cost
FPGA	$110.00	$15.00
EEPROM	$4.07	$1.00
SRAM	$1.00	$0.75
Instrument Amp	$5.16	$3.40
PCB	$32.00	$22.00
Buffers	$2.30	$1.20
Existing Unit Cost	$285.72	
New Design Unit Cost Saving	$111.15	
EAU	1800	
Annual Saving	$200K	
NRE	$150K	

Figure 5 Inputs to ROI calculation

It is important to account for the investment from the OEM. After all, OEM engineering staff is needed to review, approve suppliers work, and conduct system verification in most cases. In this case, we valued the OEM investment at $50K for 330 man-hours of work. In this example, the total investment is about equal to the savings in the first-year production of the new design. We knew the new design is expected to be in the market for at least 10 years. Therefore, this project is a "GO".

After passing the financial analysis, it is crucial to determine if all the technical documents are available. This is particularly important for redesign. Without the product specifications, functional descriptions, source codes, test specification, drawings and design files, the task to redesign the product with the same functions will become exponentially more difficult. In case essential documents are missing, a careful deliberation must be conducted to assess the difficulty of recovering the missing information either through reverse engineering, information deduction, or physical measurements. If the unknown is too daunting, it is better to abort at this point.

Before we move on the next step, it is worthwhile to mention that the EMS supplier did the component analysis in this case. It was not a trivial amount of work. It is important to gather the EAU, product lifetime, unit cost information to be confident that efforts will not be wasted. The NRE estimate can take some work the first time. After a couple projects, it is fairly easy to categorize the product complexity and assign a prescribed NRE estimate. For example, we can categorize the designs into "complex" and "simple" designs. Complex designs will typically include FPGA and/or micro-controller redesigns, and a dense circuit board. An estimated NRE around $150K, give or take $50K, is reasonable. Simple design will include circuit and PCB changes only.An estimated NRE around $100K, give or take $25K, is reasonable.

After the redesign project passes the ROI analysis, the next step is having suppliers to submit proposals to RFP. The OEM will select the best proposal with more detailed estimates in project cost, resource assignments, and schedule. At this point, we also did a more detailed ROI analysis using a template. Figure 6 is an example of the ROI calculation template. It takes into account more detailed costs and such as manufacturing tool, warranty costs, and saving from field failure reductions.

Annual Savings ($)	$ 229,985
Payback (Months)	12
ROI	99%

REQUIRED FIELDS

General Information	
Project Name	
Business Unit	
Current CM / Site	
Unit Cost	369
Yearly Volume	1800
Remaining Product Life (Years)	6
Warranty Period (Years)	5
Project Type	Complex

Labor Cost		
Efforts By BU (e.g. Review, approval, qual etc.)	Average BU Hourly Rate ($/HR)	150
	Est. Man-Hours for Redesign	500
Redesign Effort By external EMS	Average EMS Hourly Rate ($/HR)	78
	Est. Man-Hours for Redesign	1420

Production Cost		
Current Design	Current PCB Fab Cost ($)	$30.0
	Current BOM Cost	$255.7
	Current Total Pass Through Yield%	90%
	Current Assembly Scrap Loss%	10%
	Others Annual Cost($) (Test, Mfg. etc.)	$150,000.0
Re-Design	New PCB Fab Cost ($)	$26.0
	New BOM Cost	$149.0
	New / Assumed Total Pass Through Yield%	95%
	New / Assumed Assembly Scrap Loss%	5.00%
	Others Annual Cost($) (Test, Mfg. etc.)	$150,000.0

Prototype & NRE for Redesign	
Prototype Cost (Tooling + Material+EVT+DVT)	$14,000
Manufacturing Tooling NRE ($)	$3,000.0
Test Tooling NRE ($)	$30,000.0

Other Cost		
Item 1		
Item 2		
Item 3		
Item 4		
Item 5		

OPTIONAL FIELDS

Current Design	# Components Before Redesign	700
Re - Design	# Components After Redesign	650

Failure & Prevention Cost		
Current Failure & Prevention Cost	# Field return / Year (During Warranty Period)	10
	Warranty/Recall ($/Years)	$1,000.0
	Average Reman Cost (Field Return / Year)	$5,000.0
	Others. ($) e.g. Cost of Other Credits not Billed (Per Year), Unplanned Purchases ($/Year), Travel Cost (Per Year), Subcontractor Evaluations ($/Year)	$1,000.0
New / Assumed Failure & Prevention Cost	# Field return / Year (During Warranty Period)	5
	Warranty/Recall ($/Years)	$700.0
	Average Reman Cost (Field Return / Year)	$4,000.0
	Others. ($) e.g. Cost of Other Credits not Billed (Per Year), Unplanned Purchases ($/Year), Travel Cost (Per Year), Subcontractor Evaluations ($/Year)	$800.0

Re-design Services		
Compliance Certification	TUV	$0
	UL	$0
	CE	$0
	ISO	$0
	Other 1	$0
	Other 2	$0
	Other 3	$0
Lab Services	Reliability Analysis	$0
	Failure Analysis	$0
	Metrology	$0
	Others	$0
Additional Services	Others 1	$0
	Others 2	$0
	Others 3	$0
	Others 4	$0
	Others 5	$0
	Others 6	$0
	Others 7	$0
	Others 8	$0

Figure 6 ROI Calculator for Example Medical Product

Now the crucial work is complete for setting up the proper goals and constrains in cost and schedule. In our example, The EMS will recover their NRE investment across the first 2000 units of the new design with an adder of $75 each. It is still a saving for the OEM. After the first 2000 units, the OEM reaps the full cost reduction of $120 per unit. The cost reduction schedule is illustrated in figure 7.

