eSTEM

With the support of the Erasmus+ Programme of the European Union

Production planning and organization

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Scenario Based Learning

Agenda

1. Introduction
2. Storyline
3. Manufacturing strategy
4. Demand forecasting
5. Aggregate production plan
6. Production flows
7. Cycle time
8. References

01.

Introduction to the problem of production planning and organization

Introduction

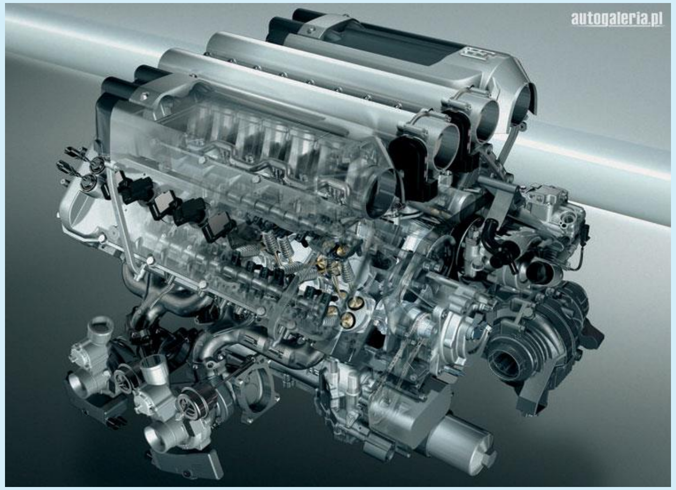
Manufacturing company - a commercial business that converts raw materials or components into finished products.

Introduction

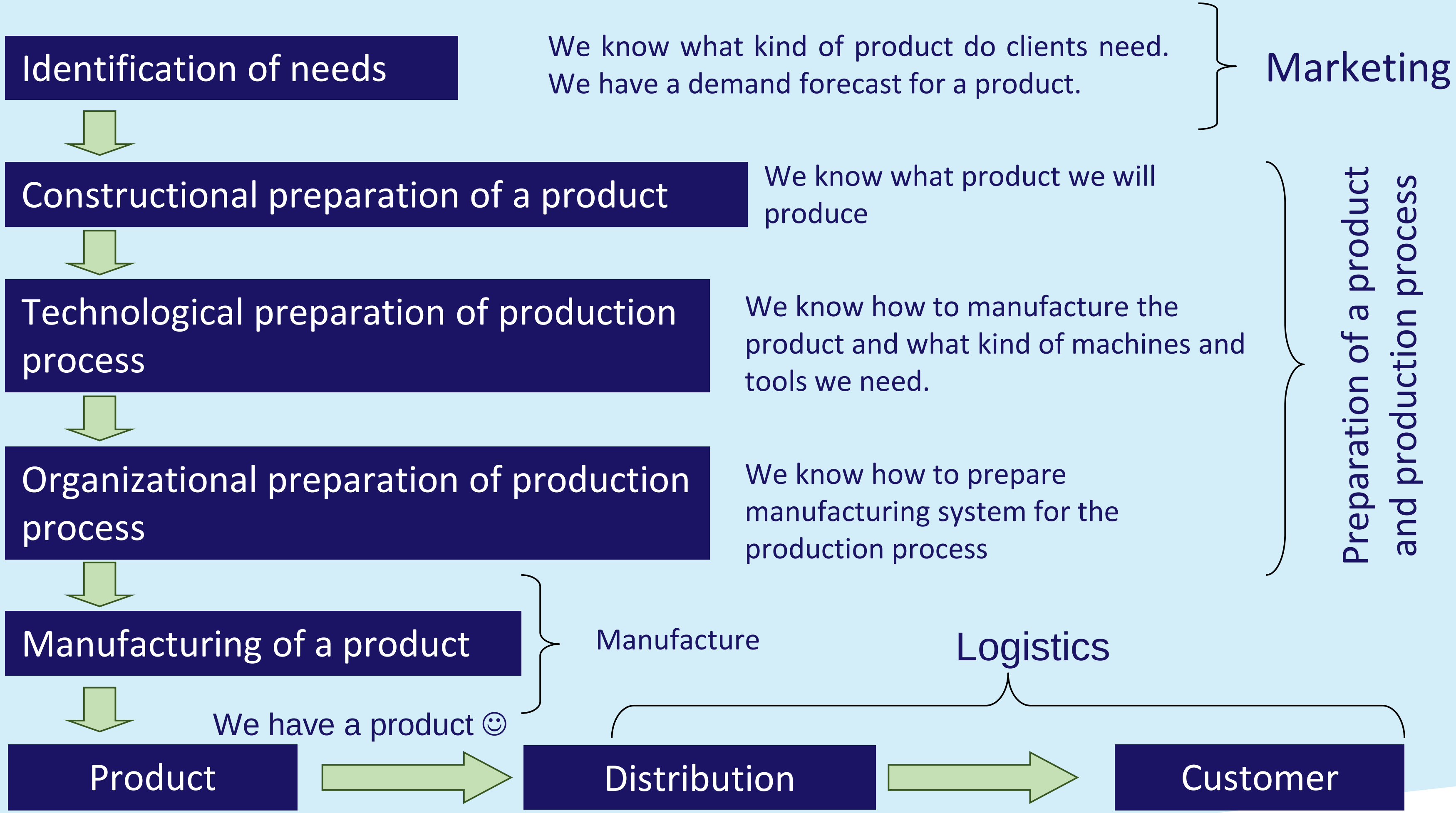
A simple product (a part) – a homogenous constructional element made from one material and not connected with other elements.

Introduction

A complex product – at least two simple product connected together. These can be: subassmeblies, assemblies or set of assemblies.



