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Effective R&D Portfolio Management:

Maximizing Return on R&D Spend by Picking the Right Projects

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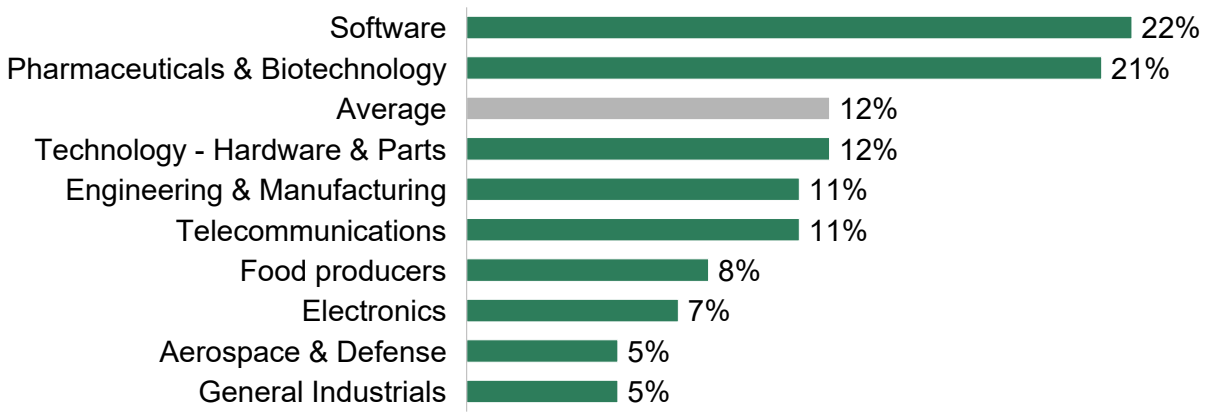
1. Introduction

R&D projects drive the future product strategy of a company. In mature businesses, effective R&D management is complex and requires significant prioritization efforts to maximize the expected return-on-investment. Central to successful R&D is spend management, enabling the distribution of scarce resources to a wide array of projects addressing multiple business opportunities. To achieve this, R&D management benefits from companies taking a portfolio approach and applying methods to evaluate the contribution of R&D projects to corporate strategy, financial results, and efficient use of resources. Time-sensitivity here is key, since being late to market means lost revenues and a reduced ability to achieve a price premium. For example, in the electronics industry, a late product introduction (9-12 months beyond target) has been estimated to cost up to 50% of a product's anticipated revenues[1].

This Value Paper describes and assesses various portfolio management methods for their strengths and weaknesses with an emphasis on how they can be combined for optimal portfolio management. Successfully adopting a comprehensive portfolio management strategy can enhance a company's ability to pick winning projects, be first to market, and achieve price premiums - in brief, to achieve business success.

Global R&D spending is at an all-time high. In 2021, the top companies in the world by R&D spend (S&P CapIQ) invested approximately $637 billion in R&D activities[2]. As shown in Figure 1, R&D intensity – the share of sales that a company spends on R&D – varies greatly depending on nature of the industry and the industry lifecycle. Investment was especially concentrated in companies within the pharmaceutical, technology (hardware, electronics, equipment, and software), and automotive industries (collectively, 85% of total investment), which have all experienced fierce competition in the development of next-gen technology including COVID-19 vaccines/boosters, VR/AR software & devices, and electric vehicles. Despite this concentration, R&D intensity across all industries has steadily increased over the past three years, indicative of large-scale change, primarily driven by advancements in science and technology and the macro-focus on the digital economy. Whatever your industry, effective R&D spending is likely critical to your business's long-term success.

Figure 1 - R&D intensity by industry for global top 350 companies 2021 (Source: S&P CapIQ)



2. The Purpose of Portfolio Management

As outlined in the previous section, R&D Portfolio Management fulfills multiple objectives. Since R&D projects involve cross-functional collaboration, internal stakeholders often have varying and competing measures of success. However, at the enterprise level, the goals of portfolio management are to:

- execute the business strategy
- maximize financial value creation
- manage risk and timing

[1] Source: SDC Exec, Georgia Institute of Technology, Production and Operations Management.
[2] Sources: S&P CapIQ, Applied Value Analysis.

