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Critical end of life analysis: Managing the downside of the lifecycle

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Abstract: Planning for product lifecycles contains many unknowns and uncertain projections of future conditions. The further into the future that planning is projected, the more uncertain or subject to change are the factors that determine product life such as market conditions, product performance in the field, economic environment, dominant legislation, competition, etc.

Through a series of detailed interviews with product developers and analysis of real-world product lifecycles, a picture emerges of the degree of uncertainty around predicting product production life. Comparisons of planned versus actual product cycle (point of introduction, production/sales volumes, rise and decay rates, end of life), provides insights into the relative impact each stage has on return on investment and decisions concerning whether a product should be removed from the market.

A sensitivity analysis has been conducted to provide a view on the criticality of end of life decisions on overall product lifecycle success. Consideration is given to premature termination of life, decisions on life extension through modification, adaptation and upgrade, as well as the implications of unmanaged terminal decline.

The consequences on passive management of end of life are considered, with the broader consequences this may have on follow-on products, service support and resource utilization.

The findings indicate that end of life planning is generally poorly done and inadequately managed. This has a significant impact on product commercial success, potentially greater than introducing the wrong product to market or not achieving desired sales volumes.

Product Lifecycles

The product lifecycle is that period of time covered by the introduction or acquisition, use and eventual disposal of a product – analogous to the lifecycle of a biological entity (Day 1981). It is often taken to mean the lifecycle of an individual product, used by a consumer; the life of an individual assembly of components in a functional role (Businaro 1983).

This study considers the lifecycle of a 'species' of products, a product family from the development of the product and its introduction to the market, through its many related variants, upgrades and derivatives over time, to the point where the product range is removed from production.

The definition of a distinct product 'species' for this study relies on a natural relationship of physical geometry features and characteristics within a 'family' of product offerings.

Lifecycle Stages

The product lifecycle stages are indicated in figure 1. An initial investment is made in engineering and product development. This includes costs for tooling, production set-up, marketing launch, etc.

Once launched the product will generate revenue and is expected to breakeven and move into profitability within a time planned in the business case for the product.

Following a typical Bass market penetration curve (Bass 1969), product sales will eventually reach a turnover point, at which, due to the effects of competition, product aging and market saturation, sales will decline and the product will be removed from sale.

The product lifecycle curve has four distinct stages:

1. Development and introduction
2. Launch to breakeven
3. Profitable production life
4. Decline and termination

This final stage, when sales are stagnant and returns on investment are relatively poor, is referred to as end of life (EoL).

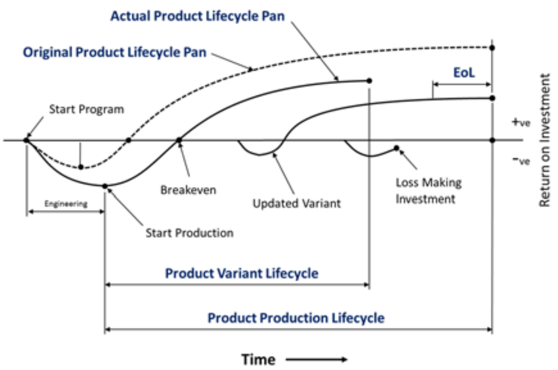

Figure 1. Lifecycle Revenue

The illustration of product lifecycle (Fig. 1) indicates a planned lifecycle for the product, used for business case justification and on known data at the time of planning. Actual lifecycles will be different as a result of market acceptance of the product, the quality of project execution and the responses of competitors, amongst a host of other factors (Klepper 1996).

An individual variant of the product can be mapped as a lifecycle, as well as the combined lifecycle of related variants, upgrades and derivatives that emerge over time – see Fig.1 above. This study considers the product production lifecycle to include all related variants of a product family up to the point of obsolescence i.e. the product family as an identifiable 'species' defined by its geometry, is no longer in production.

Methods

Information on a representative range of new internal combustion (IC) engines programs (NEP) was gathered through surveys and interviews of industry practitioners.

This data was analyzed to draw out representative heuristics for modelling the stages of product production lifecycle.

Surveys and Interviews

A survey of product developers in the IC engines industry was conducted to gain insights into experience with planning and executing full engine programs. Potential respondents to the survey (n=103) were identified from a database of professional engineers and other key stakeholders in new product development (NPD), built up from consulting contacts, industry network forums and prior work colleagues of the author. In all cases, the potential respondents were known NPD professionals in industry with >5 years' experience in the IC engines industry. Response rate to the survey was high at 53%.

