40.014 Engineering Systems Architecture

40.012 Manufacturing and Service Operations

2D Project Proposal

TOPIC 5: OPERATIONS SCHEDULING

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PROBLEM STATEMENT

This project aims to create an MRP (Material Requirements Planning) system with different subsystems. The main goal is to create an optimised system that can generate an operation schedule by setting in the inputs; Bill-of-Materials, Routings of Make Parts, Processing Time, Due Dates, and Operation Network. Upon receiving the inputs, the system is supposed to produce a schedule as an output, which is done using Mixed-Integer-Linear-Programming (MILP).

DESCRIPTION

For this case study, we are using the manufacturing system of a bicycle where we aim to create an optimal operation schedule such that production can start as late as possible without compromising production due dates. By starting as late as possible, inventory holding costs will be kept to a minimum, which is desirable. The goal is of starting production as late as possible is achieved by minimising the time between the production start time and the production due date of each operation and we would also like to minimize tardiness. The output of the programme would be the optimised start time for each operation in the job shop bicycle manufacturing problem. (Agrawal et al., 1996, pg. 655-657)

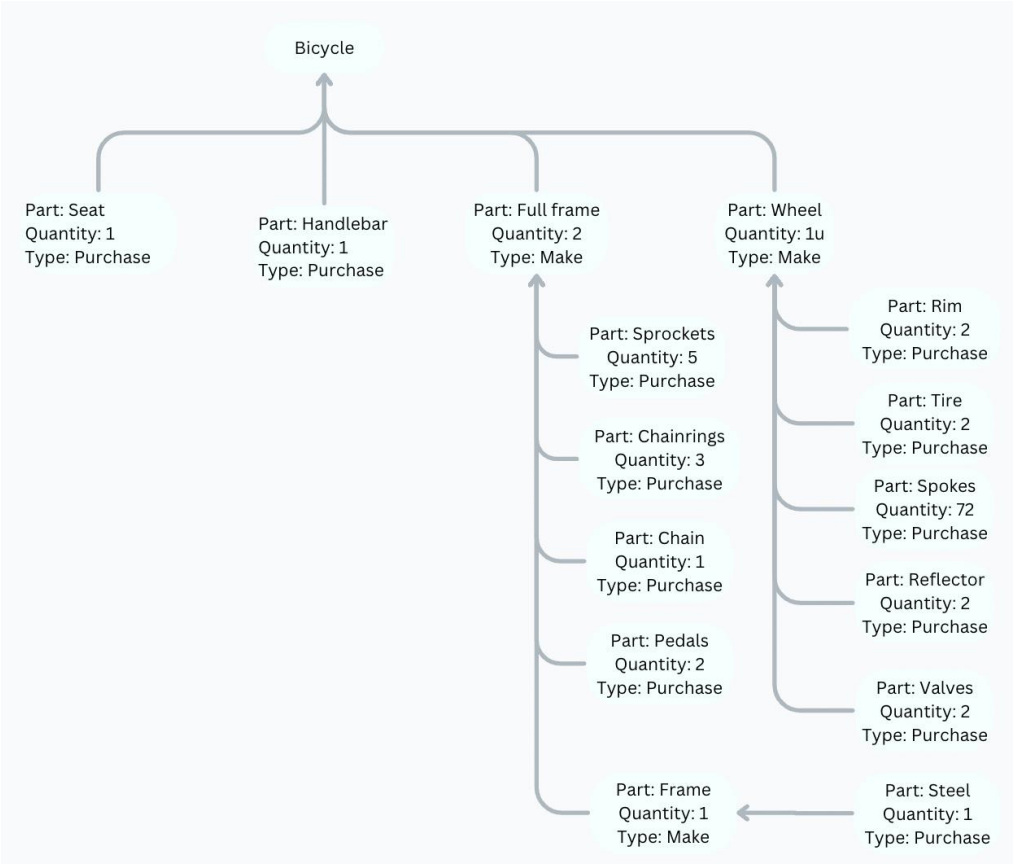
For demonstration, we aim to produce 20 bicycles as this quantity was seen to be the average production level for a bicycle manufacturing company. (Escobar-Arroyave, 2022, pg. 2079)

METHODOLOGY

1. Data on bills of material: We collected detailed information on the different manufacturing components of a bicycle
2. Categorisation of components: We categorised different components to be manufactured in-house or purchased externally
3. Collection of additional data sets: We gathered data on the time required to manufacture each component
4. Formulate the routings: We formulated the manufacturing of each component, converting this data into a structured table

DATA COLLECTED (INPUTS)

1. *Bill-of-Materials (BOM)*



A list of all the parts required to produce one bicycle. (Mecalux, 2021)

2. *Routings and processing time*
   A detailed sequence of operations for each *make/manufactured part* and processing time.

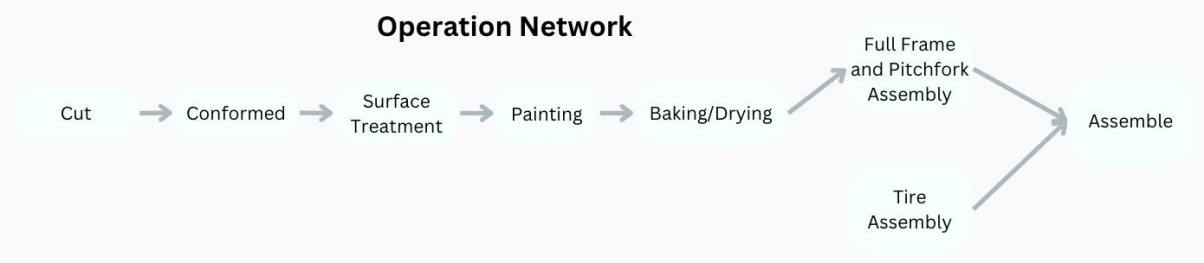
Routings of Make Parts

Part	Operation	Components Required	Processing Time (minutes)	Work Center
Wheel	Tire Assembly	Rim, Tire, Spokes, Reflector, Valves	8.47	1
Skeleton	Cut	Metal	0.27	1
	Conformed	Metal	2.48	1
	Surface Treatment	Metal	10	1
	Painting	Metal	7.25	1
	Baking/Drying	Metal	120.0	1
Frame	Full Frame and Pitchfork Assembly	Skeleton, Sprockets, Chainrings, Chain, Pedals	3.78	1
Bicycle	Assemble	Wheel, Seat, Handlebar, Frame	12.8	1

(Botto-Tobar et al.,2021, pg.116)

3. *Due dates and Quantity*
   One of the inputs/variables in the MILP is the quantity of final product. With the quantity number, the program will to able to calculate the total number of components required at each production level to form the required number of final products. This value can be adjusted based on different requirements. In this case study, we will be referencing the journal article (Escobar-Arroyave, 2022, pg. 2079), using 20 bicycles produced a month as a constant to more accurately compare the efficiency of our MILP.

4. *Operation Network*



Each of the parts and how they are connected to their predecessor and ancestor parts. It shows the sequence in which the processes are being carried out. (Botto-Tobar et al.,2021, pg.116)

JUSTIFICATION

We collected our data from research articles and credible websites to form our basis. However, our desired data is not available from a single source and not all the items listed in the BOM for the bicycle were available for the processing time data set. Thus, we will assume that those without any mention of processing time in the processing time data set will be purchased parts. This assumption is based on the rationale that detailed processing times are typically more readily available for components manufactured in-house, whereas purchased parts often lack detailed manufacturing information.

REFERENCES

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