Introduction

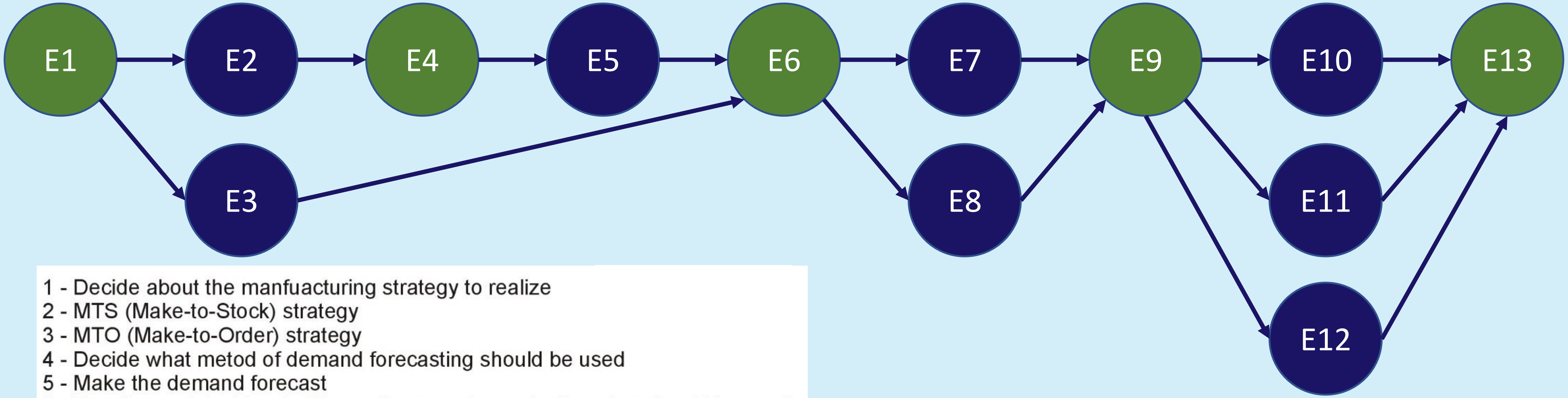


02.

Storyline

Storyline

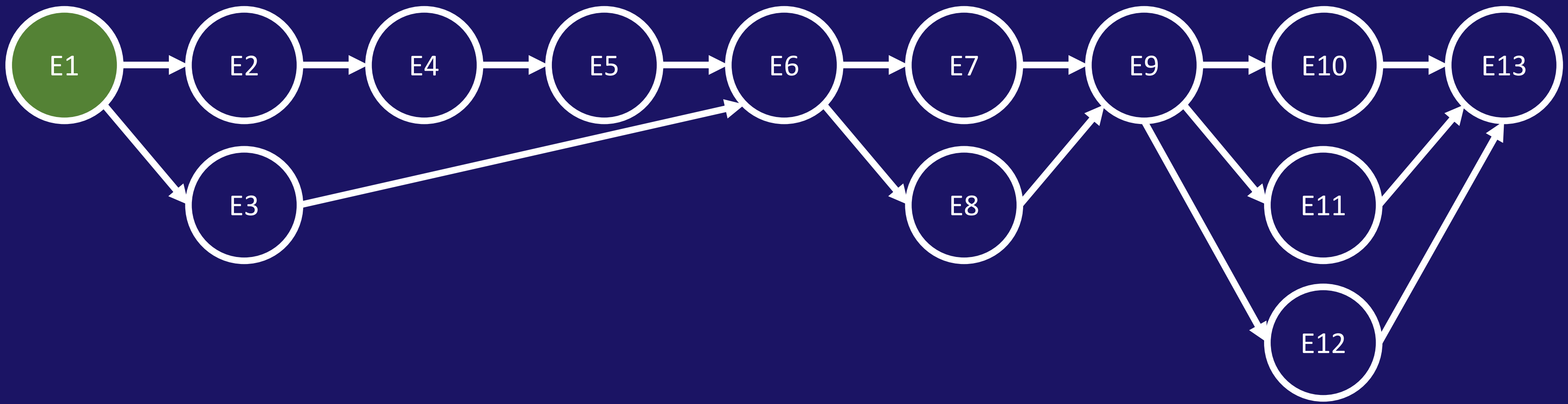
How to organize and plan the production process ?



1 - Decide about the manfuacturing strategy to realize
2 - MTS (Make-to-Stock) strategy
3 - MTO (Make-to-Order) strategy
4 - Decide what metod of demand forecasting should be used
5 - Make the demand forecast
6 - Develop and decide what type of aggregate production plan should be used
7 - Level aggregate plan
8 - Chase aggregate plan
9 - Decide about the parts flow movement organization
10 - Serial flow movement
11 - Serial-paraller flow movement
12 - Parallel flow movement
13 - Calculate the cycle time of the production process

03.

Manufacturing strategy



Manufacturing strategy

E1

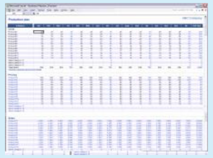
Decide about the manufacturing strategy to be realized

Manufacturing strategy E2

Make-to-Stock (MTS) - traditional production strategy used by businesses to match production with consumer demand forecasts.

Demand forecasting

Developing of production plan

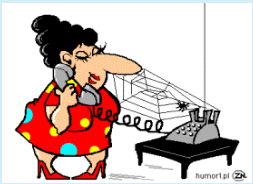


Manufacturing

Moving product(s) to stock

Delivery product(s) to customer

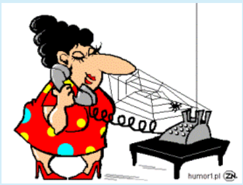
Customer's order(s)



Manufacturing strategy E3

Make-to-Order (MTO) - allows consumers to purchase products that are customized to their specifications.