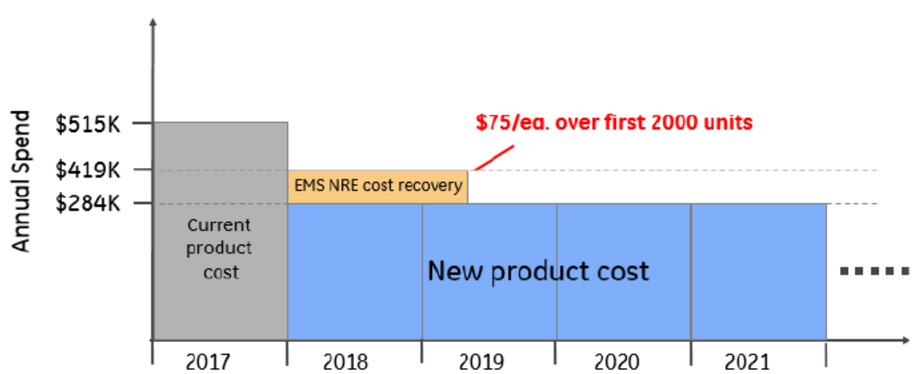


Figure 7 Example of cost reduction schedule

During the execution phase, a team of OEM and EMS participants follow the best program management practices such as periodic meetings, diligent action item tracking. It is important that OEM will commit engineering resources to support the EMS team to execute the new designs, because the OEM engineering is most familiar with the product. The PCBA board-level validation ownership usually lies with EMS. The system-level validation ownership, however, most likely lies with OEM. The reliability qualification and product certification can be negotiated between OEM and EMS.

Conclusions

Redesign provides a balance among development efforts, mitigating component EOL impacts, and reducing the product cost. In this paper, we presented a collaborative approach to overcome the common barriers. They are resources and funding constraints. OEM and EMS can collaborate to execute the redesign in a win-win arrangement. We described a process that allows rapid evaluation of the profitability and feasibility of a project. The ROI must be carefully evaluated using the process described and the ROI calculator. The role and responsibilities of the partners are also defined. We believe setting up a project in this fashion can greatly enhance the chance of success of a project.

References

1. Report by IHS (http://www.electronics-sourcing.com/2017/06/09/buyers-options-component-obsolescence/)
2. P. Singh, P. Sandborn, T. Geiser, D. Lorenson, “Electronic Part Obsolescence Driven Product Redesign Planning”, International Journal of Agile Manufacturing, Vol. 7, No. 1, pp. 23-32, 2004

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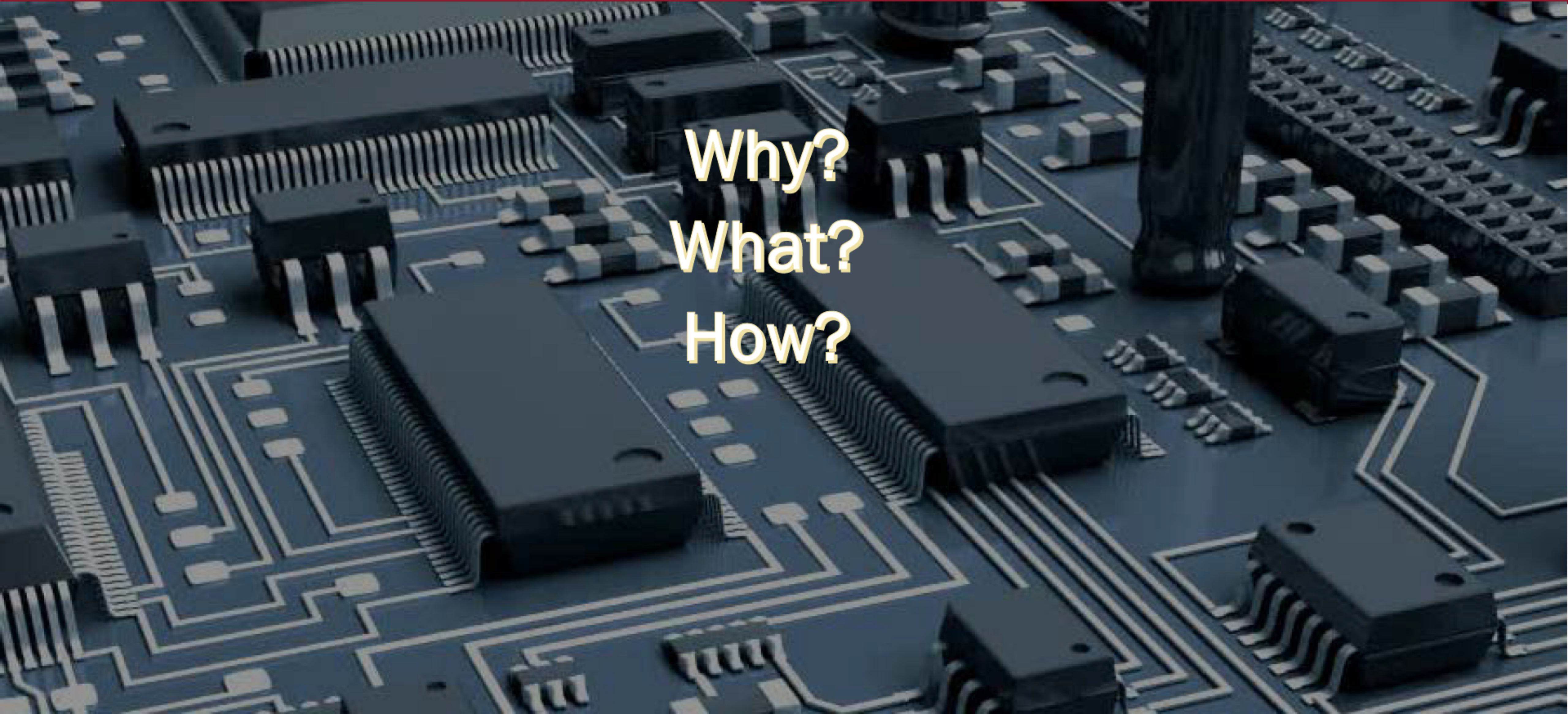
Navigating The Obsolescence and Cost Challenges



Why?

