



# Production systems and organizations

## *Case-examples*



Accounting and profitability

Projects and investing

Production as a part of value chain

Production processes and  
production control

**Production systems and  
organizations**

Creating value



# Production system's capacity: Heathrow airport



# Production system's capacity: Heathrow airport

- Started life in 1930 as a single grass runway
- In 2018, it was world's seventh busiest airport (by passenger traffic)
- Annual passengers: 80.1 million. Daily air transport movement: 1,303
- Heathrow runways operate at 99% capacity





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# In this exercise:

- Heathrow airport
  - Production processes
  - 4V-model
  - Capacity
  - Cycle time
  - Utilization rate and its effects





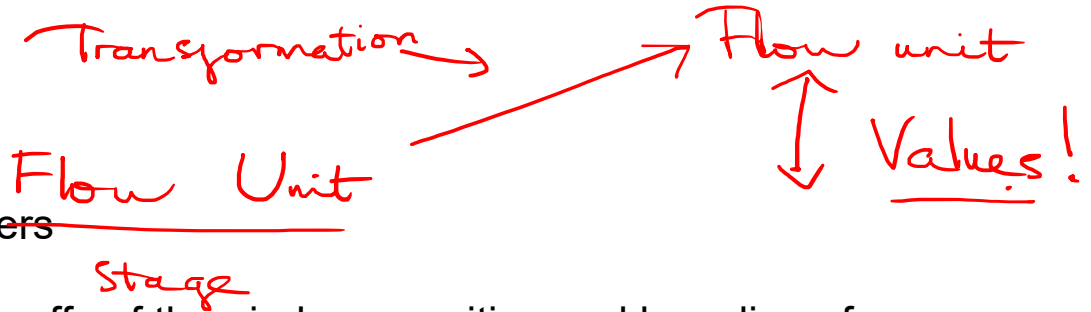
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# Production processes



- **Flow unit:** airplanes and passengers
- **Transformation:** landings and takeoffs of the airplanes, exiting and boarding of passenger
- **Necessary resources:** airport facilities, air traffic control, customer service, aircraft maintenance, ...
- **The value** of an airport is the transition of people and cargo to and from aircrafts, maintenance of airplanes...



# Production processes

- **Airports are generally considered connected line processes**
  - => Tasks are very specialized
    - Air traffic control coordinates flights
    - Passengers board planes from terminals
    - Maintenance for planes is routinely carried out
    - And much more...







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# 4V-model

- **High production volume**

- Steady flow of planes and passengers
- Employees specialized in their tasks

- **Low variety of products**

- Tasks are defined precisely
- Standard process

- **Average variation**

- Demand is known through flight scheduling
- High chance of external variation such as weather, late passenger,...

- **Low visibility**

- Air traffic control *guides* the airplane to their spot
- Passengers are *led* through the airport





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# Capacity

- **The airport is one of the busiest in the world**
  - In 2018, it was world's seventh busiest
  - ⇒ Demand is high
- **The airport operates close to the theoretical maximum capacity**
  - Heathrow runways operate at 99% capacity
  - At other major airports, the corresponding capacity is close to 70%
- **The airport has only 2 runways**
  - Frankfurt (FRA) has four, Paris Charles de Gaulle (CDG) also has four
  - ⇒ Runways are bottlenecks in Heathrow's production system





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# Cycle time

- A total of 1300 flight movements occur on runways daily. With an airport operating 24 hours a day, the average cycle time for the airport is:

$$\text{Cycle time} = \frac{\text{Time period}}{\text{Amount of flow units}} = \frac{24 * 60 \text{ min}}{1300} = 1,10 \dots \text{ min} \approx 66 \text{ s}$$

- That is, airplanes are required to take off or land at average intervals of 66 seconds





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# Utilization rate and its effects

- The runways operate at 99% capacity. Operations-wise:
  - Very high utilization rate
    - ⇒ Good operational efficiency: lower cost per flow unit
  - Long waiting time
    - ⇒ Planes usually have to line up to land/take off
    - ⇒ In the worst cases, certain flights have had to be canceled in order to keep other flights on schedule
  - Low tolerance for variability
    - ⇒ Even one factor that slows down the flow can lead to delays