Customer's order(s)



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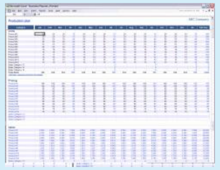
Developing of a production plan



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Manufacturing

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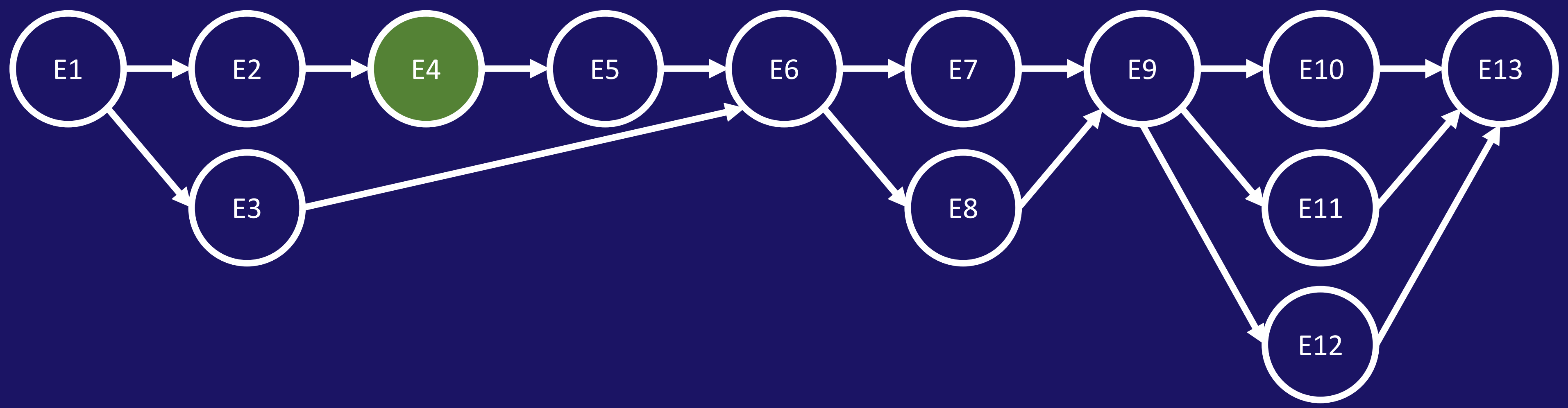
Delivery product(s) to customer

04.

Demand forecasting



Demand forecasting

E4

Quantitative methods for demand forecasting:

1. Methods of forecasting for relatively constant demand:
   - naive forecast,
   - the simple average,
   - the simple moving average,
   - the simple moving average with a filter,
   - the weighted moving average,
   - simple exponential smoothing (Brown's method).
2. Methods of forecasting for demand with a trend
   - Simple linear regression model,
   - Holt's procedure (double exponential smoothing procedure),
3. Methods of forecasting for seasonal demand
   - The method of seasonal indexes,
   - Winter's method.

Demand forecasting

E4

How to measure that demand is relatively constant?

<u>Coefficient of demand's variabilty</u>

$$V_z = \frac{\sigma_p}{\bar{v}}$$

σ_p – standard deviation of demand
$\bar{v}$ – an average demand in analyzed period

<u>Demand can be recognized as a relatively costant when the coefficien of demand's variability is lower than **5%**</u>

Demand forecasting

E4

Quantitative methods for demand forecasting:

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Demand forecasting

E4

The method of seasonal indices allows to forecast the demand for products of seasonal demand

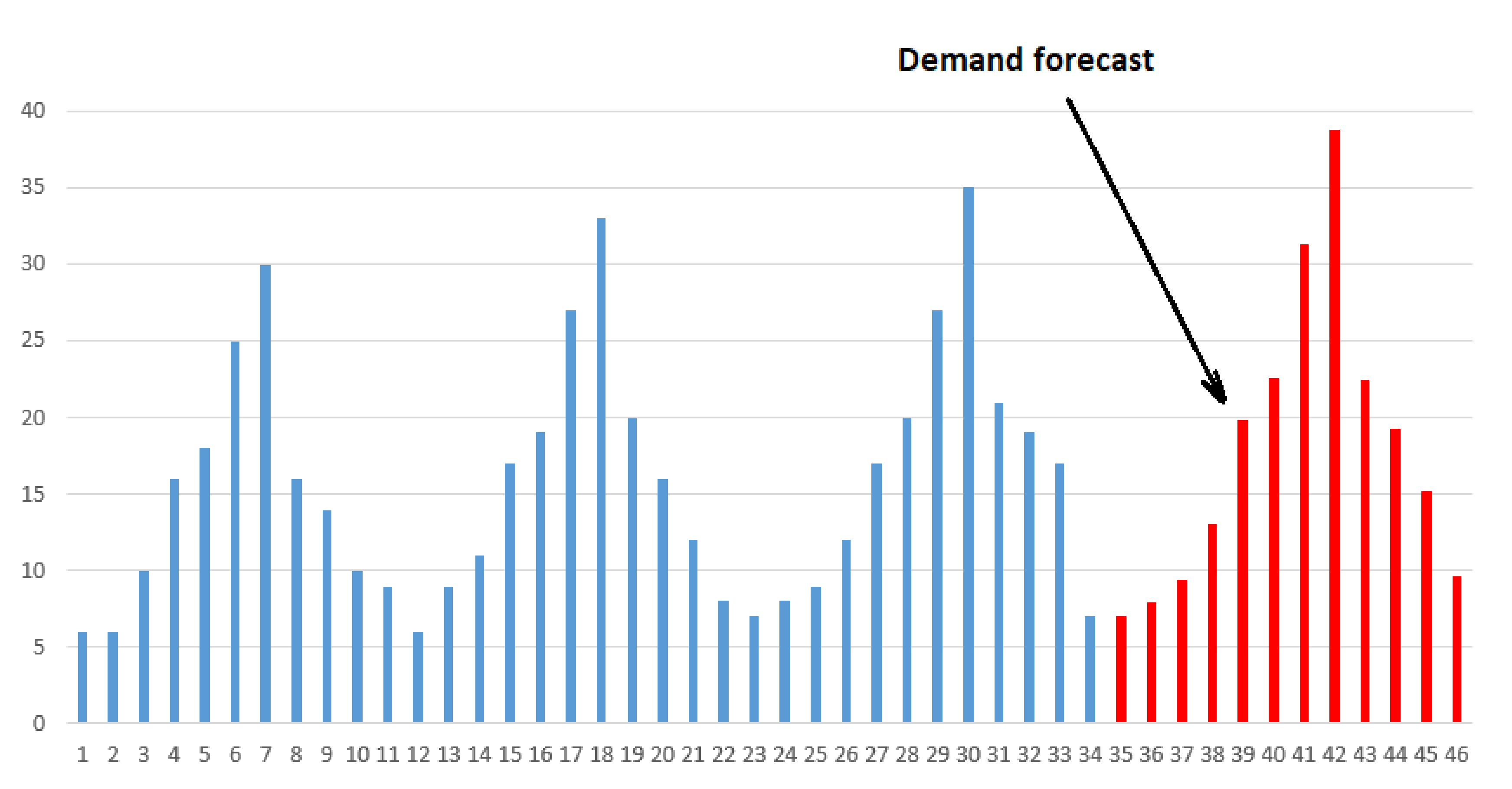
<u>The procedure of forecast developing:</u>