To execute, resource allocation must be considered a critical driver of the portfolio management function. In essence, it dictates the prioritization of projects and the long-term business strategy.

This translates into prioritizing the right projects and establishing a balance of R&D efforts between regions, segments, markets, technology development, and time frame. Project prioritization involves selecting projects that support the business strategy and generate the most financial value, while also balancing risks. Poor prioritization due to reluctance to kill projects, weak decision points, and non-strategic selection criteria can have downstream impacts that affect long-term success including having too many projects, poor financial performance, and non-strategically-aligned projects.

3. Portfolio Management Methods

R&D portfolio management methods can be classified into four categories:

- **Business strategy method:** Alignment of resources to business / corporate strategy
- **Scoring method:** Weighted qualitative scoring across several company-specific vectors
- **Financial method:** Analysis and prioritization of projects with the highest expected ROI
- **Charts method:** Preliminary visual representation of projects across key metrics

The various methods are not mutually exclusive. In fact, Applied Value recommends and will further detail that optimal portfolio management relies on combining multiple methods. In practice, the methods are also complemented by other soft factors that influence decisions. These soft factors can range from key decision-makers' experiences, to perceived customer/market needs, or requirements for unique technical competence. Determining the right combination of methods and tailored decision criteria are key first steps for companies looking to implement effective R&D portfolio management.

3.1. Business Strategy Method

The objective of the business strategy method is to allocate resources to align them with a company's business strategy. Figure 2 illustrates how the business strategy method could work in practice for a Paper & Pulp manufacturer. There are not enough resources available to support projects C and S, so they must be placed on hold or killed. Conversely, there are more available resources than projects allocated to the forest segment, so either resources should be redistributed, or projects should be added. Projects may be added by starting new research internally or through acquisition.

Figure 2 - Illustration of the business strategy method

BU	Segment	Project List
Hygiene	Consumer	Project A – Continue project
		Project B – Continue project
		Project C – Kill project
	Industrial	Project D – Continue project
		Project E – Continue project
		Project F – Continue project
Forest	Wood	Project G – Continue project
		Project H – Continue project
		_____ – Add project
Packaging	Cardboard	Project O – Continue project
		Project P – Continue project
	Wood	Project Q – Continue project
		Project R – Continue project
		Project S – Kill project

While in this example, projects are segmented by business unit and market segment, a company's R&D portfolio should segment by the most useful grouping categories. Other common project grouping include strategic goals, markets, geography, project types, technology areas/platforms, area of strategic thrust, competitive need, technology maturity and development type (maintenance, exploratory, systems, frontier research, line extension, etc.).

3.2. Scoring Method

The scoring method evaluates projects based on a weighted qualitative scoring of criteria, usually on a scale from 1–10, and yields a single score to be used in prioritization decisions. Although a variety of criteria can be used, Applied Value recommends scoring risk-adjusted financial impact, strategic importance, competitive advantage, and time-to-money (Figure 3). Further, we recommend a customized approach to criteria weighting that best reflect the company's long-term strategy and objectives. Figure 4 shows a sample project portfolio scoring across the recommended criteria.

Figure 3 – Recommended Scoring Criteria

Figure 4 - Project scoring according to four criteria with the same weight

Project Name	Weighted Score	Financial Impact	Strategic Importance	Competitive Advantage	Time-to-Money
Weight	**100%**	25%[1]	25%[1]	25%[1]	25%[1]
Project A	**10**	10	10	10	10
Project B	**9**	9	10	9	8
Project C	**8**	8	9	7	8
Project D	**7**	7	8	6	7
Project E	**5.75**	6	5	6	6

Both evaluated criteria and criteria weightings may change over time, which makes the scoring method adaptable to the company's specific situation and evolving needs. However, management should be wary of the risk of overconfidence in making decisions based on scoring method models; they can provide a sense of mathematical precision that may overstate realistic certainty.

3.3. Financial Method

Financial methods are based on a variety of profitability and return measures that are used to prioritize projects. Commonly used metrics include Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, Expected Commercial Value (ECV), and Productivity Index (PI).