# Utilization rate and its effects

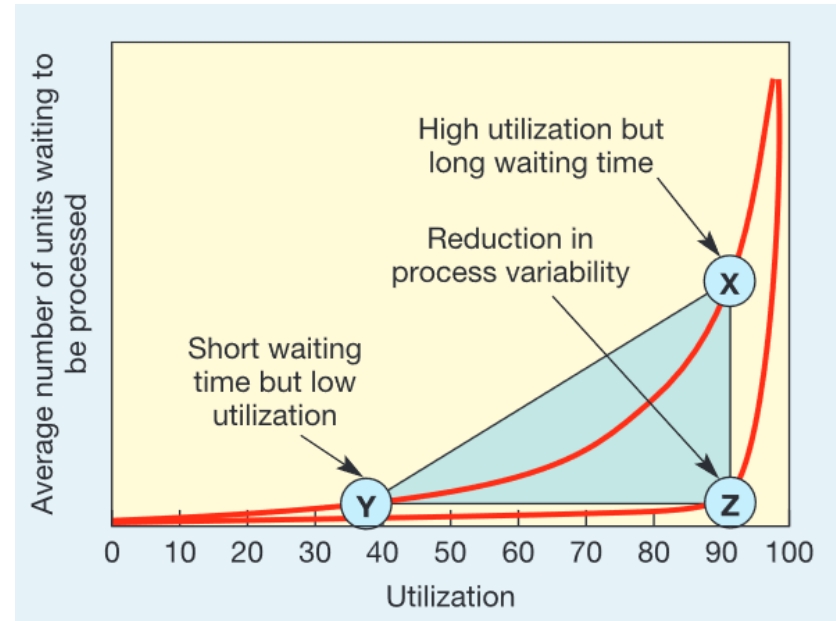
- **The runways operate at 99% capacity. Besides:**
  - Lost opportunities. Failing to catch up with increasing demands
  - Possibly inconsistent quality



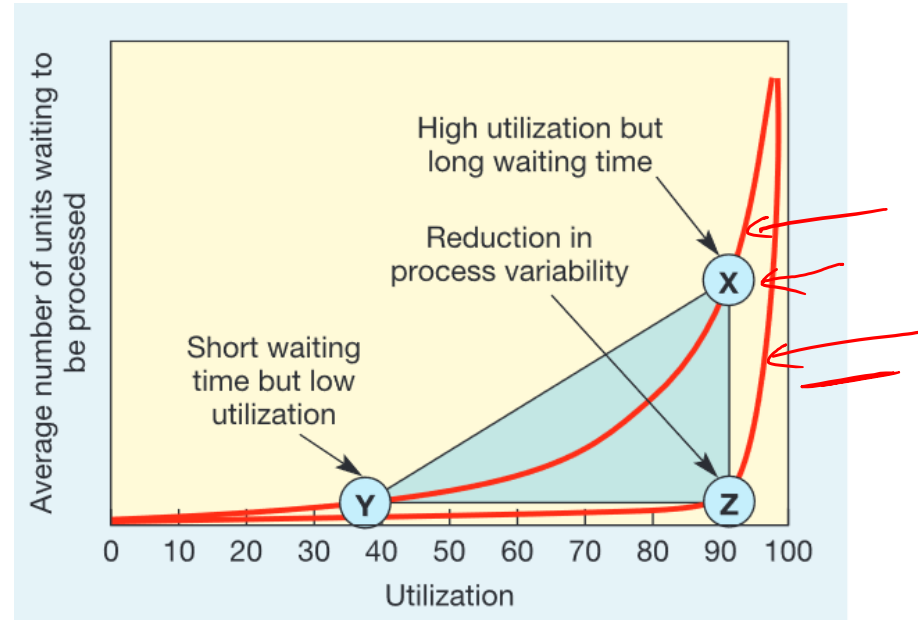
# Utilization rate and its effects

$$W = VUT$$

- **V** is variability
- **U** is utilization
- **T** is processing time
- **W** is cycle time (can also be wait time)