1. Calculating the average demand for each of the year,
2. Calculating the seasonal coefficient for each quarter or month,
3. Calculating the value of average seasonal cooeficient,
4. Developing the general forecast for a following year,
5. Developing forecasts for each quarter or month.

Demand forecasting E5

Make the demand forecast

Demand forecasting E5



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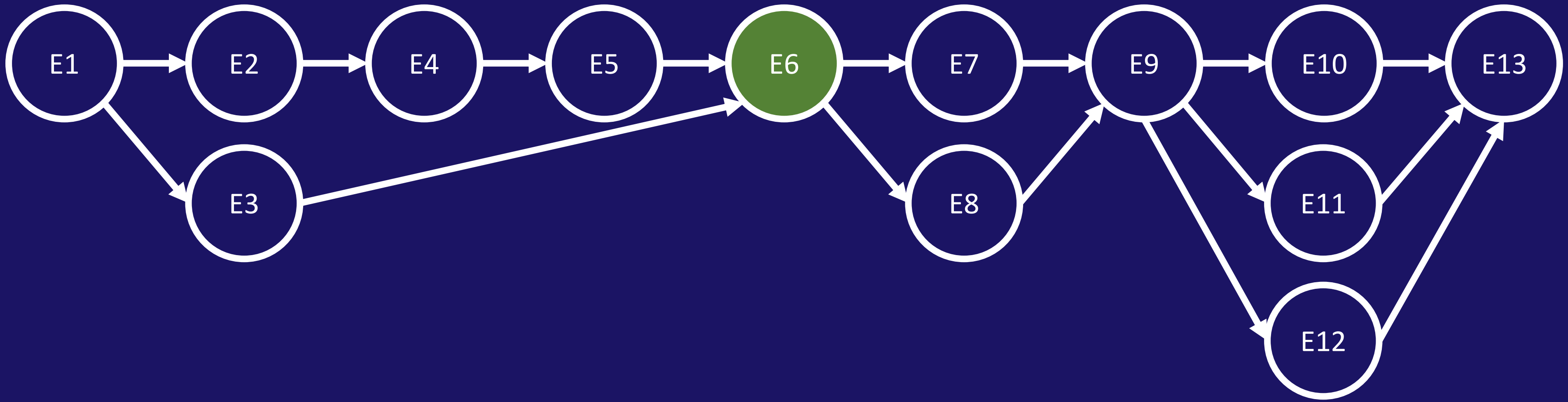
Aggregate production plan



Aggregate production plan E6

Develop and decide what type of aggregate production plan should be used

Aggregate production plan

E6

*„**Production planning** means to fix the production goals and to estimate the resources which are required to achieve these goals. It prepares a detailed plan for achieving the production goals economically, efficiently and in time”.*

Vollman, T. E., W. L. Berry and D. C. Whybark, Manufacturing Planning and Control Systems, 3 rd edition, Burr Ridge Ill., Richard D. Irwin Inc., 1992.

Aggregate production plan

E6

*„**Aggregate production planning** is intermediate-range capacity planning that typically covers a time horizon of 2 to 12 months.*

The goal of aggregate production planning is to achieve a production plan that will effectively utilize the organization’s resources to match expected demand.

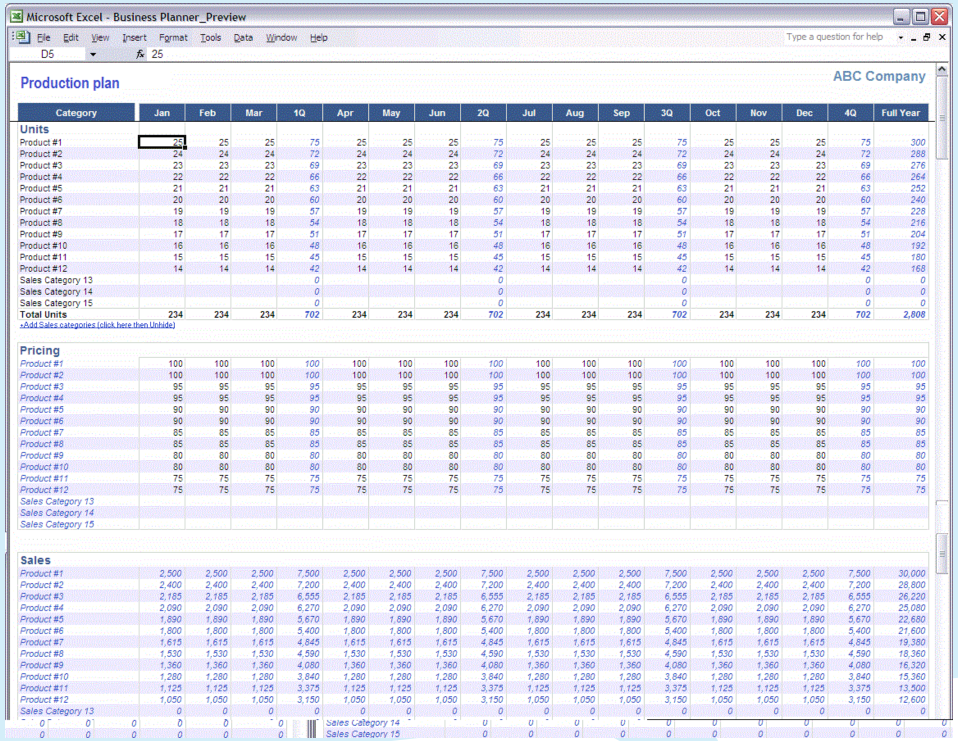
Aggregate production plan

E6

When we have forecasted demand of the product – how many product should we produce?