A selection of survey respondents (n=19) with the most relevant experience of new engines programs, were selected for follow up interviews. Interviewees were from a number of sub-disciplines: Designers (n=9), project managers (n=6) and marketing professionals (n=4).

Interviewees were globally dispersed, located in Asia (n=3), Europe (n=7) and the Americas (n=9).

Both engineering consulting companies (n=10) and engine manufacturers (n=9) were represented in the interviewee group.

The combined relevant new engine program experiences of the engines NPD professional consisted of 84 projects covering a period of nearly 30 years, the majority completed in the last 15 years.

Average experience of the interview cohort was 16.1 years (SD=6.03, Max. 30, Min 6).

No significant difference was noted in responses based on location, role or type of business.

Interviews were conducted to gather data on new engine programs (NEP) experiences of the interviewees. The definition of a NEP for the purposes of this study was taken as an engine design project that was substantively 'new' from previous products in the company portfolio, with major changes to geometry and layout e.g. different engine bore/stroke, displacement, number of cylinders, etc. NEP engines were not derivatives or variants of existing engines, but a new 'family' of engine for the business, with substantially different geometry to the product they replaced.

To be included, any NEP example had to be personally experienced by the interviewee or one that they had intimate knowledge of, so that the details of product planning and delivery were internally validated and realistic.

Lifecycle Modelling

Based on the responses from the NPD professional interviews, a series of modelling heuristics were developed to allow a sensitivity study of the potential impact of each stage of the NEP lifecycle to be generated. These heuristics were used to consider the role of end of life (EoL) in overall product return on investment (RoI).

Results

The results of the study were compared to published secondary data to establish comparative benchmarks that might be used for future program planning activity.

Planned vs Actual Product Lifecycles

The results of the combined projects considered in the study show a significant deviation from planned product production lifecycle (average 10.6 years) compared to actual time to replacement or end of life (average 5.5 years).

Table 1 shows the data from the survey, including the ranges of responses and the delta (Δ) or deviation of actual from planned.

(years)	Planned	Actual	Δ	Δ%
Max	15	12	2	20%
Min	6	2	-11	-83%
Average	10.6	5.5	-5.2	-46%
SD	2.16	2.04	3.02	23.89%

Table 1. Study Product Lifecycle Duration.

These results compare to data obtained from secondary published sources for a range of engines product production lifecycles (Table 2). Secondary data sources used to compile these industry benchmarks are from Autodata (2013), Sankaido (1999) and Wards/Mahle (2014).

(years)	Industrial	Automotive	Motorcycle	Utility
Max	40	35	18	24
Min	5	2	1	3
Average	16.12	8.32	5.38	12.34
SD	2.9	3.04	2.87	3.02
n	132	537	234	118

Table 2. Engines Industry Product Lifecycle Durations.

The new engines programs used for Table 1 were primarily a combination of automotive and motorcycle programs. In comparison to published data in Table 2, the results are closest to motorcycle and high performance applications, which may partially be the result of the types on products considered.

The data used to generate industry lifecycles in Table 2 is drawn from a wide variety of sources responding to generic surveys. Errors in interpretation and anomalies when compared to known engines product lifecycles with the industry published data, suggest that the study survey data in Table 1 has a higher degree of internal consistency and validity, albeit taken from a smaller sample size.

Utilizing a single secondary source (Autodata 2013) to ensure better internal consistency, Figure 2 shows the product lifecycle for motorcycle models in Europe from 1987 through to 2013. These results indicate the span of individual motorcycle models utilizing a unique engine configuration. The data used are for products in the marketplace where the product has both an introduction date and market exit date for all examples i.e. no longer in production.

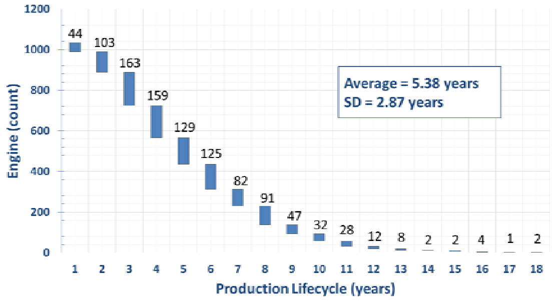

Figure 2. Motorcycle Product Lifecycle Duration.

The size of the bars for each year indicate the number of motorcycles that had a completed lifecycle within the period indicated e.g. 44 motorcycles had a complete production cycle of only one year from introduction to termination of production. The position of the bar indicates the total number of motorcycles in production with at least one year of production e.g. 1034 motorcycle models had *at least* one year of production, of which 44 had *only* one year of production.

