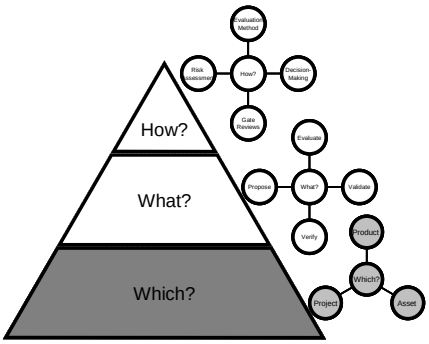
# 2. Life Cycles Involved in Projects




## 2.1 Introduction

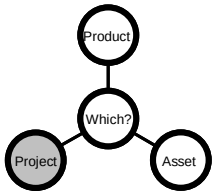
A project can be defined as a temporary undertaking with a specific objective as well as a definite beginning and end [98] or as "*a temporary endeavour undertaken to create a unique product or service*" [96]. Companies are increasingly accountable for implemented projects' impacts on the society, environment and economy long after the project's completion, i.e. beyond the normally considered project life cycle [96].

With these definitions of a project as a departure point, it stands to reason that the project itself will have minimal economic, environmental and/or social consequences, since it is temporary and merely a vehicle to implement change, i.e. the product or service. The project's "product" or deliverables will, however, have economic, environmental and social consequences and impacts. Companies are specifically accountable for these impacts. This concept is supported in projects' financial analyses, where the financial implications of the project's deliverables are included in the profitability, Return on Investment (ROI) and Net Present Value (NPV) calculations [115].

This thesis focuses specifically on the process industry, in which a project can be described as a vehicle to implement the capital investment in a new or improved asset. Since this type of project results in a tangible deliverable, it is essential to distinguish between the project life cycle and the life cycle of its deliverable [116], i.e. asset in the process industry scenario. The implemented asset is normally used to manufacture products, which are either further refined or sold directly to the customer. The following three distinct life cycles are involved:

- project life cycle;
- asset life cycle, which can also be referred to as process life cycle; and
- product life cycle [103].

## 2.2 Project Life Cycle




A project life cycle can be defined as *"an orderly sequence of integrated activities, performed in phases, leading to success"* [117]. The complex nature as well as the diversity of projects results in industries, or even companies within the same industry sector, failing to agree on the life cycle phases of a project [98]. Various project life cycle approaches therefore exist in literature, e.g. the control-oriented model, the quality-oriented model, the risk-oriented model, a fractal

approach to the project life cycle as well as some company-specific project life cycles [118]. Furthermore, there is no consensus on the number of phases, which constitute a project life cycle, neither on the names used to describe these phases. Table 2-1 summarizes project life cycle phases proposed by various researchers, while Table 2-2 shows seven possible generic life cycle phases in a project, together with a basic description and alternative names for each phase [97]. Such a generic project life cycle can be tailored to suit individual projects' requirements. For example, a number of phases can be combined or phases deemed irrelevant to the type of project can be omitted.

**Table 2-1: Phases in the Project Life Cycle**

| Researcher | Number of Phases | Phases |
|---|---|---|
| Bonnal, Gourc and Lacoste [118] | 5 | Initation/Concept/Identification; Feasibility Phase; Basic Design; Detailed Design; Construction; Turnover/Start-up |
| Quality-Oriented [118] | 3 | Conceptualisation, Materialisation, Turnover |
| Stage-Gate ® (Cooper and Edgett) [100] | 7 | Discovery Stage, Scoping, Build Business Case, Development, Testing and Validation, Launch |
| Buttrick [97] | 7 | Idea generation, Pre-feasibility, Feasibility, Development and execution, Commissioning, Launch, Post Implementation Review (PIR) |
| Merrifield [119] | 6 | Idea, Feasibility Demonstration, Product/Process Development, Pilot Plant, Semi-Commercial, Full-Scale Production. |
| Buttrell [120] | 5 | Concepts, Production Prototype, Field Testing, Marketing Development, Field Sales |
| Hoo [121] | 5 | Strategic Analysis/Planning, Idea Generation/Screening, Development, Test Marketing, National/Regional Launch |
| Feldman & Page [122] | 6 | Exploration, Screening, Concept testing, Business Analysis, Development, Market Testing |
| Eggers [123] | 6 | Idea Formulation, Identification, Feasibility Studies, Financing, Implementation, Evaluation |
| Yahie [124] | 5 | Identification, Preparation, Appraisal, Implementation, Evaluation |
| Picciotto et al [125] | 4 | Listing, Piloting, Demonstrating, Mainstreaming |
| Ward and Chapman [126] | 4 | Conceptualisation, Planning, Execution, Termination |
| Morris [127] | 4 | Feasibility, Planning and Design, Production, Turnover and Start-up |

