

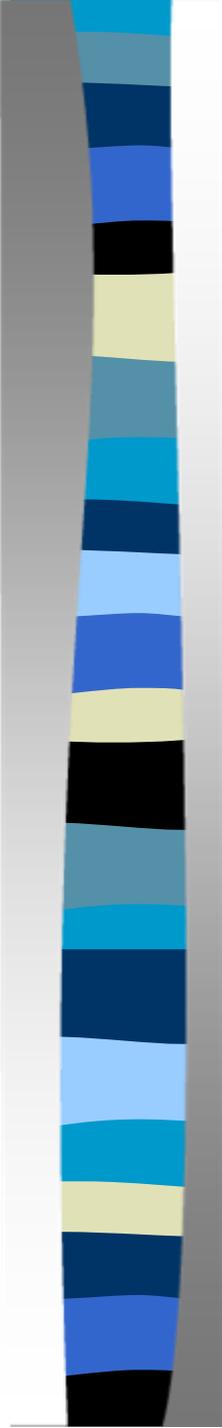
Systems Modelling and Simulation (Lab 8)

Topics:

- Some Key Arena Simulation Project Variables
- Overview of Key Performance Factors through Arena Output Analyser

Sources:

- Simulation with Arena, Kelton et al, Fourth Edition, 2007.
- Arena Variables Guide, Rockwell Software Inc., 2000.



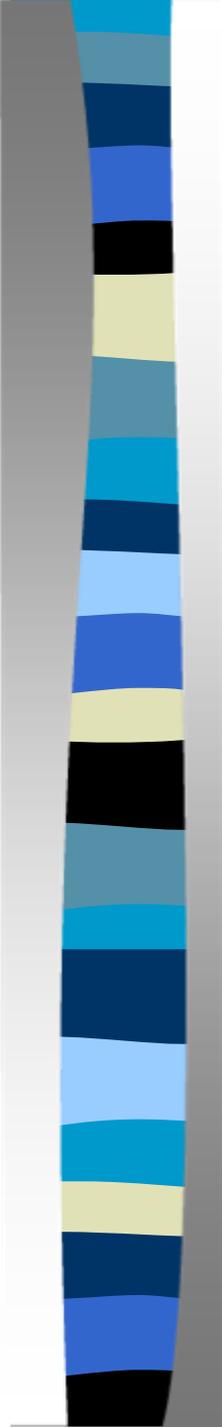
Arena Variables

■ In-Built Variables and User-Defined

- The in-built variables are predefined by attributes that store information for each entity
- User-defined set in the *Assign* module by the modeller

■ Useful When:

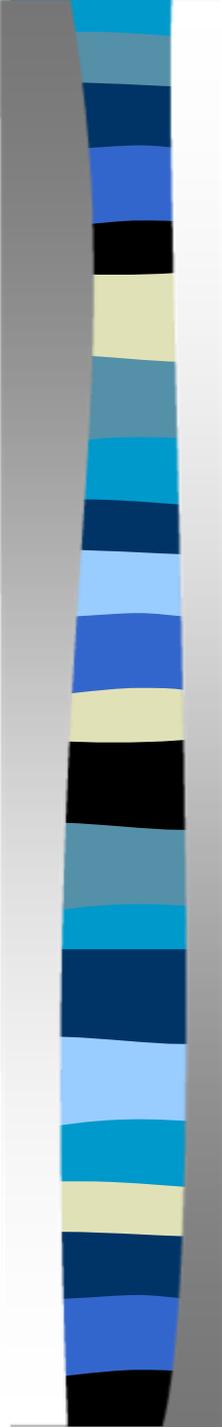
- Building your model e.g. *NQ(Parts.Queue)*, *NR(Resource1.Utilization)*, ...
- Animation e.g. *LT (Transporter ID, Unit Number)* – for location, *ACC (Transporter ID)* – for acceleration
- Collecting statistics during simulation run e.g. *TAVG(Time in System)*



Some of the Arena in-built Attributes

1. Entity:

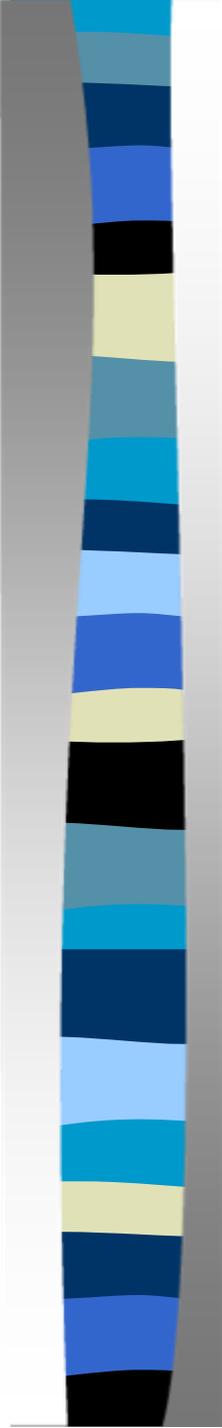
- ***Entity.Type (Entity Number)***: Refers to entity type or names, useful to assign pictures, cost and specify statistics
- ***Entity.Jobstep (Entity Number)***: Refers to *sequence index* attribute. It increments by one each time a sequential transfer occurs
- ***Entity.Sequence (Entity Number)***: Assigns a sequence number and determines the sequence that the entity follows in the model (station by station)