Demand forecast

Capacity



Microsoft Excel - Business Planner_Preview

File Edit View Insert Format Tools Data Window Help

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Production plan — ABC Company

Category	Jan	Feb	Mar	1Q	Apr	May	Jun	2Q	Jul	Aug	Sep	3Q	Oct	Nov	Dec	4Q	Full Year
Units																	
Product #1	25	25	25	75	25	25	25	75	25	25	25	75	25	25	25	75	300
Product #2	24	24	24	72	24	24	24	72	24	24	24	72	24	24	24	72	288
Product #3	23	23	23	69	23	23	23	69	23	23	23	69	23	23	23	69	276
Product #4	22	22	22	66	22	22	22	66	22	22	22	66	22	22	22	66	264
Product #5	21	21	21	63	21	21	21	63	21	21	21	63	21	21	21	63	252
Product #6	20	20	20	60	20	20	20	60	20	20	20	60	20	20	20	60	240
Product #7	19	19	19	57	19	19	19	57	19	19	19	57	19	19	19	57	228
Product #8	18	18	18	54	18	18	18	54	18	18	18	54	18	18	18	54	216
Product #9	17	17	17	51	17	17	17	51	17	17	17	51	17	17	17	51	204
Product #10	16	16	16	48	16	16	16	48	16	16	16	48	16	16	16	48	192
Product #11	15	15	15	45	15	15	15	45	15	15	15	45	15	15	15	45	180
Product #12	14	14	14	42	14	14	14	42	14	14	14	42	14	14	14	42	168
Sales Category 13				0				0				0				0	0
Sales Category 14				0				0				0				0	0
Sales Category 15				0				0				0				0	0
Total Units	234	234	234	702	234	234	234	702	234	234	234	702	234	234	234	702	2,808

+Add Sales categories (click here then Unhide)

Category	Jan	Feb	Mar	1Q	Apr	May	Jun	2Q	Jul	Aug	Sep	3Q	Oct	Nov	Dec	4Q	Full Year
Pricing																	
Product #1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Product #2	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Product #3	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Product #4	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Product #5	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Product #6	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Product #7	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Product #8	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Product #9	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Product #10	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Product #11	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Product #12	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Sales Category 13																	
Sales Category 14																	
Sales Category 15																	

Category	Jan	Feb	Mar	1Q	Apr	May	Jun	2Q	Jul	Aug	Sep	3Q	Oct	Nov	Dec	4Q	Full Year
Sales																	
Product #1	2,500	2,500	2,500	7,500	2,500	2,500	2,500	7,500	2,500	2,500	2,500	7,500	2,500	2,500	2,500	7,500	30,000
Product #2	2,400	2,400	2,400	7,200	2,400	2,400	2,400	7,200	2,400	2,400	2,400	7,200	2,400	2,400	2,400	7,200	28,800
Product #3	2,185	2,185	2,185	6,555	2,185	2,185	2,185	6,555	2,185	2,185	2,185	6,555	2,185	2,185	2,185	6,555	26,220
Product #4	2,090	2,090	2,090	6,270	2,090	2,090	2,090	6,270	2,090	2,090	2,090	6,270	2,090	2,090	2,090	6,270	25,080
Product #5	1,890	1,890	1,890	5,670	1,890	1,890	1,890	5,670	1,890	1,890	1,890	5,670	1,890	1,890	1,890	5,670	22,680
Product #6	1,800	1,800	1,800	5,400	1,800	1,800	1,800	5,400	1,800	1,800	1,800	5,400	1,800	1,800	1,800	5,400	21,600
Product #7	1,615	1,615	1,615	4,845	1,615	1,615	1,615	4,845	1,615	1,615	1,615	4,845	1,615	1,615	1,615	4,845	19,380
Product #8	1,530	1,530	1,530	4,590	1,530	1,530	1,530	4,590	1,530	1,530	1,530	4,590	1,530	1,530	1,530	4,590	18,360
Product #9	1,360	1,360	1,360	4,080	1,360	1,360	1,360	4,080	1,360	1,360	1,360	4,080	1,360	1,360	1,360	4,080	16,320
Product #10	1,280	1,280	1,280	3,840	1,280	1,280	1,280	3,840	1,280	1,280	1,280	3,840	1,280	1,280	1,280	3,840	15,360
Product #11	1,125	1,125	1,125	3,375	1,125	1,125	1,125	3,375	1,125	1,125	1,125	3,375	1,125	1,125	1,125	3,375	13,500
Product #12	1,050	1,050	1,050	3,150	1,050	1,050	1,050	3,150	1,050	1,050	1,050	3,150	1,050	1,050	1,050	3,150	12,600
Sales Category 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sales Category 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sales Category 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