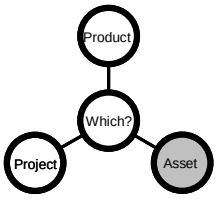
**Table 2-2: Life Cycle Phases in a Project [97]**

| Phase Names | Alternative Names | Description of Phase |
|---|---|---|
| Idea generation | Proposal<br>Concept<br>Initiation<br>Ideation | In this phase, the idea for a new project is generated and the initial proposal describing the business need must be prepared. This phase does not require a formal project plan. |
| Pre-feasibility | Initial investigation<br>Initial assessment<br>Preliminary Investigation<br>Evaluation<br>Research | The goal of this phase is to evaluate the existing proposal in terms of financial, operational and technical viability as well as against the company's strategy. Overlapping or synergy with other projects should also be checked. |
| Feasibility | Detailed Investigation<br>Definition<br>Business case<br>Evaluation<br>Authorisation | The optimum solution to address the business need must be identified and defined. All areas of this solution must be analysed and assessed to determine killer concerns and risks. |
| Development and execution | Implementation<br>Realisation<br>Production<br>Construction<br>Build<br>Develop and test | This phase involves design, development, creation and building the chosen solution. The supporting system, manuals, business processes and training for the solution must also be developed during this phase. |
| Commissioning | Trial<br>Beta test<br>Validation | In this phase the solution is tested in an operational environment. The purpose is to validate the solution's acceptance and capabilities. |
| Launch | Release<br>Completion<br>Implementation<br>Handover<br>Acceptance | The project is handed over to the business units and thus released to the operational environment during this phase. This phase also marks the beginning of operational support. |
| Post Implementation Review (PIR) | Business review<br>Project audit<br>Post project review | After sufficient time, i.e. 9 - 15 months, the project should be assessed to determine whether the benefits were delivered and what the project's impact was on the business. Lessons learned should be captured for future reference. |

There is no agreement on a generic project life cycle model in the South African context. Companies within the South African process industry also use different project life cycles. The analysis of the content of project management frameworks (see section 1.3.2) showed that project life cycles with a more practical approach are used in the process industry. These project life cycles show similarities with those proposed by Buttrick [97], Bonnal, Gourc and Lacoste [118], Cooper and Edgett [100], Merrifield [119], Eggers [123], and Ward and Chapman [126]. The thesis chose a generic project life cycle that entails similar phases to those found in the South African process industry, since the process industry is the main focus of the research. Figure 2-1 depicts the generic project life cycle, which is used for the remainder of the thesis.


**Figure 2-1: Generic Project Life Cycle**

## 2.3 Asset Life Cycle




The project normally delivers a "product", which in the process industry is a new or improved asset, also referred to as an operational activity. The project life cycle and the asset life cycle contribute to the same value chain, i.e. the project implements the asset. These two cycles are consequently often viewed as one life cycle. Nevertheless, there are definite differences between a project and an operational activity or asset, as can be seen in Table 2-3 [128].

