Queuing theory:

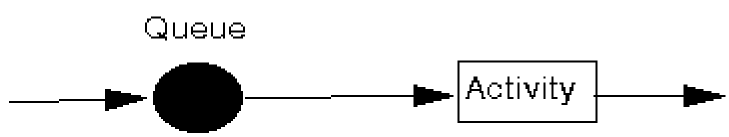
Queuing theory deals with problems which involve queuing (or waiting). Typical examples might be:

- banks/supermarkets - waiting for service
- computers - waiting for a response
- failure situations - waiting for a failure to occur e.g. in a piece of machinery
- public transport - waiting for a train or a bus

As we know queues are a common every-day experience. Queues form because resources are limited. In fact it makes *economic sense* to have queues. For example how many supermarket tills you would need to avoid queuing? How many buses or trains would be needed if queues were to be avoided/eliminated?

In designing queueing systems we need to aim for a balance between service to customers (short queues implying many servers) and economic considerations (not too many servers).

In essence all queuing systems can be broken down into individual sub-systems consisting of *entities* queuing for some *activity* (as shown below).



Typically we can talk of this individual sub-system as dealing with ***customers*** queuing for ***service***. To analyse this sub-system we need information relating to:

- **arrival process:**
  - how customers arrive e.g. singly or in groups (batch or bulk arrivals)
  - how the arrivals are distributed in time (e.g. what is the probability distribution of time between successive arrivals (the ***interarrival time distribution***))
  - whether there is a finite population of customers or (effectively) an infinite number

  The simplest arrival process is one where we have completely regular arrivals (i.e. the same constant time interval between successive arrivals). A Poisson stream of arrivals corresponds to arrivals at random. In a Poisson stream successive customers arrive after intervals which independently are exponentially distributed. The Poisson stream is important as it is a convenient mathematical model of many real life queuing systems and is described by a single parameter - the average arrival rate. Other important arrival processes are scheduled arrivals;

batch arrivals; and time dependent arrival rates (i.e. the arrival rate varies according to the time of day).

- **service mechanism:**
  - a description of the resources needed for service to begin
  - how long the service will take (the ***service time distribution***)
  - the number of servers available
  - whether the servers are in series (each server has a separate queue) or in parallel (one queue for all servers)
  - whether preemption is allowed (a server can stop processing a customer to deal with another "emergency" customer)

  Assuming that the service times for customers are independent and do not depend upon the arrival process is common. Another common assumption about service times is that they are exponentially distributed.

- **queue characteristics:**
  - how, from the set of customers waiting for service, do we choose the one to be served next (e.g. FIFO (first-in first-out) - also known as FCFS (first-come first served); LIFO (last-in first-out); randomly) (this is often called the *queue discipline*)
  - do we have:
    - balking (customers deciding not to join the queue if it is too long)
    - reneging (customers leave the queue if they have waited too long for service)
    - jockeying (customers switch between queues if they think they will get served faster by so doing)
    - a queue of finite capacity or (effectively) of infinite capacity

  Changing the queue discipline (the rule by which we select the next customer to be served) can often reduce congestion. Often the queue discipline "choose the customer with the lowest service time" results in the smallest value for the time (on average) a customer spends queuing.

Note here that integral to queuing situations is the idea of uncertainty in, for example, interarrival times and service times. This means that probability and statistics are needed to analyse queuing situations.

In terms of the analysis of queuing situations the types of questions in which we are interested are typically concerned with measures of system performance and might include:
The Importance Of Replacing

In the year 2018, consumers expect expeditious service and unforgettable customer experiences. Part of your company's ability to please its client base is to employ a staff made up of hard-working, dedicated and friendly individuals who believe in your brand's overall mission statement. Another important part of being successful is ensuring that your company is also equipped with all of the best tools and supplies to allow its staff to complete tasks effectively.

But what happens when your equipment becomes outdated or broken down? As MicroMain.com explains, when your equipment breaks down, “everything from your productivity to your bottom line is disrupted”. It’s important to quickly consider whether or not you need to repair the old equipment or invest in a brand new replacement.