A family of engines may be used on more than one model, extending the lifecycle of the engine beyond that of the vehicle model. This explains why the Autodata lifecycles appear to be shorter than the study results.

Figure 3 shows the motorcycle model lifespan including products that have exited the marketplace as well as current production offerings (Autodata 2013).

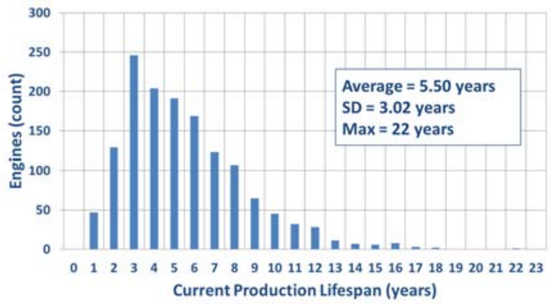

Figure 2. Motorcycle Current Product Lifecycle Duration.

Cost Impact Analysis

Data on the investment costs for typical IC engines programs was obtained from secondary sources (MIRA 1997) and validated against known project performance information from study interviewees.

Benchmark data on the investment costs of sample engines project (n=9) across a range of automotive engines programs (MIRA, 1997), indicates an average cost of launch at $557m (SD=$428). Average return on investment for automotive programs is 8% (SD=4%).

Table 3 shows the impact of project overruns to cost and time for the study projects (n=84), together with impacts on time to breakeven and end of life.

	Investment Cost Overrun	Launch Time Overrun	Ramp Up Rate	Ramp Down Rate
Max	65%	50%	18%	24%
Min	-8%	0%	-20%	-58%
Average	16.7%	7.9%	1%	-15%
SD	11.70%	11.76%	5.89%	12.33%

Table 3. Motorcycle Current Product Lifecycle Duration.

It can be seen from Table 1 that there are significant deviations of planned product production life before major changes to geometry compared to actual lifecycles, with an average 46% reduction over expected time to replacement. This is a reflection of the need to respond to unanticipated legislative change, such as more stringent emissions standards, as well as reflecting higher demands from the marketplace for improved products (Daniels 1997).

Interviewees consistently expressed the view that initial planning contained significant uncertainties and that this resulted in an over confidence in the product solution having a long production life. In order to get business case approval for the high capital expenditures required, there has been a tendency to downplay the need for regular refresh of the product and to be somewhat optimistic about both sales volumes and life of the product in the marketplace.

Relatively little time is spent in quantifying end of life (EoL) of the product, as information on this end of the lifecycle is speculative and uncertain. The emphasis is on initial launch success and immediate market acceptance.

Applying the reduced product return on investment due to premature end of life, indicates a significant potential net negative impact when compared to the effects of delayed launch, reduced ramp up rate or extended time to market. This is as a result of a greater emphasis on front-end planning of projects and the greater degree of certainty of events proximate to launch.

End of life is a generally a poorly managed stage in the product lifecycle, with all interview respondents indicating a reactive culture that is generally slow to respond to changes.

A poorly managed end of life phase has the potential to eliminate the lifecycle profits of the product.

Planning of initial launch was estimated to consume the vast majority of time in planning lifecycles for new products, with end of life only being given cursory consideration by contrast.

Conclusions

The current study provides some useful benchmarks for IC engine lifecycle performance. These can be used to present a more realistic picture of the need for regular product replacement to deal with unknown, but expected changes to engine architecture. A more detailed planning activity around all phases of product lifecycle would allow better returns on investment and utilization of resources.

Product architectural geometry changes under uncertainty can be provided for by planning shorter product lifecycles, allowing for better planning of obsolescence or replacement; or by configuring capacity for likely, but ill-defined changes in product architecture at a future date. Such a strategy would allow quicker times to market for appropriate variants, extending the useful life of the product in the market and reducing waste.

Premature exit from the market, due to mis-calculated EoL results in wasted investment and negative impacts on service support provision beyond EoL.

Further work to extend the application of heuristic models to different IC engine industry applications and ultimately to other products is being currently being investigated.

A limitation of the approach is that it is most suited to products that have a combination of long production lives (>10 years), requiring high investment costs and relatively low rates of return (<10%). These types of product lifecycle are most susceptible to dynamic market conditions, competitive pressures, legislative changes and other factors that create uncertainty on product planning over an extended lifecycle period.

Products that allow a fast return on investment, have stable, known market expectations and relatively short, planned lifecycles, can achieve suitable returns on investment in expected timeframes.

This means that the proposed technique is best suited to capital intensive products with long lifespan, such as high value/volume manufacturing, infrastructure products, building and civil engineering projects, etc.

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