**Table 2-3: Comparison Between the Characteristics of a Project and an Operational Activity [128]**

| Project | Operational Activity |
|---|---|
| • Produces a new specific deliverable | • Delivers some product |
| • A defined start and end | • Continuous |
| • Multidisciplinary team | • Specialised skills |
| • Temporary team | • Stable organisation |
| • Uniqueness of project | • Repetitive and well understood |
| • Work to a plan within defined costs | • Work within an annual budget |
| • Canceled if objectives cannot be met | • Continual existence almost assured |
| • Finish date and cost more challenging to predict and manage | • Annual expenditures calculated based on past experience |

The asset implemented by a project can take various forms. It has been argued that the traditional system life cycle phases [129] could be applied to an asset [130] (Figure 2-2 shows this asset life cycle).

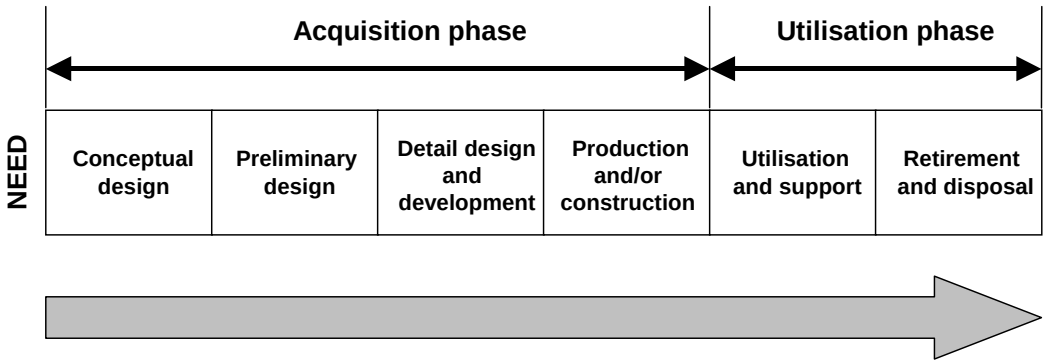



**Figure 2-2: System Life Cycle Applied to Assets [130]**

In the process industry the asset would normally be a new or improved sub-process or an entire plant or process. A typical plant or process life cycle (Figure 2-3) consists of six phases, namely two design phases, a construction phase, a start-up/commissioning phase, an operation/maintenance phase and a decommissioning phase [Intergraph as quoted in 103].

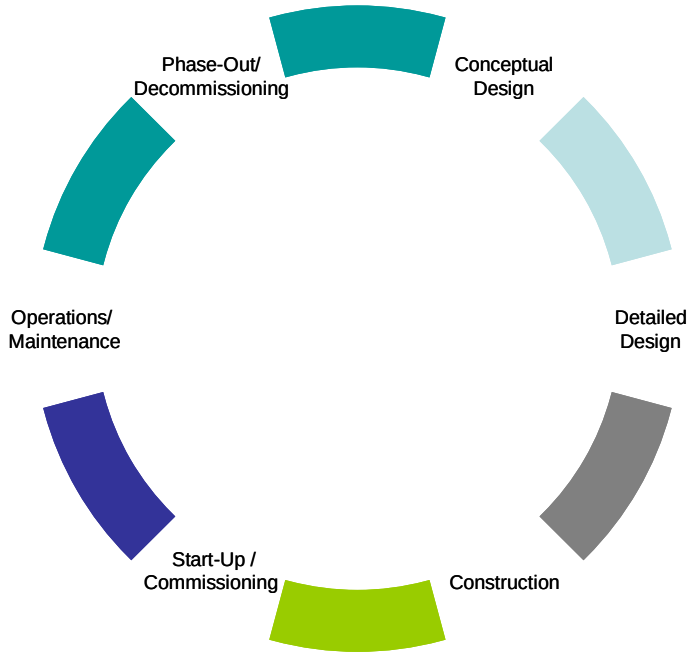



**Figure 2-3: Plant or Process Life Cycle [103]**

If all design phases are treated as one phase and the start-up and commissioning phases are treated as part of the construction phase (see Figure 2-5), the asset life cycle can be simplified to four phases (see Figure 2-4). An asset's design phase can also be the selection phase of manufacturing equipment if the asset is purchased and not an in-house design.