Portfolio projects are initially ranked by their calculated financial value. Resources are then distributed down the rankings until they run out. Projects without allocated resources are placed on hold or eliminated. Figure 5 shows an example of a resource constrained project prioritization. Assuming there are 25 resources available, project A, B, and C would be pursued with a target NPV of 109 MUSD.

[1] Illustrative example shows equal weighting across the criteria, though AV recommends customized weighting to fit business strategy.

Figure 5 - Prioritization according to NPV and resource constraint

	Project Name	NPV (MUSD)	Remaining Resource Requirement (FTE)	Accumulated Resource Requirement (FTE)
NPV 109 MUSD	Project A	50	15	15
	Project B	32	3	18
	Project C	27	7	25
	Project D	34	6	31
	Project E	17	4	35
	Project F	15	2	37
	Project G	12	2	39
	Project H	10	1	43

Robust use of the financial method goes beyond this initial review. Further analysis shows that although project A has the largest NPV, it requires 15 FTE – by far more than any other project. By using an "NPV per Resource" approach, this dimension can also be built into the portfolio valuation. The way to do this is to simply divide the NPV by the constraining resource, i.e., the remaining resource requirement. This is to say, NPV per Resource = NPV / Total Remaining Resources.

When sorting the list again, using the "NPV per Resource", the project prioritization changes. Now only project J, A and I are put on hold or eliminated, and the total value of the selected portfolio is now estimated to 137 MUSD (Figure 6).

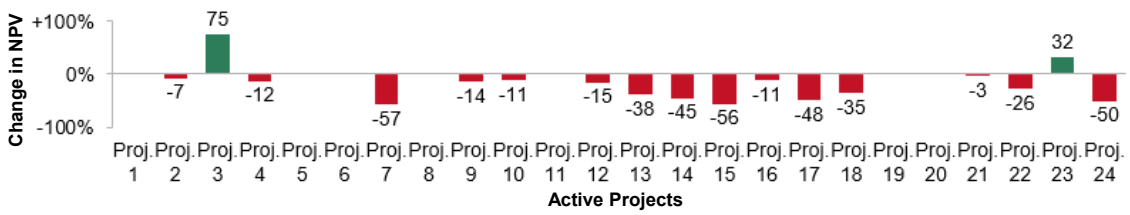
Figure 6 - Prioritization according to NPV per Resource and resource constraint

	Project Name	NPV (MUSD)	NPV per Resource (NPV / FTE)	Remaining Resource Requirement (FTE)
NPV 137 MUSD	Project B	32	10.7	3
	Project H	10	10.0	1
	Project F	15	7.5	2
	Project G	12	6.0	2
	Project E	17	4.3	4
	Project D	24	4.0	6
	Project C	27	3.9	7
	Project A	50	3.3	15

The "NPV per Resource"-based prioritization creates a better balance between small and large projects; by doing so in this case, it increases expected economic benefit by 28 MUSD. The "NPV per Resource" method also promotes finalization of started projects as the remaining resource requirements will decrease as the projects advance in the development process.

The financial method is simple and straightforward, and its strength lies in the fact that it maximizes the portfolio's expected financial value. However, the financial method is dependent on estimated financial data and is often heavily assumption driven. Valuing new products categories – often key in R&D – can also be difficult without historical demand guidance. As seen in Figure 7 from an AV analysis for a consumer electronics company, NPVs can change drastically throughout the lifecycle of the project, which can pose difficulties in resource allocation.