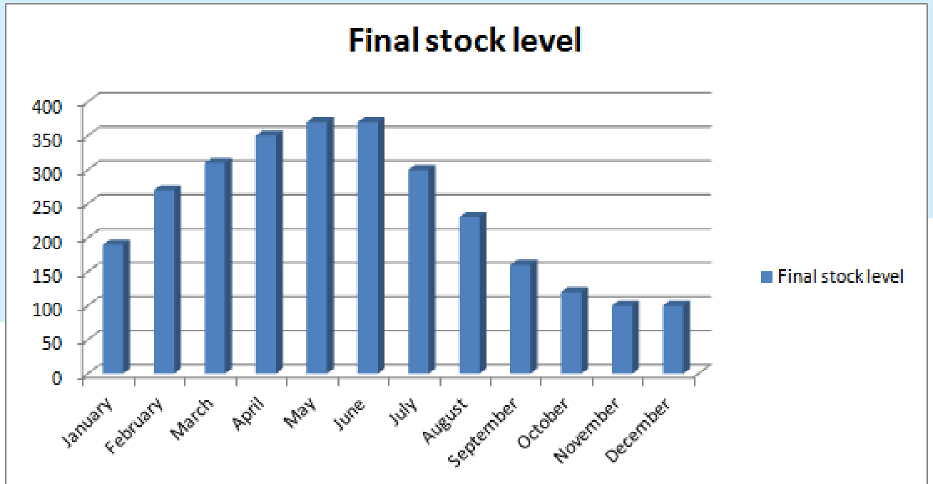
Production plan

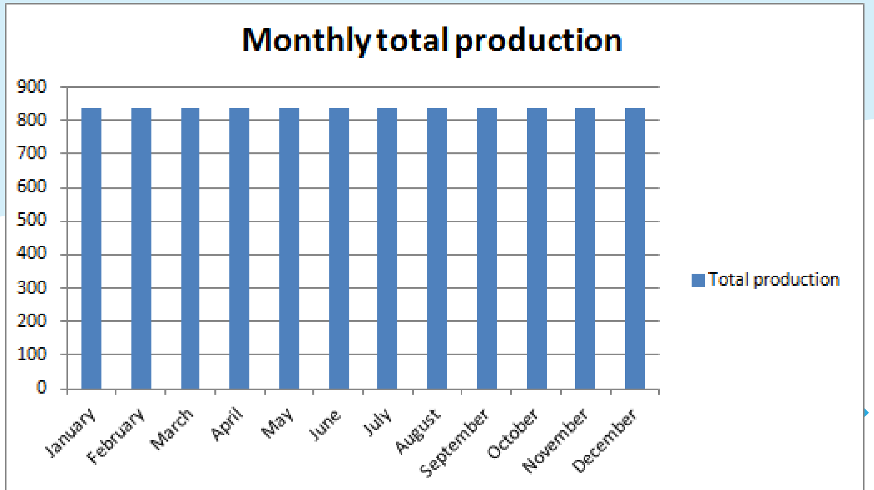
Aggregate production plan

E7

level – the size of production is equal in every period of time and the difference between the size and production level is compensated by stocks

Month	Demand forecast [pieces]	Number of needed man-hours	Number of needed emploees	Actual number of emploees	Regular production [pieces]	Possible production in overtime [pieces]	Acutal production in overtime [pieces]	Number of employments	Number of discharges	Final stock level
January	750	15000	93,75	105	840	85	0	5	0	190
February	760	15200	95	105	840	85	0	0	0	270
March	800	16000	100	105	840	85	0	0	0	310
April	800	16000	100	105	840	85	0	0	0	350
May	820	16400	102,5	105	840	85	0	0	0	370
June	840	16800	105	105	840	85	0	0	0	370
July	910	18200	113,75	105	840	85	0	0	0	300
August	910	18200	113,75	105	840	85	0	0	0	230
September	910	18200	113,75	105	840	85	0	0	0	160
October	880	17600	110	105	840	85	0	0	0	120
November	860	17200	107,5	105	840	85	0	0	0	100
December	840	16800	105	105	840	85	0	0	0	100
			105					0	5	
			Total during the year:		10080		0	5	5	2870

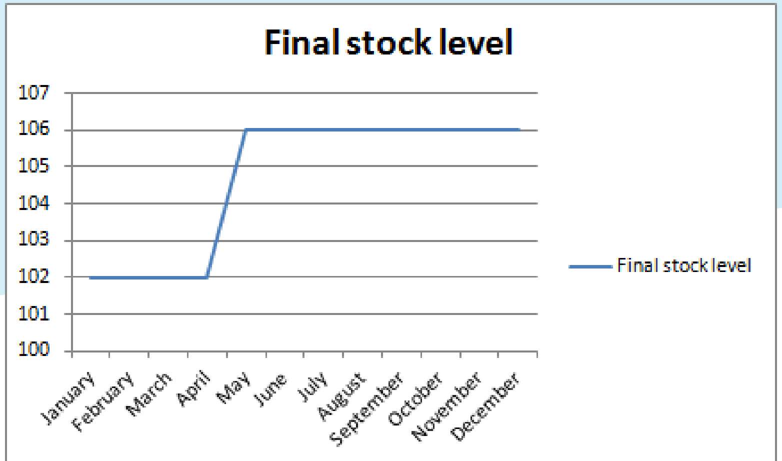


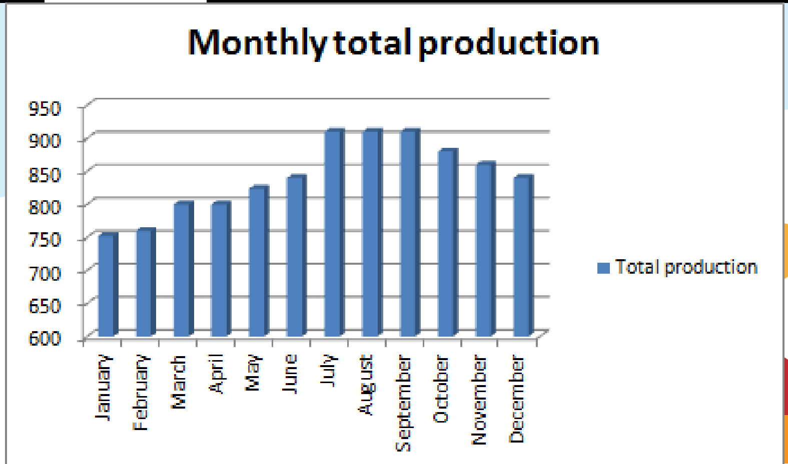


Aggregate production plan E8

chase – the opposite of the compensated plan - the size of production is changeable and suited to the demand forecast. The stock is on the stable level.