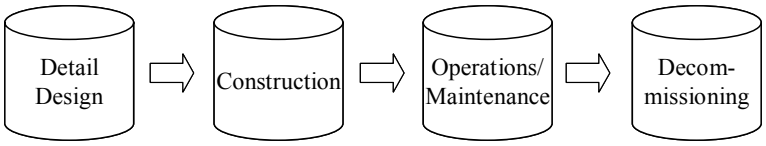



**Figure 2-4: Generic Asset Life Cycle**

The project is the vehicle to design, where applicable, and implement the asset. Although two distinct life cycles are involved, the two life cycles still interact. The project normally ends after the asset commences stable operations according to the performance requirements, also referred to as the "handover to operations" [131]. The design, construction and a small part of the operational phase are therefore completed during the project's life cycle. A post-implementation review will take place when the asset is in its operational life cycle. Figure 2-5 and Table 2-4 shows the interaction between the two life cycles, i.e. project and asset life cycles.

**Table 2-4: Interaction Between Project and Asset Life Cycles [103]**

| Asset Life Cycle Phase | Project Life Cycle Phase |
|---|---|
| Detail design | Pre-feasibility<br>Feasibility<br>Basic development<br>Execution and testing |
| Construction | Execution and testing<br>Launch |
| Operations | Launch<br>Post implementation review |

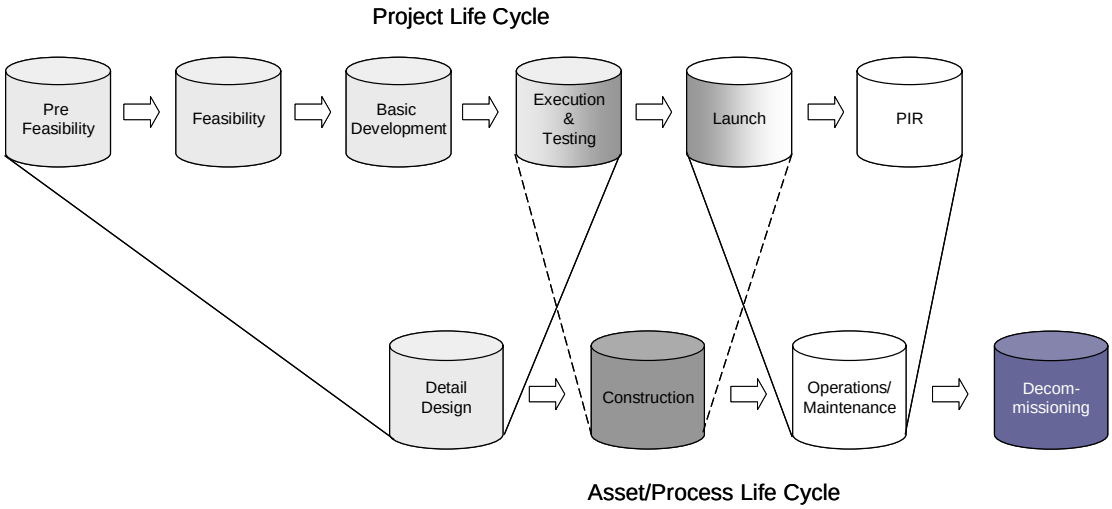
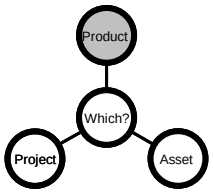



**Figure 2-5: Interaction Between the Project and Asset Life Cycles**

## 2.4 Product Life Cycle




The main goal when implementing a new asset is to manufacture a product or to improve the manufacturing of a product to meet the customer's needs. In recent years, product life cycles played an important role in the field of Life Cycle Assessment (LCA), which is used to evaluate products' environmental performances [132]. A product life cycle consisting of five phases has been proposed from an LCA perspective [133] (see Figure 2-6). These phases are pre-manufacturing, product manufacturing, product delivery, product use as well as refurbishment, recycling and disposal.