What?

How?

Why?

- Industrial electronic challenges

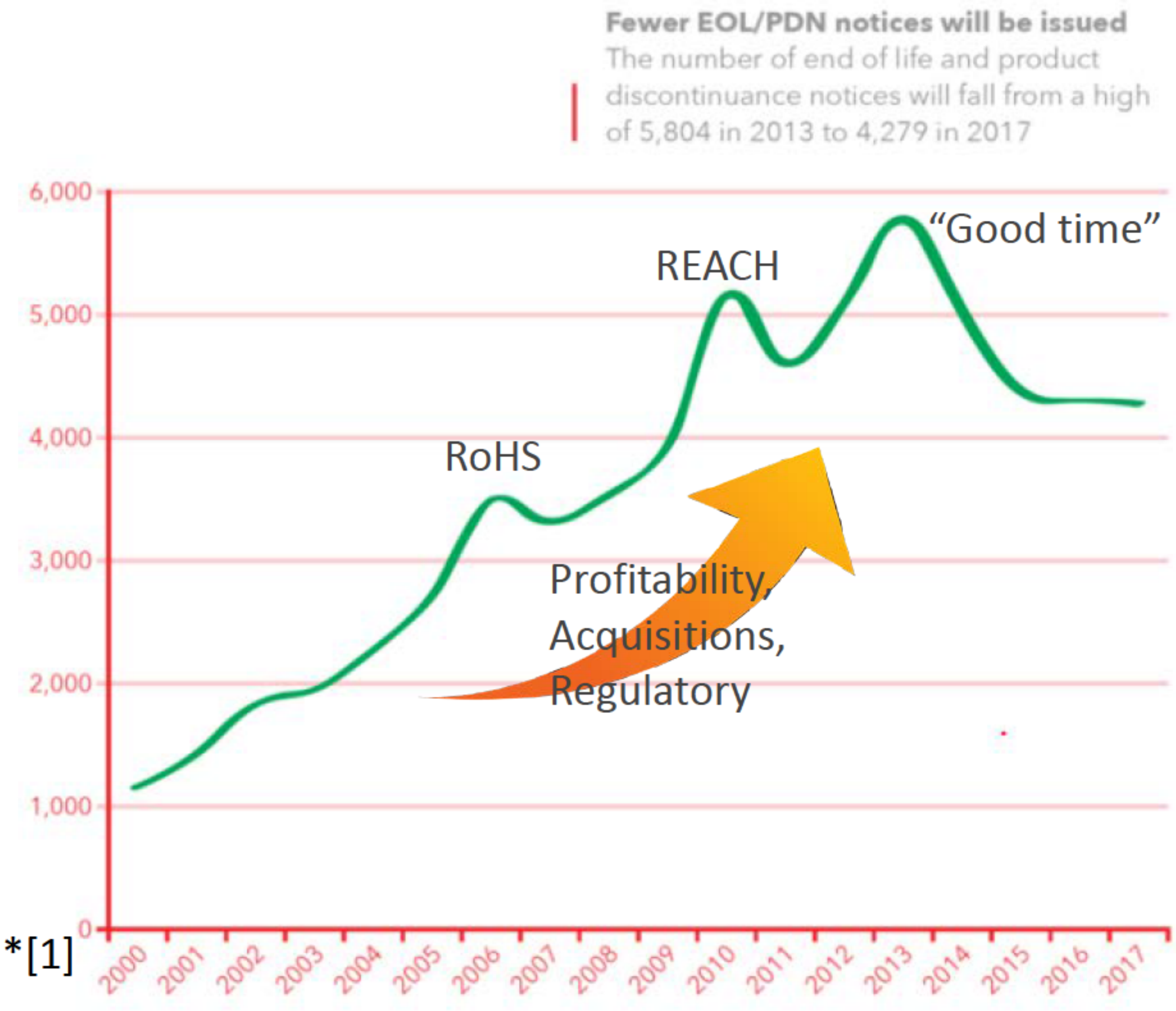
Long Lifecycle

Regulated Industries

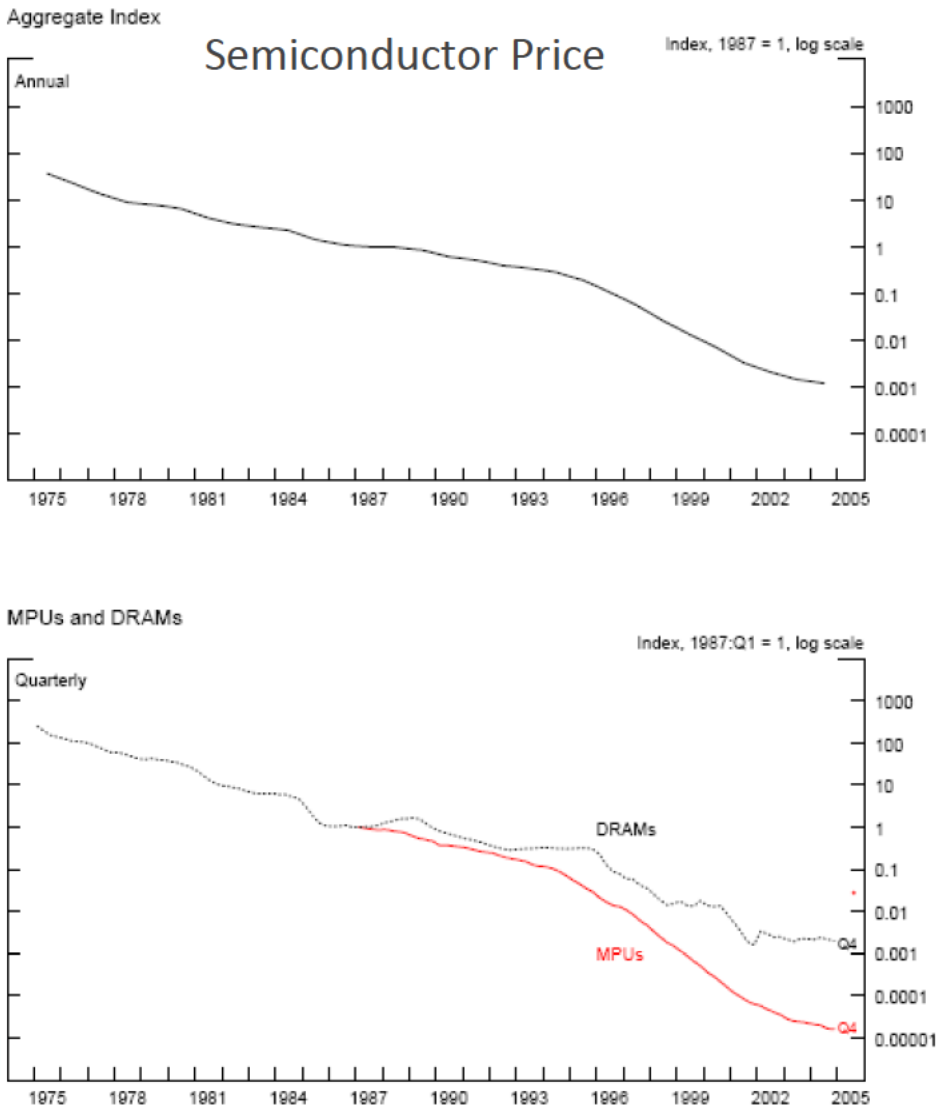
Price Erosion

Why?

- Component EOL, declining prices are the enemies of industrial electronics



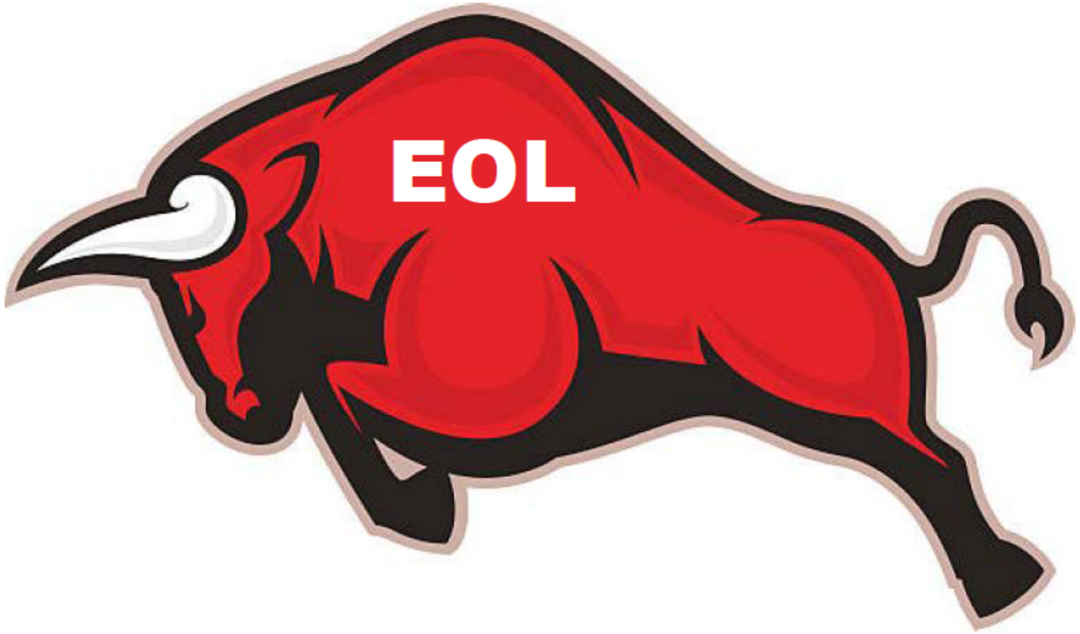
*[1]



*[2]

Why?

- Battle component EOL
- Avoid Last-Time-Buy / Life-Time-Buy / Bridge-Buy



What?

- PCBA redesign to
  - Cost reduce with *newer, cheaper* components, *manufacturing efficiency*
  - *Address field failures/reliability/return issues*
  - Out-source product lifecycle maintenance
  - *Fund the future*