Some of the Arena in-built Attributes

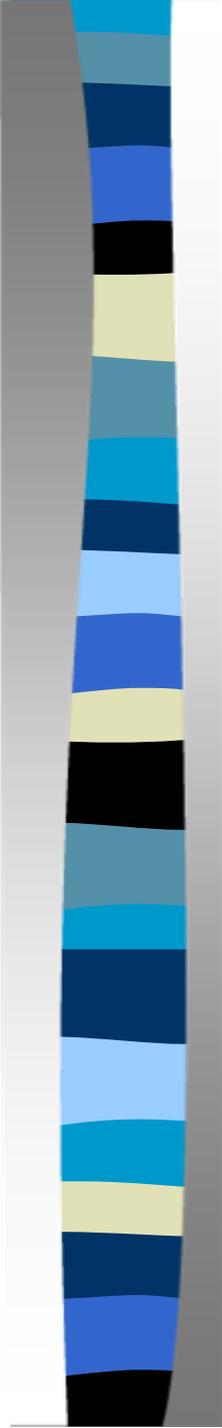
2. Time:

- ***Entity.VATime*** – Entity value added time: This is the time the entity spends in processes and the delays that are specified as value added - *Also Entity.NVATime*
- ***Entity.WaitTime*** – total time accumulated in queues, processes and delays designated as *Wait*.
- ***EntityTransferTime*** – Total transfer time accumulated in transfers e.g. transporters, conveyors or processes and delays designated as transfer
- **Entity Cost attributes that you can assign costs for.**



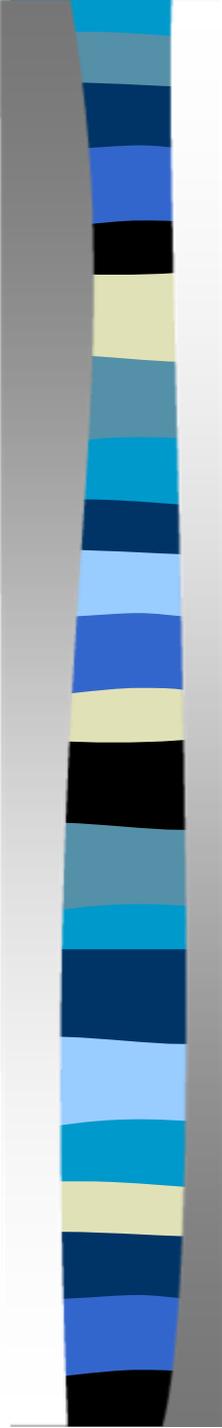
A few Entity-Type Variables

- *EntitiesIn(EntityType), EntitiesOut(Entity Type), Initial Picture(Entity Type), EntityWIP (Entity Type),...*
- Other Entity Variables:
 - ***IDENT – Active Entity Number:*** A unique number given to an entity when its created as a record of its existence. The number is re-used as entities are disposed and created
 - ***NUMENT – Number of Active Entities:*** NUMENT increases upon the creation of each entity and decreases upon dispose. A very good indication of the state of the system (i.e. *steady state(?)*). If ***NUMENT*** increases all the time there is an indication of logical problem in you model! **(important)**



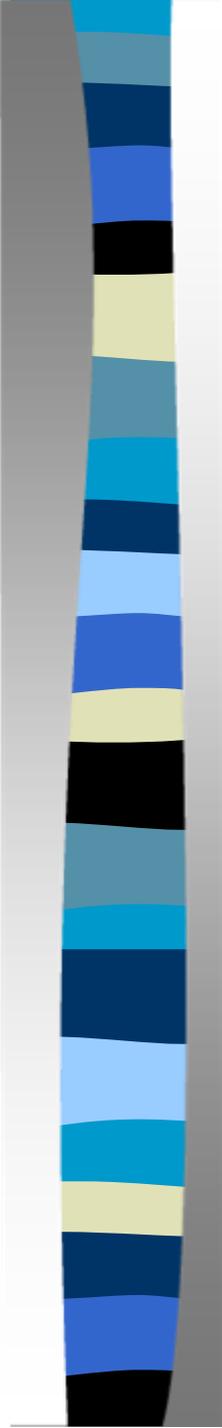
A few Queue Variables

- *NQ (Queue ID)* – specifies number in Queue
- *FirstINQ* and *LastINQ* – return the first and the last the entity number (*IDENT*), respectively.