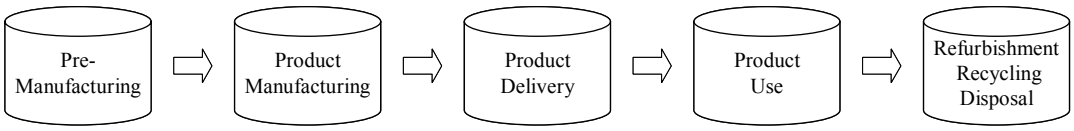



**Figure 2-6: Product Life Cycle [133]**

Another approach is to apply the generic systems life cycle (shown in Figure 2-2) to products [134]. The difference between these two life cycles is that the first uses a supply chain perspective while excluding the product's design phase. This cycle also focuses specifically on all the activities necessary to produce the product, i.e. use the product and discard the product.

The second approach starts a product's life cycle with need identification and considers supply chain activities as part of the production phase. A Socio-Eco Efficiency (SEE) Analysis Tool was developed

internationally to assist management in orienting the product portfolio according to sustainability criteria. The tool is an instrument that compares various product or process alternatives with each other in terms of environmental, social and economic impacts [135]. The tool can be applied during product development to ensure that new products are aligned with the principles of sustainable development.

This research therefore uses a supply chain focused product life cycle view, as tools already exist to incorporate business sustainability in product development.

In the process industry, the asset is used to manufacture the product in various steps. The two life cycles are therefore bound to interact. The assets are manufactured, i.e. the product manufacturing life cycle in the asset life cycle's operational phase. Figure 2-7 shows the interaction between the asset and product life cycle.

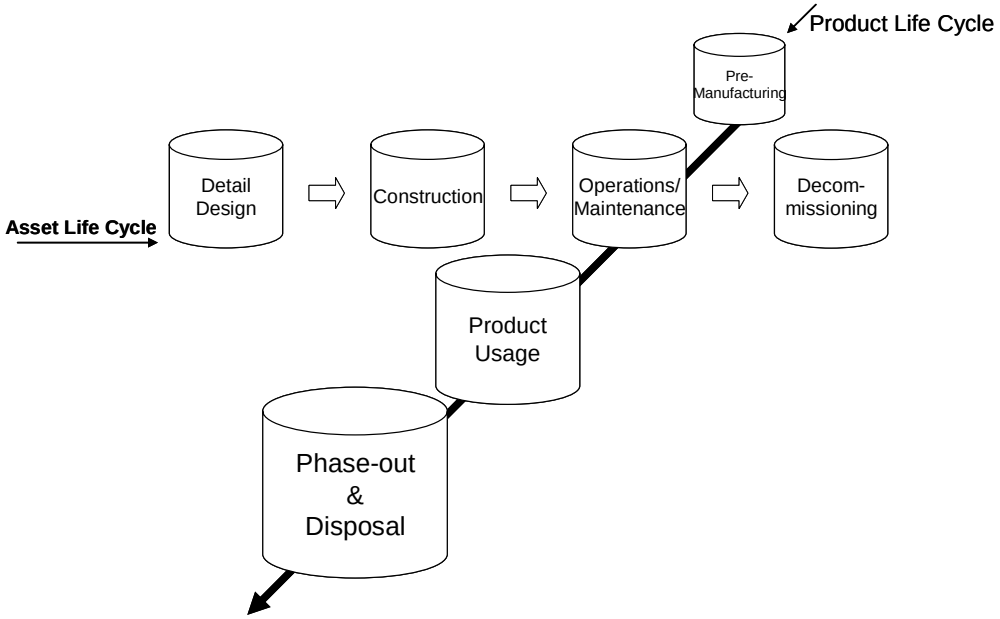



**Figure 2-7: Interaction Between the Asset (Process) and Product Life Cycle**

## 2.5 Conclusion: Life Cycle Interaction

In conclusion, the asset life cycle resulting from the project and the subsequent product life cycle resulting from the asset have economic, social and environmental consequences, which are in turn associated with an implemented project (see Figure 2-8). Aligning project management methodologies with sustainable development principles therefore requires that the sustainability consequences of these asset and product life cycles must be considered during the project life cycle and specifically during project appraisals at the various decision gates (see Figure 1-4).