Obstacles

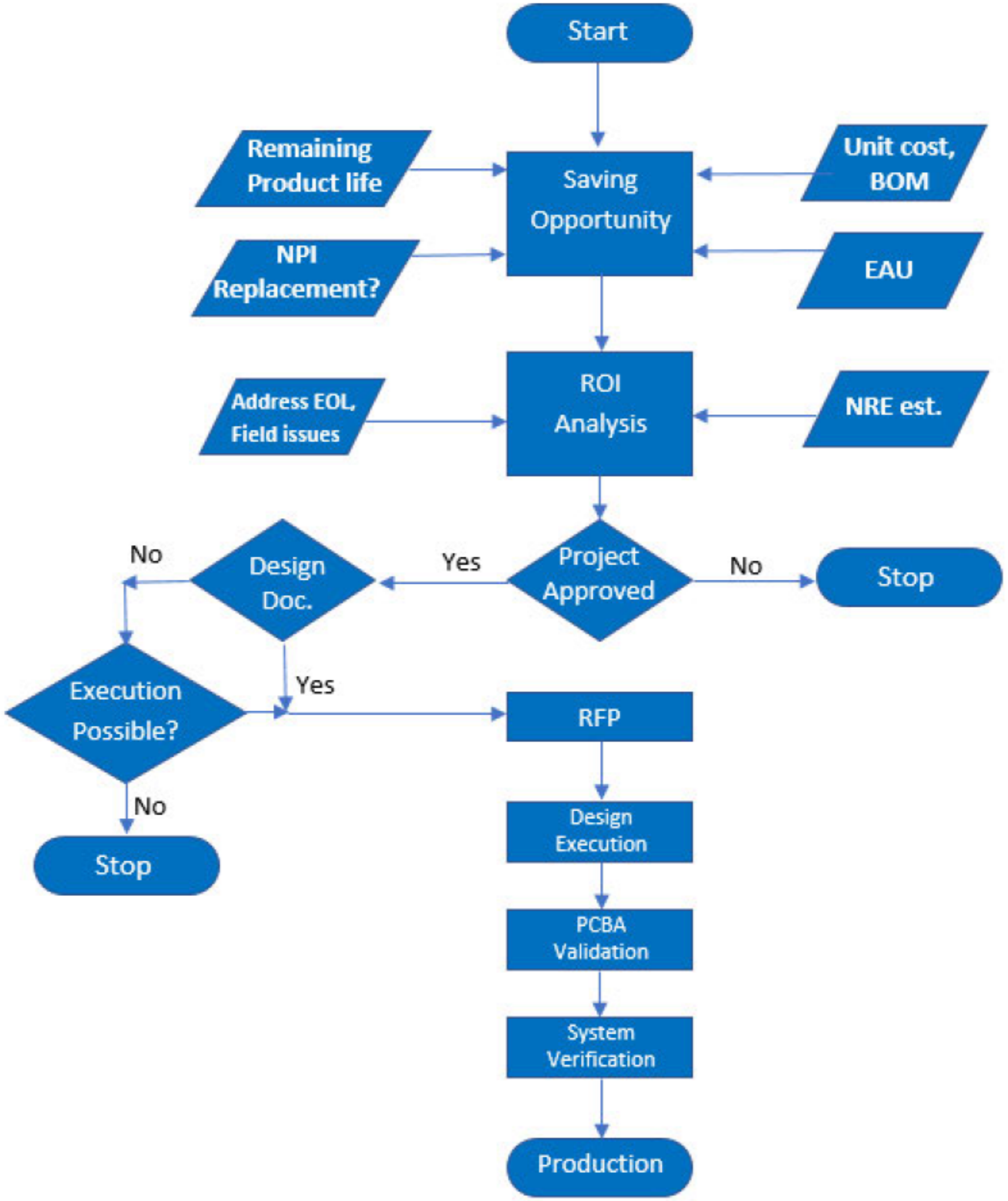
- Resource constraints
- Funding constraints

Opportunities

- OEM-EMS partnership
- Cost, resource sharing
- Leverage EMS engineering services
- Amortize NRE across unit-cost
- A Win-Win strategy

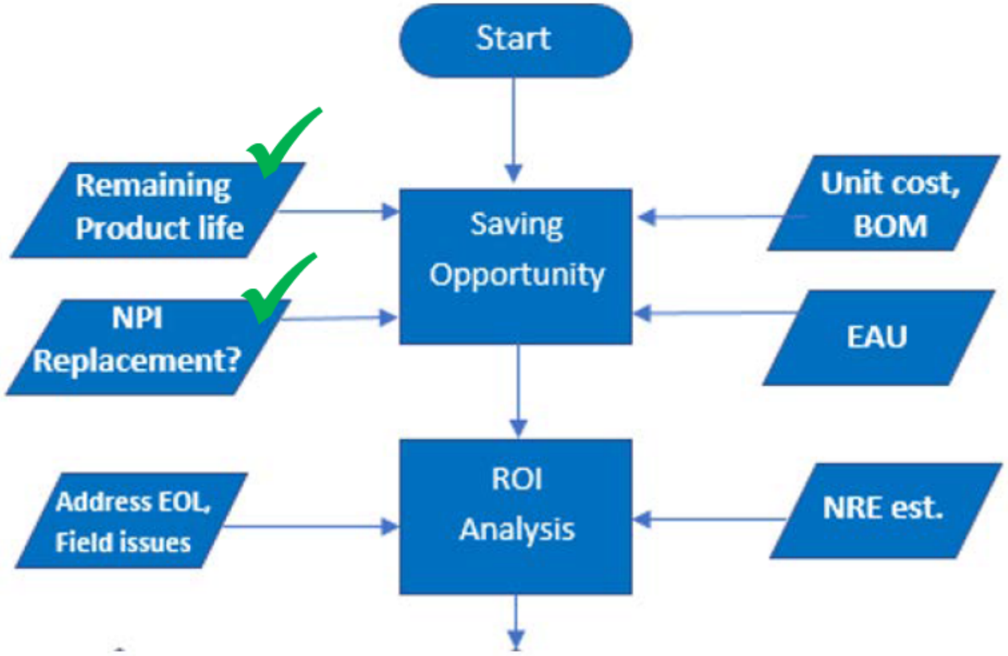
How?