A few Resources Variables

- $MR(\text{Resource ID})$ – Resource Capacity
- $NR(\text{Resource ID})$ – Number of Busy Resource Units
- $RESUTIL(\text{Resource ID})$ – Returns the instantaneous resource utilisation between 0 and 1
- $STATE(\text{Resource ID})$ – Returns the current state of the resource:
 - $STATE(\text{Resource ID}) == IDLE_RES$, or $BUSY_RES$, or $INACTIVE_RES$, or $FAILED_RES$



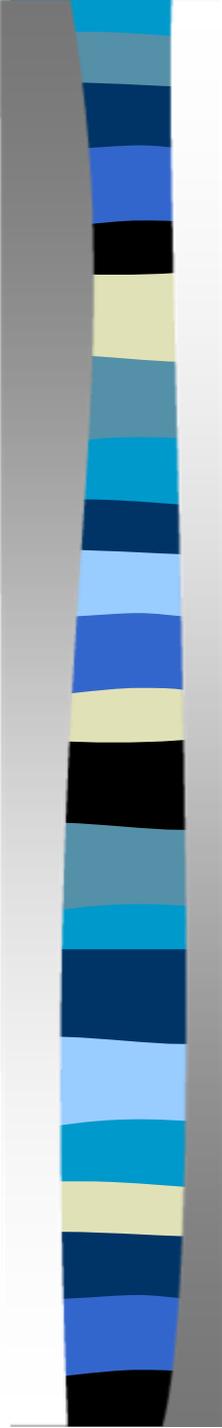
Some Other Variables

■ Time and Replication Variables:

- *MREP* – *Maximum Replication*
- *NREP* – *Replication Number*
- *TFIN* – *Final Simulation Time*: Represents replication length
- *TNOW* – *Current Simulation Time*

■ System Response Variables

- *Total.Throughput* – *Total entity throughput*: Represents the total number of entities that have finished processing



Arena Output Summary

- Run Example

1. *Tally Statistics (discrete-time stats)*: Results taken from the minimum, or maximum or average of a list of numbers (e.g. average, min. or max. total time in the system of n number of parts. (end of simulation run))
2. *Time Persistent Statistics (continuous-time stats)*: Are from time average, min. or max. of a plot of a factor during a simulation (on the x continuous axis). It is the accumulated area under the plotted curve (i.e. integral), the average or number of parts in queue or the instantaneous resource utilisation are time persistent stats. (accessed at any time)
3. *Counter Statistics*: accumulated sums of something, i.e. how many times something has happened. Number of parts in or out, total number seized, ...

Summary Report

```

Model6-1.out - Notepad
File Edit Format View Help
SIMAN Run Controller.
39.00179 Hours>
                ARENA Simulation Results
    Authorised User - License: 1953000875
                Summary for Replication 1 of 1

Project: Example                      Run execution date :11/23/2009
Analyst: Simulation and Modelling      Model revision date:11/23/2009

Replication ended at time      : 100.0 Hours
Base Time Units: Hours

                TALLY VARIABLES
Identifier                Average  Half Width  Minimum  Maximum  Observations
-----
Part.VATime                .01644    2.0161E-04 .00893   .02455   1216
Part.WaitTime              .00173    3.0732E-04 .00000   .03717   1216
Part.TotalTime             .01817    4.0573E-04 .00893   .05314   1216
Machining Process.Queue.WaitingTime .00173    3.0732E-04 .00000   .03717   1216

                DISCRETE-CHANGE VARIABLES
Identifier                Average  Half Width  Minimum  Maximum  Final Value
-----
Part.WIP                  .22101    .00896     .00000   3.0000   .00000
Machine 1.NumberBusy      .19996    .00744     .00000   1.0000   .00000
Machine 1.NumberScheduled 1.0000    (Insuf)    1.0000   1.0000   1.0000
Machine 1.Utilization     .19996    .00744     .00000   1.0000   .00000
Machining Process.Queue.NumberInQueue .02104    .00327     .00000   2.0000   .00000

                OUTPUTS
Identifier                Value
-----
Part.NumberIn              1216.0    (Counter)
Part.NumberOut             1216.0    (Counter)
Machine 1.NumberSeized     1216.0    (Time Persistent Stats)
Machine 1.ScheduledUtilization .19996    (Time Persistent Stats)
System.NumberOut           1216.0    (Counter)

Simulation run time: 0.07 minutes.
Simulation run complete.
    
```