Month	Demand forecast [pieces]	Number of needed man-hours	Number of needed emploees	Actual number of emploees	Regular production [pieces]	Possible production in overtime [pieces]	Acutal production in overtime [pieces]	Number of employments	Number of discharges	Final stock level
January	750	15000	93,75	94	752	85	0	0	6	102
February	760	15200	95	95	760	85	0	1	0	102
March	800	16000	100	100	800	85	0	5	0	102
April	800	16000	100	100	800	85	0	0	0	102
May	820	16400	102,5	103	824	85	0	3	0	106
June	840	16800	105	105	840	85	0	2	0	106
July	910	18200	113,75	106	848	85	62	1	0	106
August	910	18200	113,75	106	848	85	62	0	0	106
September	910	18200	113,75	106	848	85	62	0	0	106
October	880	17600	110	106	848	85	32	0	0	106
November	860	17200	107,5	106	848	85	12	0	0	106
December	840	16800	105	105	840	85	0	0	1	106
			105					0	5	
			Total during the year:		9856		230	12	12	1256





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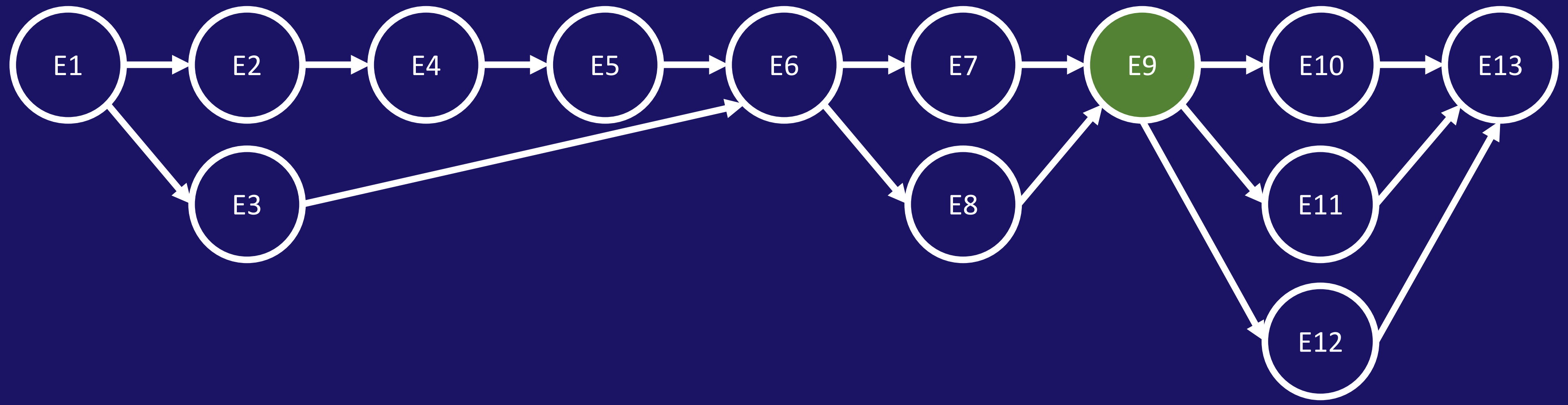
Production flows



Production flows

E9

Decide about the parts flow movement organization

Production flows

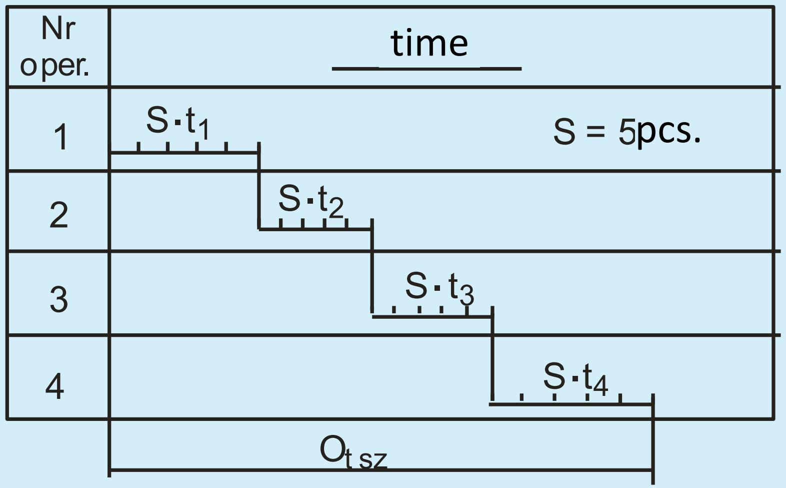
E9

The choice of the form of movement (transfer) of products from the workstation to the workstation during technological operations (technological phases) may refer to the following systems:

- serial,
- serial-parallel,
- parallel.

Production flows E10

The serial movement of the batch from operation to operation or station to station is such that the machined parts are transferred to the next operation after the previous operation has been performed on all pieces of the batch.

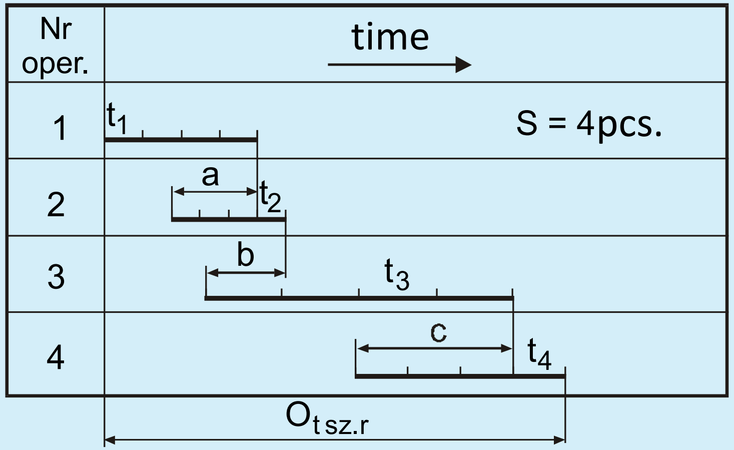


The serial movement system is characterized by:

- the longest production cycle time,
- the lowest number of transport operations,
- high degree of utilization of workstations and continuity production.