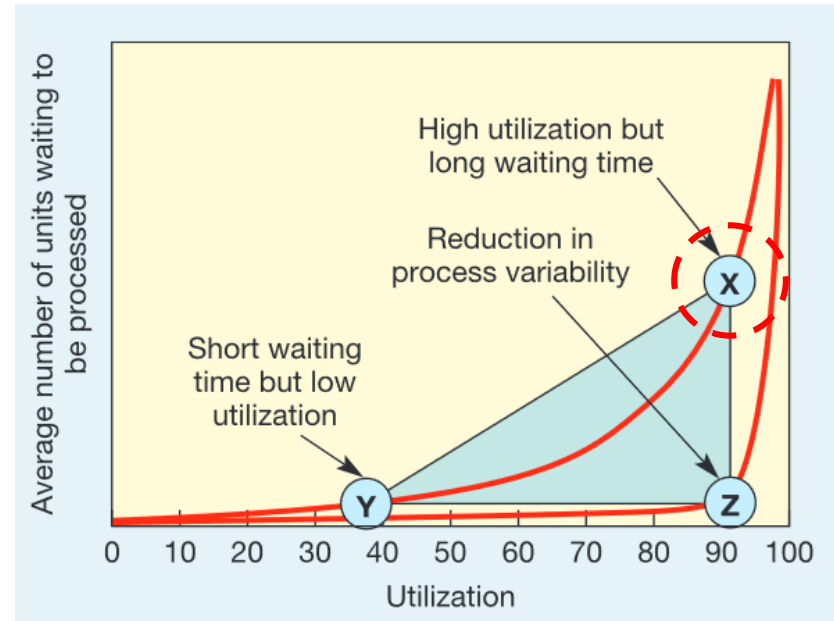


# Utilization rate and its effects



# Utilization rate and its effects

- **Point X represents Heathrow airport**
  - If a small change in the process line happened, the flow units will have to queue
  - Almost theoretical capacity, which results in high resource utilization



# A solution to the bottleneck

## British Courts In Favour Of Third Runway At Heathrow

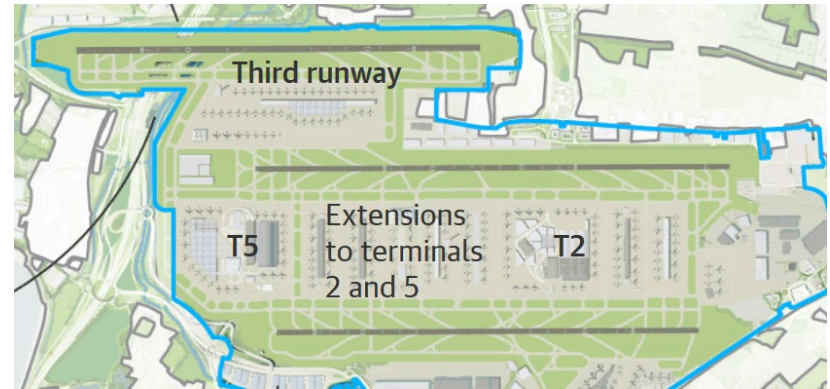
by **Jay Singh** · May 3, 2019 ·  One comment ·  2 minute read

London Heathrow is Britain's most well-known airport. For years, the airport has seen the number of free slots dwindle. Nowadays, coming across slots at Heathrow are next to impossible. Heathrow's solution was to build a third runway, however, some were opposed to this for various reasons. It seems now that the British Courts are siding with Heathrow and allowing the Heathrow Expansion Plan to continue.



# A solution to the bottleneck

- Increase airport capacity
- Better cycle time
- Better resistance against volatility
- Surplus capacity decreases utilization rate  
⇒ Higher cost per flow unit



# Week 2 assignment:

## Production system

### 1. Planning of production system (2 pages)

- Describe your production with the 4V model (Volume, Variety, Variation, Visibility)
- Which type of production process is used in your production? (*Wheelwright and Hayes*)
- What stages the production process involves?
- Explain the flow units, transformation and value created in your production
- Specify the resources needed in the production phases
  - *Raw materials, equipment and labor*

### 2. Capacity (1-2 pages)

- Estimate the capacity of your production system
  - *Provide an estimate of the theoretical capacity and describe the capacity constraints*
- Estimate the utilization rate of resources, i.e. how efficiently resources are used
- What stage / resource in your production is a potential bottleneck?



# Week 2 assignment:

## Production system

- **Return the assignment as a PDF to MyCourses**
- **The weekly assignment must be returned by Monday, 28th**
- **Remember to give feedback:**
  1. How long did it take to do the assignment?
  2. What new did you learn?
  3. What should be developed in this exercise?
  4. General comments on the course so far?
- **Next week we will discuss production processes and production control**

