

Introduction of a newly available 3D printing technology workflow system; The tangible and intangible benefits, and evaluation of justifications using appropriate financial appraisal tools

Inhouse manufacturing versus outsourcing

A financial appraisal of a capital expenditure project

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The project

The business plans to invest in some additional 3D prototyping and small-scale manufacturing of key components of an NPD. To enable the additional capability, a selective laser sintering (SLS) workflow system has been selected. The technology has recently become arguably affordable for SMEs when the Fuse1+ SLS was launched by FormLabs Inc.

The workflow package comprises a powder laser sintering unit and a post processing station. The build volume and parts are managed within the postprocessing station in a time efficient, safe manner and provide the additional benefit of high unused powder recovery to be reused within the SLS unit. A nitrogen generator is also desirable to provision processing of powders with fibre additives, facilitating part builds with required flexural and tensile strength characteristics. A further benefit of building in a nitrogen environment is the recovery of used powder is increase, enabling potential zero waste production.

The benefits

Prototyping in the NPD phase will continue for at least 12 months following the commencement of the project. There is expected to be a significant number of small and medium sized parts requiring numerous iterations to arrive at a final design.

Lead time

Installation on site of an effective SLS system will allow iterations to be evaluated, finessed, and committed back for build within a 24-hour window. The short development iteration timeframe is significant in achieving a final design within the Industrial Research phase (fully working prototype objectives).

In contrast, commissioning required parts for manufacture at a 3D bureau normally involves 5-7 working days lead time.

Intellectual property and knowhow

Several elements of the new product are innovative and the subject of progressing patent applications. Inhouse manufacture is preferred as a means of preserving knowhow.

Capital budgeting

The focus of the report is the financial appraisal of the SLS installation and how the new capability would be justified on accepted appraisal benchmarks. As the product is in development (and not generating profit), in contrast exemplar costs for like part manufacture at commercial bureau rates will be presented.

The project was appraised, and the outcomes discussed by the following techniques

1. Simple Payback period
2. Discounted payback
3. Net Present Value (NPV)
4. Accounting Rate of Return (ARR)
5. Internal Rate of Return (IRR)
6. Profitability Index (PI)

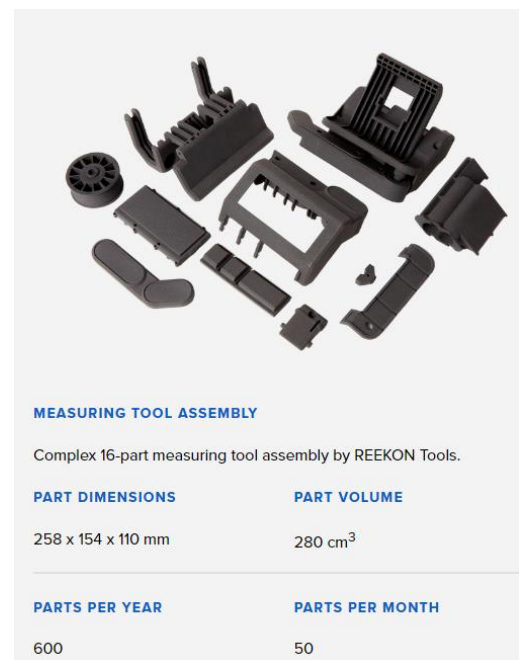
As a basis for the project costs and revenue, we will consider the difference between a sample set of parts manufactured by a contracting 3D bureau, and the operational cost of producing a like set of parts by inhouse manufacture. The project proposes installation of a FormLabs SLS workflow system. The operational savings will increase net revenue against the alternative of using a contracting manufacturing bureau.

The SLS workflow costs are as follows

Fuse1+ 30w High Efficiency Package	£46,393
Delivery	£500
Nitrogen Generator (Delivery inc.)	£1500
One day install labour	£200
Necessary infrastructure (none required)	£0
Total Ex VAT	£48593

Assumptions

- SLS workflow solution has a 5-year working life with a zero residual value
- Example part assembly for manufacture is a complex 16-part assembly shown in Fig. 1
- At maximum throughput the SLS workflow solution can produce 600 part sets per annum.
- Year 1 requirement for prototyping is 30 part sets
- Year 2 to year 5 annual requirements for small scale production is 325 part sets
- Contract bureau cost per part set is £168



Simple Payback period

The criteria threshold for the business is payback in less than 30 months. The project Payback is 23.8 months and passes the first basic assessment.

Discounted payback

Discounted payback is slightly longer and represents a more realistic projection, however, still passes the 30-month threshold at 26.6 months.

Discounted Net Present Value (NPV)

The sum of all future discounted cashflow over the life of the capital asset (SLS) is a very attractive £85,012.27, and beyond being just positive, is significantly favourable for project acceptance.