Production flows E11

The serial-parallel movement of the batch from operation to operation or from workstation to workstation consists in the fact that the processed parts are transferred to the next operation earlier than the operation is completed on all pieces of the batch:

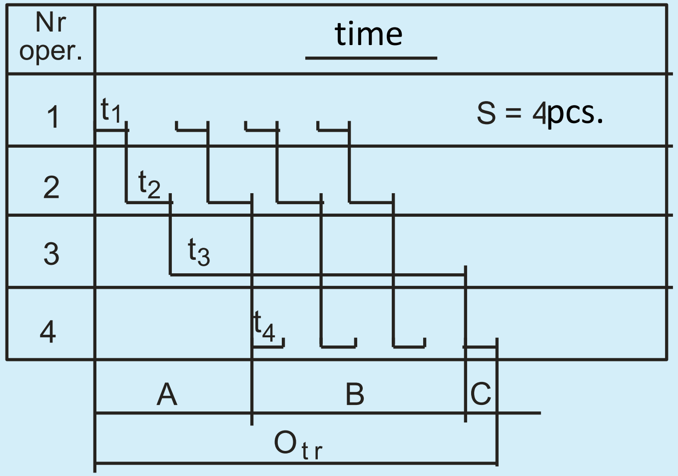


The series-parallel system is characterized by:

- shortening the length of the production cycle (compared to with serial arrangement),
- increased frequency of transport operations,
- high utilization of workstations and continuity production.

Production flows E12

Parallel batch movement means that individual parts are transferred to the next operation immediately after the previous operation has been performed, which creates a situation where one batch is simultaneously processed in parallel in different operations for several workstations).

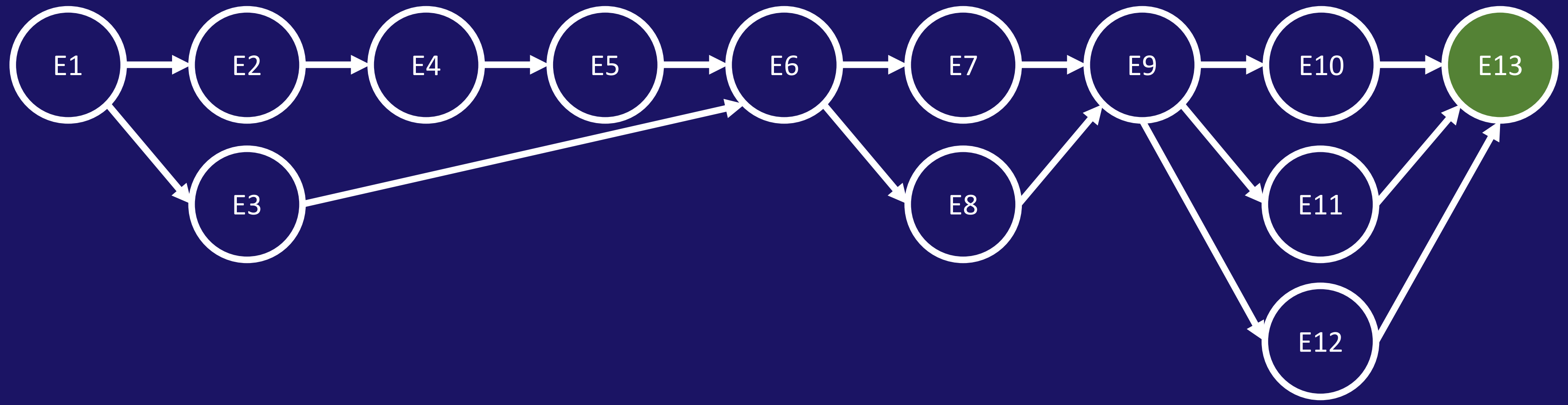


The parallel arrangement of the batch flow is characterized by:

- the shortest production cycle,
- increasing the number of transport operations,
- increasing the number of changeovers.

07.

Cycle time



Cycle time E13

Calculate the cycle time of the production process

Cycle time E13

The cycle time is the period between the beginning and the end of the production process of a product, in which the raw material going through subsequent stages of production, is transformed into a finished product.

Cycle time E13

The length of the cycle time in the serial detail flow system is calculated according to the formula:

$$O_{tsz} = S \cdot \sum_{j=1}^{n} t_j \quad ,$$

where: *S* – the size of the production batch,

t_j – unit time of the j-th operation,

n – consecutive number of operations in the technological process of the detail.

Cycle time

E13

The length of the cycle time in a serial-parallel part flow system is calculated according to the formula:

$$O_{tsz.r} = S\sum_{j=1}^{n} t_j - (S - p_t)\sum_{j=1}^{n-1} t_{mn/\,j;\,j-1/} \quad ,$$

where: S – the size of the production batch,

t_j – unit time of the j-th operation,

p_t – the size of the shipping batch,

n – consecutive number of operations in the technological process of the detail.

Cycle time

E13

The length of the cycle time in a parallel flow of details is calculated according to the formula:

$$O_{tr} = p_t \sum_{j=1}^{n} t_j + (S - p_t) \cdot t_{max.j} \quad .$$

where: S – the size of the production batch,

t_j – unit time of the j-th operation,

p_t – the size of the shipping batch.

n – consecutive number of operations in the technological process of the detail.

08.

References

References

1. Stevenson W.: Operations management, McGraw Hill, New York, 2021.
2. Heizer J.H.: Operations management: sustainability and supply chain management, Pearson, London 2020.
3. Slack N., Brandon-Jones A.: Operations management. Pearson, London, 2019.
4. Bozarth C.C., Handfield R.B.: Introduction to operations and supply chain management, Pearson Education Limited, 2019

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