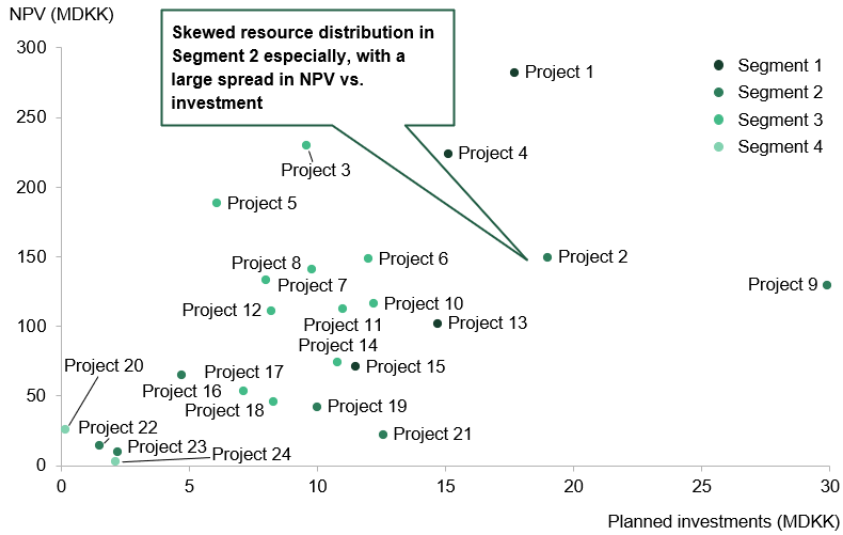
Figure 7 - % Change in NPV Estimate vs. Initial Projections



3.4. Chart Method

Companies' R&D portfolios are often unbalanced. Portfolios are typically overweighted on short-term projects and lack visionary long-term projects. Plotting different charts is the most popular way to visualize the portfolio and provide a good basis to begin management discussions regarding portfolio balance and specifics on individual projects. After plotting projects like in Figure 8, across different charts, gaps or concentration in certain types of projects (e.g., short-term vs. long-term) are readily apparent, helping to inform changes to project prioritization based on these factors.

Figure 8 – Existing R&D Projects at a Consumer Electronics Company



While the charts method provides a good basis for internal discussion, portfolio balance analysis, and outlier identification, it does not provide a clear decision path. Applied Value recommends leveraging visualizations to begin the discussion while incorporating other methods for prioritization efforts.

3.5. Summary of strengths and weaknesses of each method

The purposes of portfolio management are to execute the business strategy, maximize financial value creation, and manage risk and timing. Tactically, this translates to effective project prioritization while ensuring balance of R&D efforts across regions, segments, markets and timeframe. The pros and cons of the various methods are summarized in Figure 9 below.

Figure 9 - Strengths and weaknesses of different portfolio management methods

Method	Strengths	Weaknesses
Strategic	› Creates a clear link between the business strategy and R&D resources › Promotes balance of efforts	› Rough prioritization between individual projects
Financial	› Focuses on the financial value of the portfolio and thus shareholder value › Possibility to take resource constraints into account by using NPV per resource method	› Financial value is difficult to estimate, especially at the beginning of a project
Scoring	› Yields a single score which can be used for decisions › Multiple goals are captured › Efficient usage, based on a limited number of questions	› Lost transparency of individual evaluation parameters which are blended into an average › Risk of overconfidence in model's effectiveness
Charts	› Provides an overview of the portfolio balance › Creates good input for discussions	› Provides no clear decision