NPV is widely used because it considers the time value of money, it could be earning if applied elsewhere, it solely focusses on the cashflow forecasted and the opportunity cost of capital and finally present values are in today's pounds and have the property of additivity (Brealey et al., 2014)

Accounting Rate of Return (ARR)

The profit expected from the investment or the return on capital stands at 55.9%. A positive indicator for project acceptance.

ARR is generally used to compare project returns in Project Portfolio Management (PPM). ARR has a limitation is that it fails to differentiate between investments that have differing return profiles over the life of the project (MURPHY, 2022). ARR fails to take account of the time value of money and is therefore not one of the discounting appraisal tools.

Internal Rate of Return (IRR)

An IRR of 52.5 % indicates significant headroom to accommodate an adverse change in risk, such as shrinkage in sales, increase in raw material costs or increases in energy costs.

IRR makes a comparison of different projects in PPM easier. Within the project, the IRR rate brings the future cashflows to zero, and as such makes comparisons with WACC or cost of capital as a base hurdle rate simple (CFI, 2022). The higher the positive difference of IRR minus WACC is, the more attractive the investment is, providing the discounted NPV also meets threshold tests in consideration of the investment value.

Profitability Index (PI)

The project PI is more than one at a figure of 2.75 so for every £1 invested, £1.75 in revenue is generated. The project should be accepted.

PI is also known as the profit investment ratio and allows decision makers to rapidly assess if a project will return a profit or not (Dheeraj Vaidya, 2018), the PI in this report uses the discounted future cashflow as the basis for its calculation and is therefore more realistic than a simple PI evaluation.

Benefit-Cost Ratio

As the BCR >1 and the IRR is greater than the discount rate, the project will generate incremental value, Should the BCR have been equal to one, the project would neither create or diminish project value. BCR<1 and IRR is less than the discount rate, the project destroys future value. BCR is extremely sensitive to cashflow forecasts and discount rates, so care must be exercised to ensure assumptions are not biased (CFI, 2022).

Conclusions

Project Appraisal Matrix

Appraisal Tools		pass/fail ?
Simple Payback	1 yr 11.9mth	pass
Discounted Payback	2 yr 2.8mth	pass
Discounted NPV	£ 84,605.27	pass
ARR	55.25%	pass
IRR	52.06%	pass
BCR	1.73	pass
PI (profitability index)	2.73	pass

Following consideration of costs, benefits and risks, the appraisal tools used for the financial basis of acceptable return on investment are conclusively in favour of progressing the project as outlined.

Apart from the tangible financial justifications, below the line intangible benefits include

- Rapid evaluation of prototype iterations through reduced iteration cycle periods
- On demand small scale manufacturing, agile response to demand
- Zero investment in hard tooling
 - Agile response to part design changes to enhance or correct part performance in small scale manufacturing
- Reduction of manufacturing 'miles'
 - Limited drops of bulk raw materials as opposed to multiple single part deliveries
- Near zero inventory requirement
 - Zero waste in deprecated parts held in stock, Just in Time (JIT) manufacturing
- Near zero raw material waste
 - High rate of unused powder recovery for reuse in manufacture
- Preservation of knowhow and intellectual property

Appendices

Project Fuse SLS		Year				
		Investment	1	2	3	4
Present Value	(49,000)	£4,159	£45,052	£45,052	£45,052	£45,052

Simple_Payback	1 yr 11.9mth	IRR	52.06%
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Discount Rate (WACC)	10.00%
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Denominator	1.00	0.909	0.826	0.751	0.683	0.621
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Discounted project revenue	(49,000)	3,780	37,213	33,834	30,770	27,977
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Discounted Payback	2 yr 2.8mth
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NPV	84,574
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84,605

PI (profitability index)	2.73
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Discounted NPV	84,605.27
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BCR	1.73
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ARR	55.25%
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Main Appraisal tool excel SS

[Financial SS appraisal.xlsx](#)

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Project appraisal matrix

[appraisal matrix.xlsx](#)

Costs per part breakdown		Contract Bureau	Inhouse production	Inhouse production
			Year 1	Year 2-5
Variable costs		£168	£26.38	£26.38
Labour costs		0	£3.00	£3.00
Cost per part		£168	£29.38	£29.38
	Prototype/product volumes	Contract Bureau	Year 1	Year 2-5
Year 1 Volumes_ Costs	30	£5,040	£881.40	
Year 2-5 Volumes_ Costs	325	£54,600		£9,548.50
outsourcing-inhouse production cost difference			£4,158.60	£45,051.50

Comparative costs inhouse versus bureau

[in_outsource_difference.xlsx](#)

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