In the environmental dimension of sustainability, initiatives such as Design for Environment (DFE) [136] have been developed. These initiatives have a pro-active approach to incorporate environmental aspects early in the design phase of processes and products. To follow the same pro-active approach, social aspects have to be considered from the first phase in the project life cycle to ensure the biggest influence on the design. To simplify the various life cycle interactions, the following asset life cycle phases' social consequences and impacts will be evaluated and/or addressed in each project life cycle phase, i.e. Construction, Operation and Decommissioning. The social consequences and impacts of the product's life cycle will be grouped under the Operation phase.

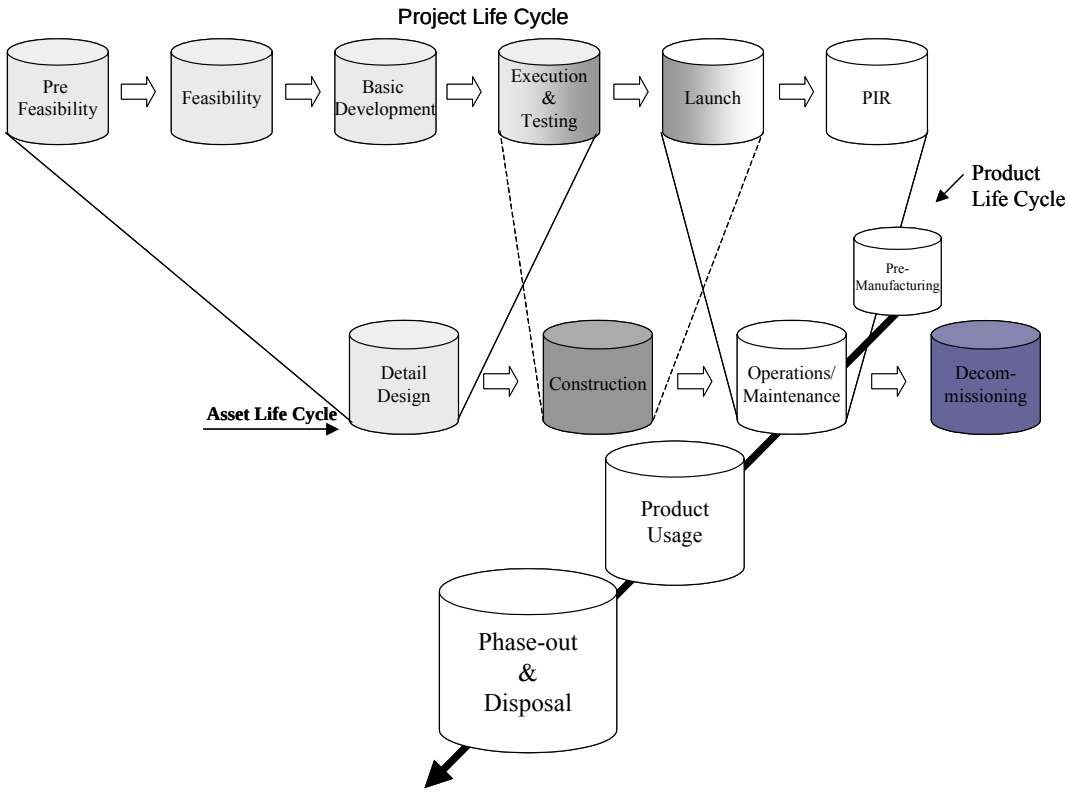



**Figure 2-8: Interaction Between the Project, Asset and Product Life Cycles**