4. Best Practice Portfolio Management

4.1 Combining Portfolio Management Methods

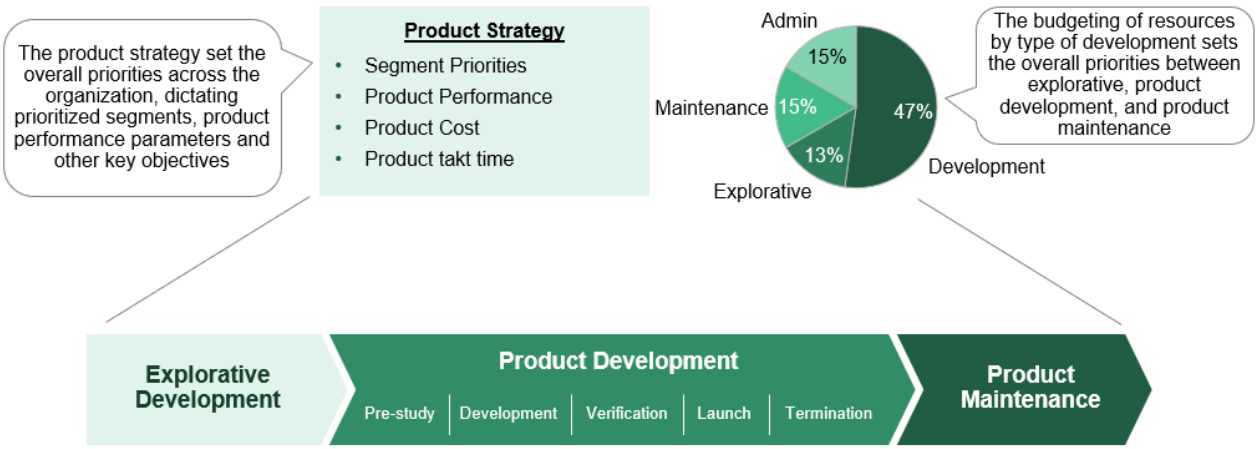
All the described portfolio management methods have specific advantages, and top performing companies benefit from using more than one method to prioritize their R&D project portfolio. In fact, it is our recommendation to use all the methods to fulfill the multiple purposes of portfolio management, such as ensuring strategy alignment, maximizing financial value, and achieving a balanced portfolio.

This serves to take advantage of each method's strengths, balance their weaknesses, and integrate resource allocation into decisions, thereby enabling efficient project execution. We'll now walk through what this best practice method looks like in practice.

4.2. Strategy Alignment

As a first step in the best practice method, the R&D budget is divided between business areas. By taking the corporate strategy into account, the company ensures that it invests R&D resources proportional to the need to grow and defend its business units and take strategic investment risks.

Figure 10 - Business unit budgeting of R&D resources



4.3 Prioritization

Prioritization takes place at multiple development process levels and stages. Effective prioritization follows a three-step approach: first sizing the opportunity, then seizing it, and finally sustaining the project for the long term. Opportunity sizing involves assessing current performance for its drivers and evaluating options for performance improvement. To preemptively manage resistance to change, Applied Value recommends sending clear communication of the company's prioritization framework to all affected personnel and ensuring consensus amongst senior leaders. The following phase, opportunity seizing sees the mobilization around key projects and initiatives. This process involves the organization picking the most critical projects to accelerate, while putting less impactful projects on hold. Finally, sustaining the opportunity means to embed capabilities for change and continuous process improvement within the organization.

4.4 Balancing

Balancing is performed with two different objectives in mind and is done by using the chart method. The first is to secure balance in the portfolio; the second is to identify projects that do not fit (although they were scored high).

Balance can be reviewed by comparing the share of R&D resources spent on different market regions, segments, and product lines with the associated share of sales. The company should consider reprioritization of projects if the overall resource spend does not fit the business strategy.

For example, if the strategy is to grow in the Eastern Europe region, the company should overweight the share of R&D resources in projects targeting that region. Overweight investment of R&D resources in projects in Eastern Europe also implies that the share of R&D resources will be less in other regions and sometimes lag the share of sales from those regions. However, this may be desirable as the company must make trade-offs between where to invest and where to defend its position in its R&D efforts, thus causing some highly scored projects in other regions to be excluded.

4.5 Resource allocation

The final step of the portfolio management process is to allocate resources. This is often a strenuous process, dependent on high quality planning, time-reporting, and tracking of time consumption. Further, a large degree of uncertainty in the development process impacts precision. Nevertheless, it is a critical final step in order to achieve efficient and effective R&D project and portfolio management.

The solution to design a simple yet effective resource plan is first to make a high-level check that the number of project resources required per department do not exceed the number of existing resources within that department. Then, starting from the top of the project prioritization list, classify the projects that together require 80 percent of R&D resources as A-projects and the rest as B-projects. Later, this classification will be used to signal to engineers that B-projects are projects that they are allowed to postpone when resource constraints arise in day-to-day work, thus overcoming precision constraints.