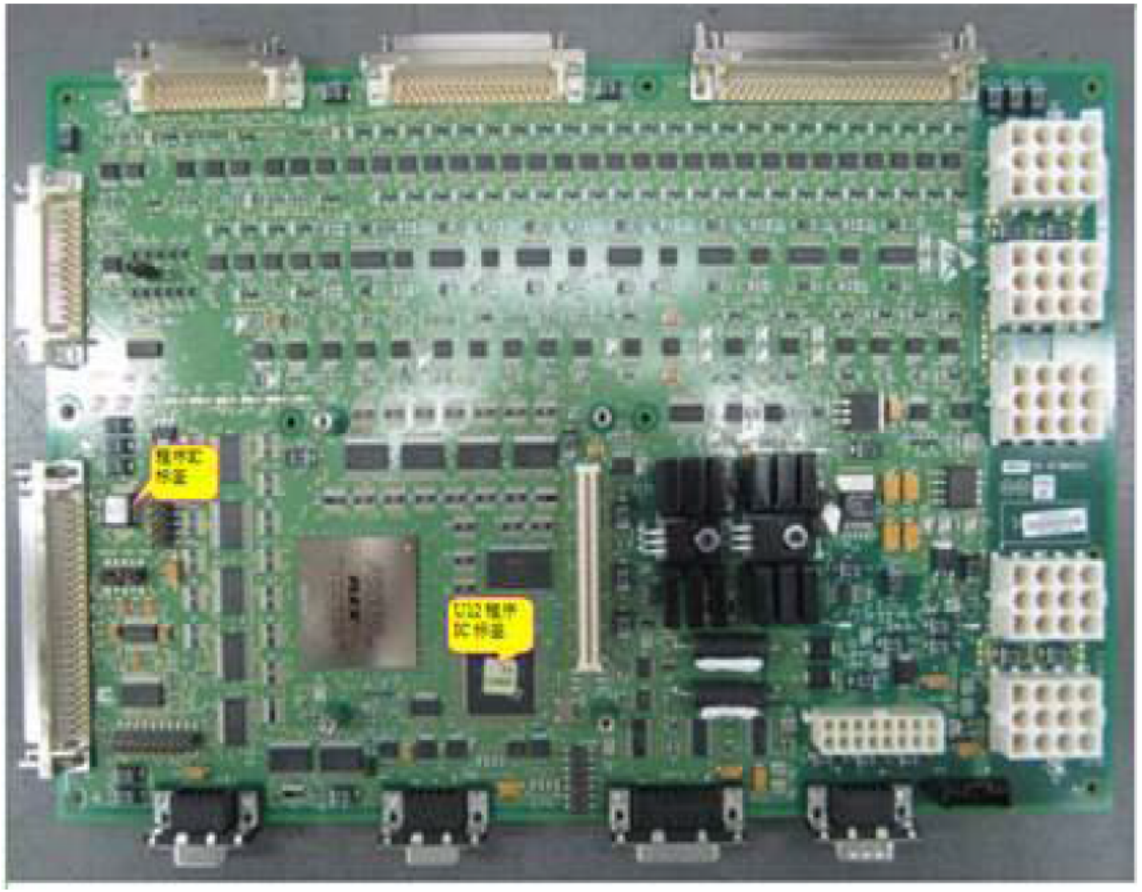
- A redesign framework



An Illustrative Example

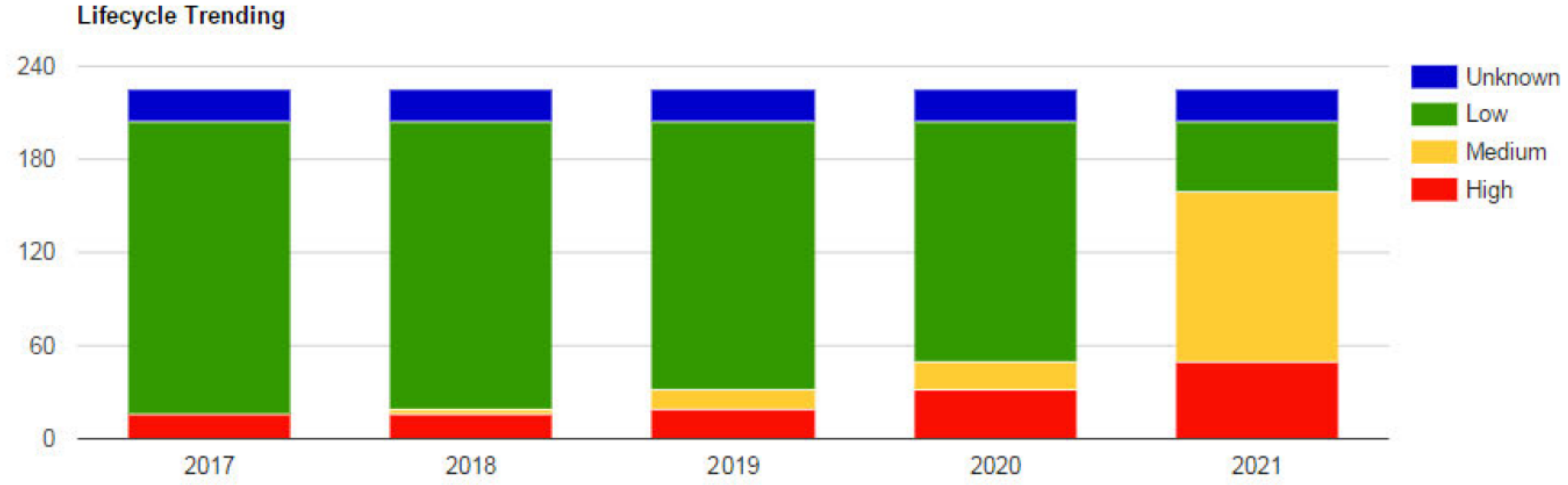
- Medical device PCBA
- 15 years in production
- >10 years remaining product life





BOM Analysis

Lifecycle Trending Report (CPN) | Add to My Briefcase | Download Lifecycle Trending Report (CPN)