4.6. Case Study: Electronics company R&D Portfolio Management

Situation & Approach

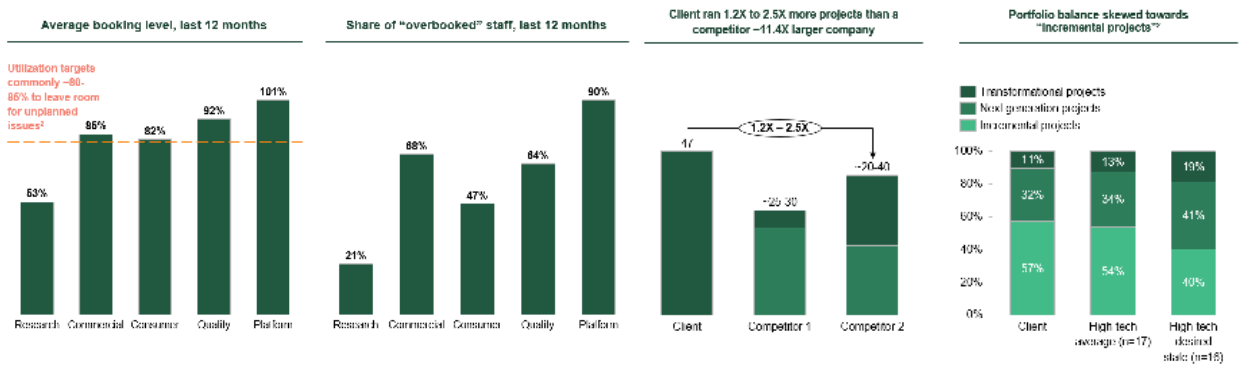
***Client Challenge & AV's Approach*:**

- Challenge: Identify opportunities in product development that support the company's efforts to return to growth and profitability
- Approach: AV conducted extensive data analysis on the project portfolio and staffing; interviewed key stakeholders and experts to find existing pain points and solve with operational best-practices; and developed a portfolio balancing framework for the client

Analysis & Results

***Analysis*:**

- Via analysis of the company's R&D approach, identified four opportunity areas within R&D:
  - Size and structure of the portfolio was ~1.75X of a peer that is ~11X larger; overly optimistic NPV estimates consistently led to slippage;
  - Projects significantly lagged peers in speed of execution prior to concept freeze;
  - Sub-optimal resource allocation due to overbooked development staff, increasing project costs and lengthens project timeline; and
  - Excessive evaluation/validation points led to development staff spending ~25% of their time on non-development work.



Results:

- Reviewed project portfolio and helped the client make "go", "no-go", and "accelerate" decisions considering the defined strategic direction with implied launches and "drop rates" per product category. Review approach was based on a clear framework to minimize downside risk (e.g., reduction of portfolio NPV);
- Established a clarified technology and feature roadmap to improve foresight, planning, and ODM collaborations;
- Drove resource optimization through reinforcement of prioritization mechanisms, visibility on utilization levels and capacity constraints, and a strengthened staffing process;
- Redefined project execution model by changing core team construct (shared responsibility) and establishing dedicated end-to-end project leaders (single point of responsibility); and
- Provided a portfolio management foundation and playbook for continued evaluation and decision-making for the company's future R&D investments and project portfolio management.

5. Conclusion

Since 2020, annual global R&D spend has increased ~11% to $2.5 trillion. No matter the R&D budget of an individual company, resources must be allocated responsibly. R&D drives the future of the business and therefore must be aligned with long-term business goals.

Unoptimized R&D portfolios pose significant short-term and long-term risk to companies. R&D projects always have the risk of non-commercial viability or project failure, and a misallocation between business areas or short/long-term projects can lead to critical product and capability deficiencies.

Conversely, an optimized R&D portfolio can see synergies beyond the pure NPV of the project. By aligning projects with corporate strategy, companies stand to develop new core competencies through targeted investment in specific business areas, product categories, or functions, enabling cheaper and faster future projects within that business area and expedited time-to-value.

The approach set out in this Value Paper is based on Applied Value's view of portfolio management and industry experiences and can be used to establish and maintain a competitive advantage through an effective and efficient use of R&D resources.

Applied Value can help companies optimally allocate their R&D budget and in driving best-practice initiatives to prioritize projects for increased returns, aligned to your corporate strategy.

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