8 EOL
5 LTB
3 NRND

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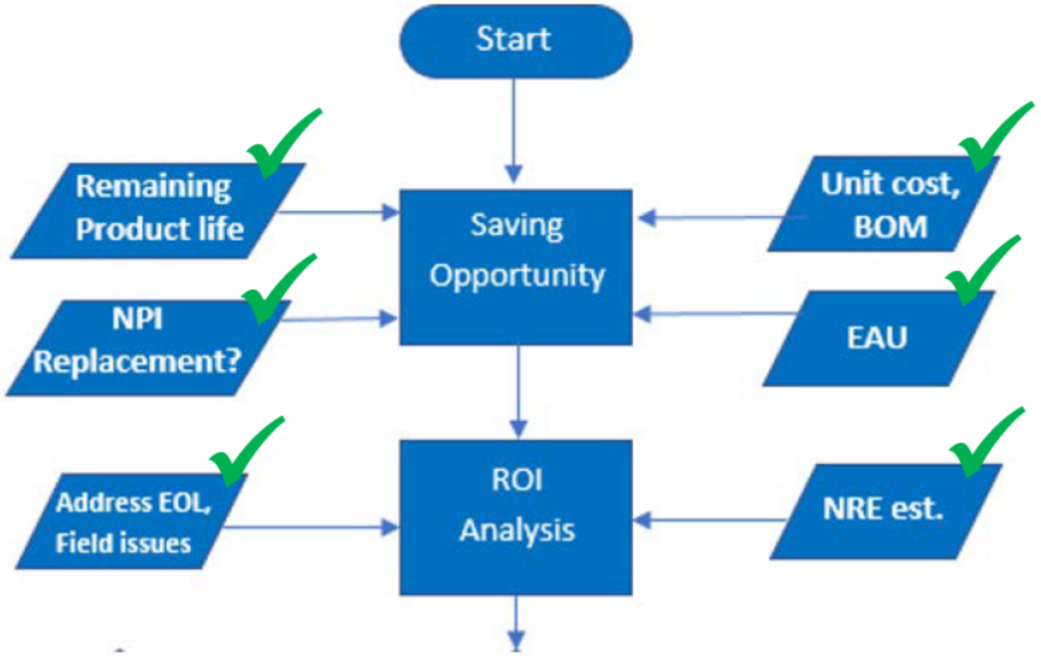
ROI Analysis

- Don’t forget to account for internal resources
  - *Design review, approval, qualification, etc.*



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Existing Unit Cost	$285.72	
New Design Unit Cost Saving	$111.15	
EAU	1800	
Annual Saving	$200K	
NRE	$150K	

Detailed ROI Calculator for Example Medical Product

- Account for manufacturing tooling, prototyping, warranty costs, saving from field failure reductions, etc.

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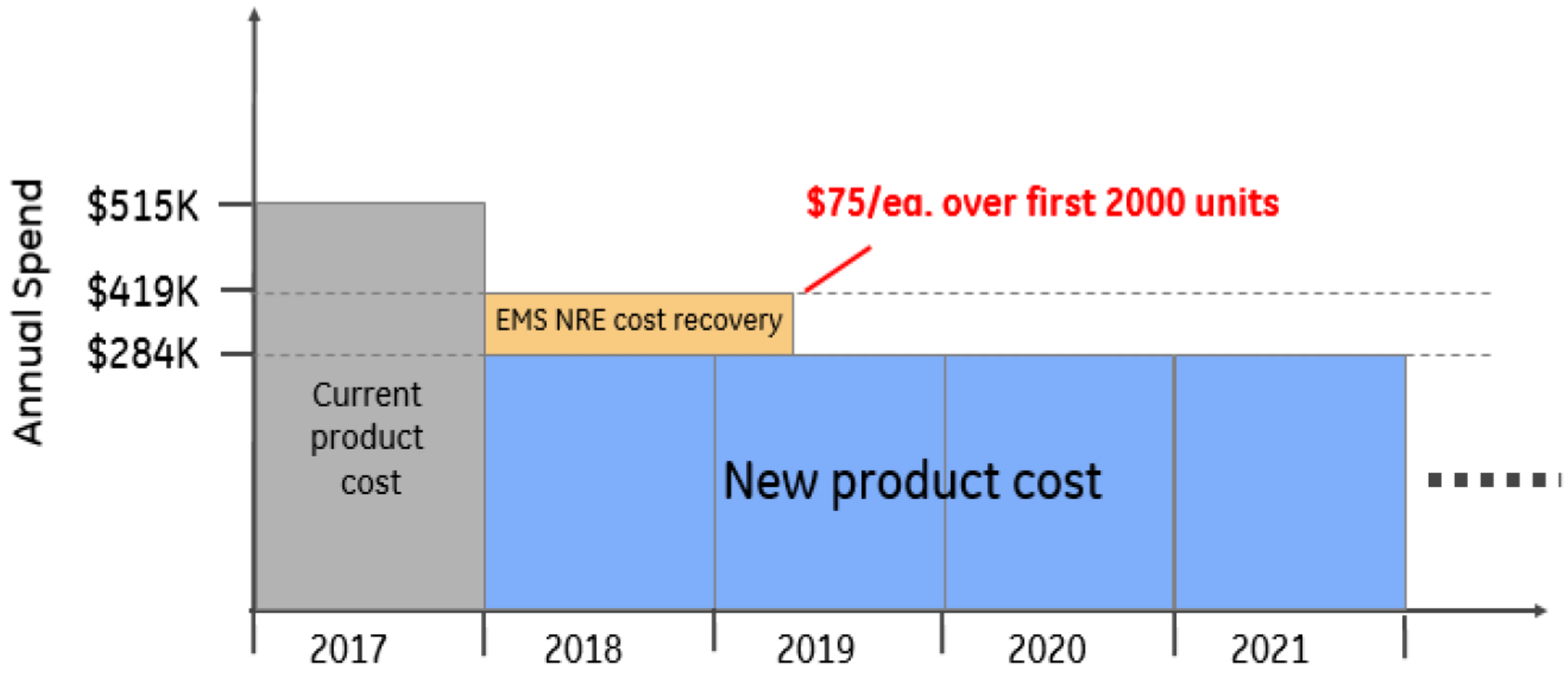
Re-design Services		
Compliance Certification	☐ TUV	$0
	☐ UL	$0
	☐ CE	$0
	☐ ISO	$0
	☐ Other 1	$0
	☐ Other 2	$0
	☐ Other 3	$0
Lab Services	☐ Reliability Analysis	$0
	☐ Failure Analysis	$0
	☐ Metrology	$0
	☐ Others	$0
Additional Services	☐ Others 1	$0
	☐ Others 2	$0
	☐ Others 3	$0
	☐ Others 4	$0
	☐ Others 5	$0
	☐ Others 6	$0
	☐ Others 7	$0
	☐ Others 8	$0

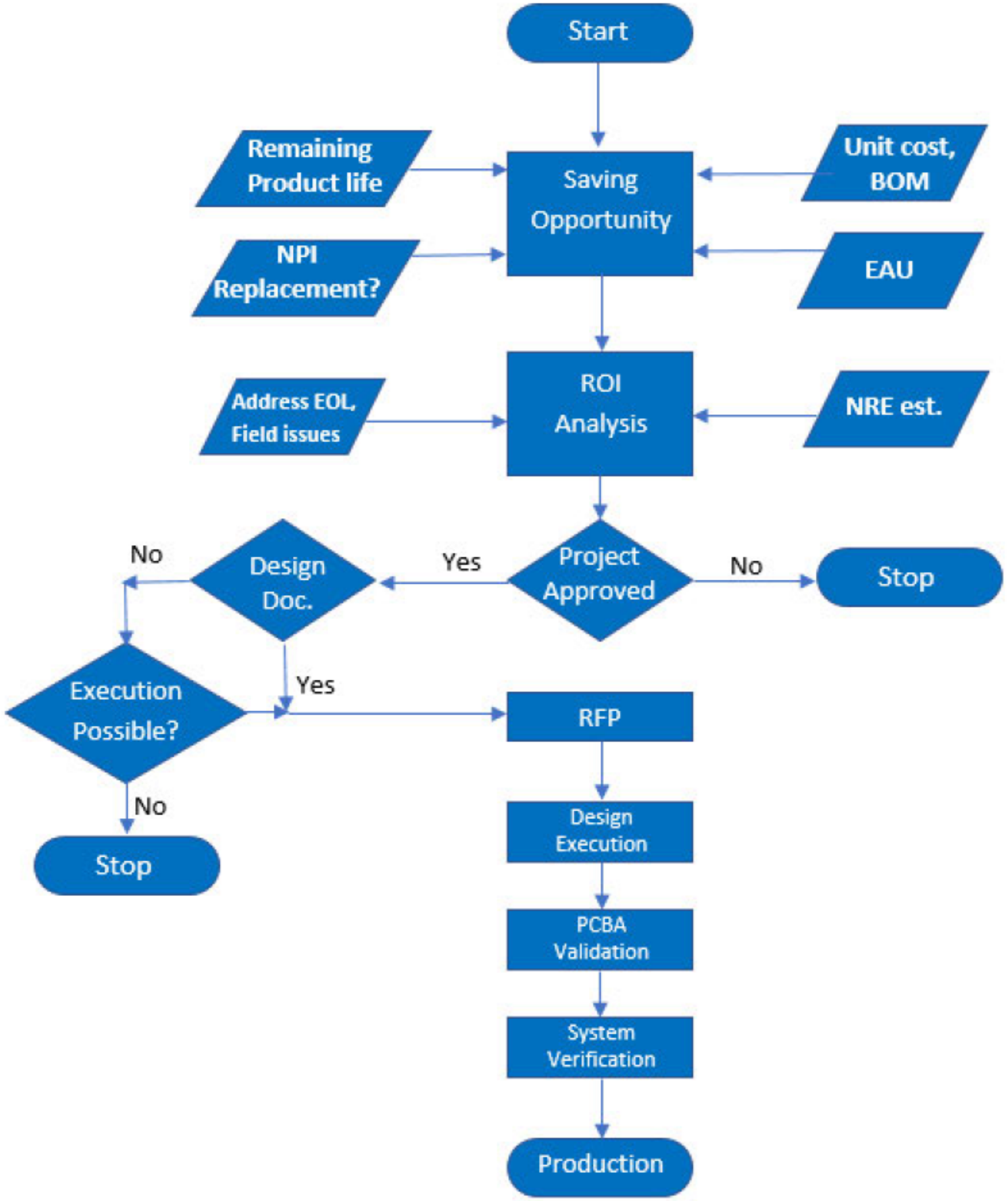
Saving Schedule

- NRE amortization
- Cost step-down schedule



Cautions for Project Execution

- Ensure documentation is complete
- Test and validation ownership and responsibilities
- Board-level validation – EMS
- System-level verification - OEM



Conclusions

- Redesign - a balance among development efforts, EOL mitigation, cost reduction
- A collaborative approach to overcome the common barriers
  - *Resources and funding constraints*
- OEM and EMS collaborate to execute the redesign in a win-win arrangement
- A process that allows rapid evaluation of the profitability and feasibility of a project
- ROI must be carefully evaluated using the process, ROI calculator
- Roles and responsibilities of the partners are defined
- Setting up a project properly can greatly enhance the chance of success

References

1. Report by IHS (http://www.electronics-sourcing.com/2017/06/09/buyers-options-component-obsolescence/)

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