

# Requirements Gathering for Simulation

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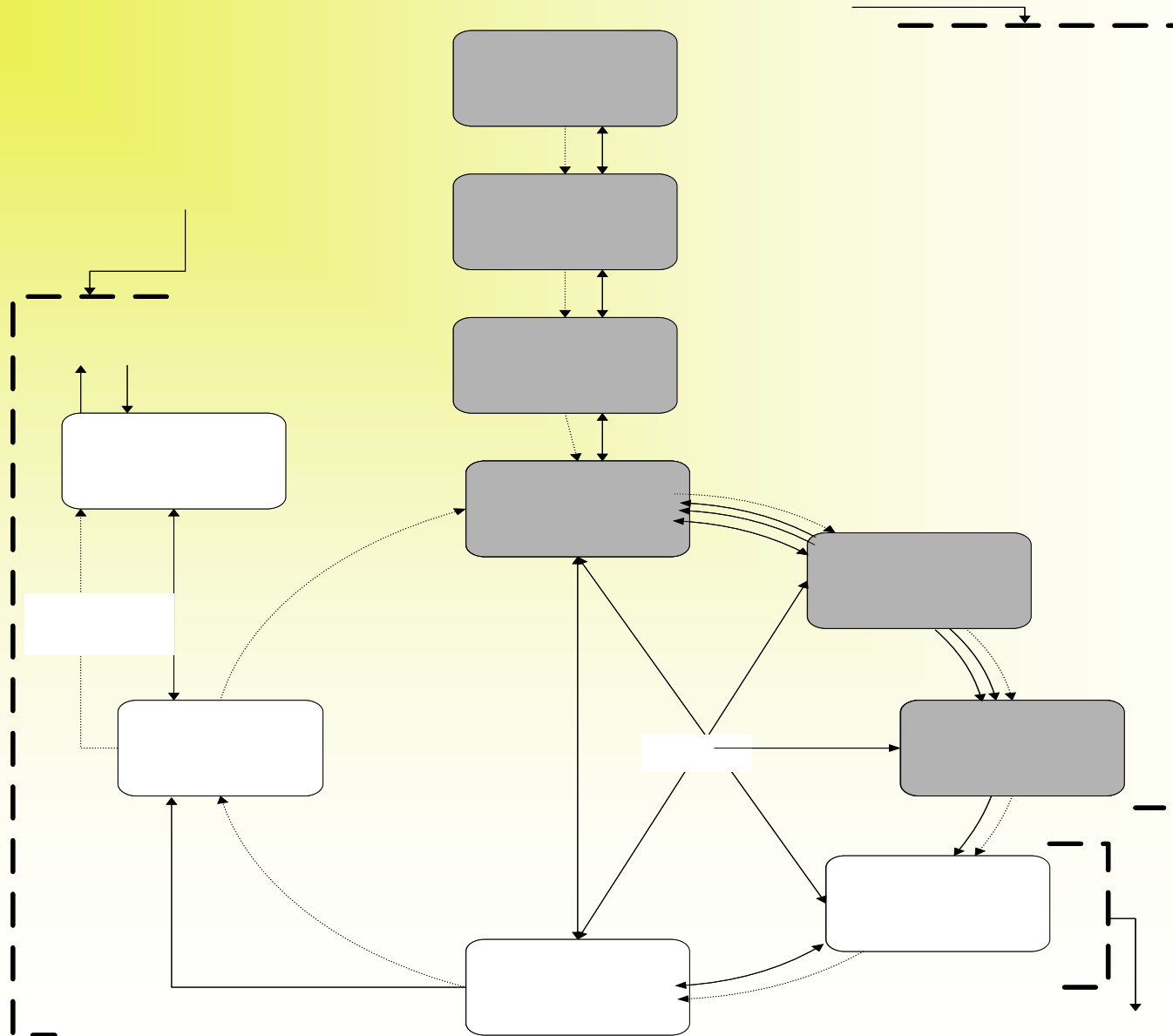
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# Life cycle of a simulation project



# Development Objectives

- To develop a process modelling technique to support the pre-coding phases of a simulation project that:
  - Could capture a detailed description of the various aspects of a Discrete Event System (DES);
  - Has a low modelling burden;
  - Facilitates understanding and communication;
  - Has good visualisation capabilities to facilitate communication between a model developer and system personnel.

# Development Objectives

- Some of the shortfalls that need to be addressed to facilitate this include a means of representing:
  - The flow of work, or change of state of a discrete event system;
  - The flow of information associated with the control of a discrete event system;
  - The resources necessary and their usage in the execution of the activities associated with work and information;
  - The modelling of a system from the perspective of a system user and their interactions with the system;
  - Access to a means of elaborating graphical models to facilitate further communication.

## **SAD Development Process**

- A review of process modelling techniques specifically developed to support the pre-coding phases of a simulation project highlighted the lack of research in this area.
- A broader review of process modelling techniques which it was felt were capable of modelling aspects of discrete event systems was then undertaken.
- This highlighted many techniques which were capable of broadly satisfying at least some of the design objectives outlined previously – in fact too many to practically review.



# SAD Development Process

- Conclusions:
  - There are a number of process modelling techniques and software tools available that may be used to support the requirements gathering phases of a simulation project;
  - None of the techniques however are capable of capturing, representing and communicating the various aspects of a discrete event system and their interactions in such a way as to aid understanding by non-simulation experts;
  - As a result of this initial review the development of a technique known as Simulation Activity Diagrams (SADs) was undertaken.

# Simulation Activity Diagrams (SADs)

- Modelling Primitives:
  - Activity – An activity is any event that causes the change of state of a discrete event system;
  - Action – An action element represents the individual task or tasks that have to be performed within a system at a particular instance;
  - Action list – An action list consists of the time phased sequence of the individual actions that make up a particular activity at a particular time;

# Simulation Activity Diagrams (SADs)

- Modelling Primitives:
  - Primary resource – A primary resource element represents any resource located within a discrete event system which facilitates the transformation of a product, physical or virtual, from one state of transition to another;
  - Queue – A queue modelling element represents any location or phase of a discrete event system where a product, virtual or physical, is not in an active state of transformation within the system;

# Simulation Activity Diagrams (SADs)

- Modelling Primitives:
  - Entity – An entity element represents any product, physical or virtual that is transformed as the result of transitioning through a discrete event system;
  - Entity state – An entity state represents any of the various states that a physical or virtual object explicitly represented within a discrete event system transitions through during physical transformation;

# Simulation Activity Diagrams (SADs)

- Modelling Primitives:
  - Informational element – An informational element represents any information that is used in the control or operation of the process of transition by an entity, through a discrete event system;
  - Informational state element – An informational state element represents any of the various states that information, used in the control or operation of the process of transition by an entity state through a discrete event system, can transition through.

# Simulation Activity Diagrams (SADs)

- Modelling Primitives:
  - Auxiliary resource – An auxiliary resource represents any resource used in the support of any phase of transition of any state element within a system;
    - Actor auxiliary resource – An actor auxiliary resource represents any auxiliary resource used in the direct support of the execution of an action or actions within the process of transitioning a system from one state to another;
    - Supporter auxiliary resource – A supporter auxiliary resource represents any auxiliary resource used in the direct support of an actor auxiliary resource or primary in the execution of an action or actions within the process of transitioning a system from one state to another.

# Simulation Activity Diagrams (SADs)

## ■ Branching Elements.

**AND**

**An asynchronous “And” branch element**

**XOR**

**An asynchronous exclusive “Or” branch element**

**OR**

**An asynchronous inclusive “Or” branch element**

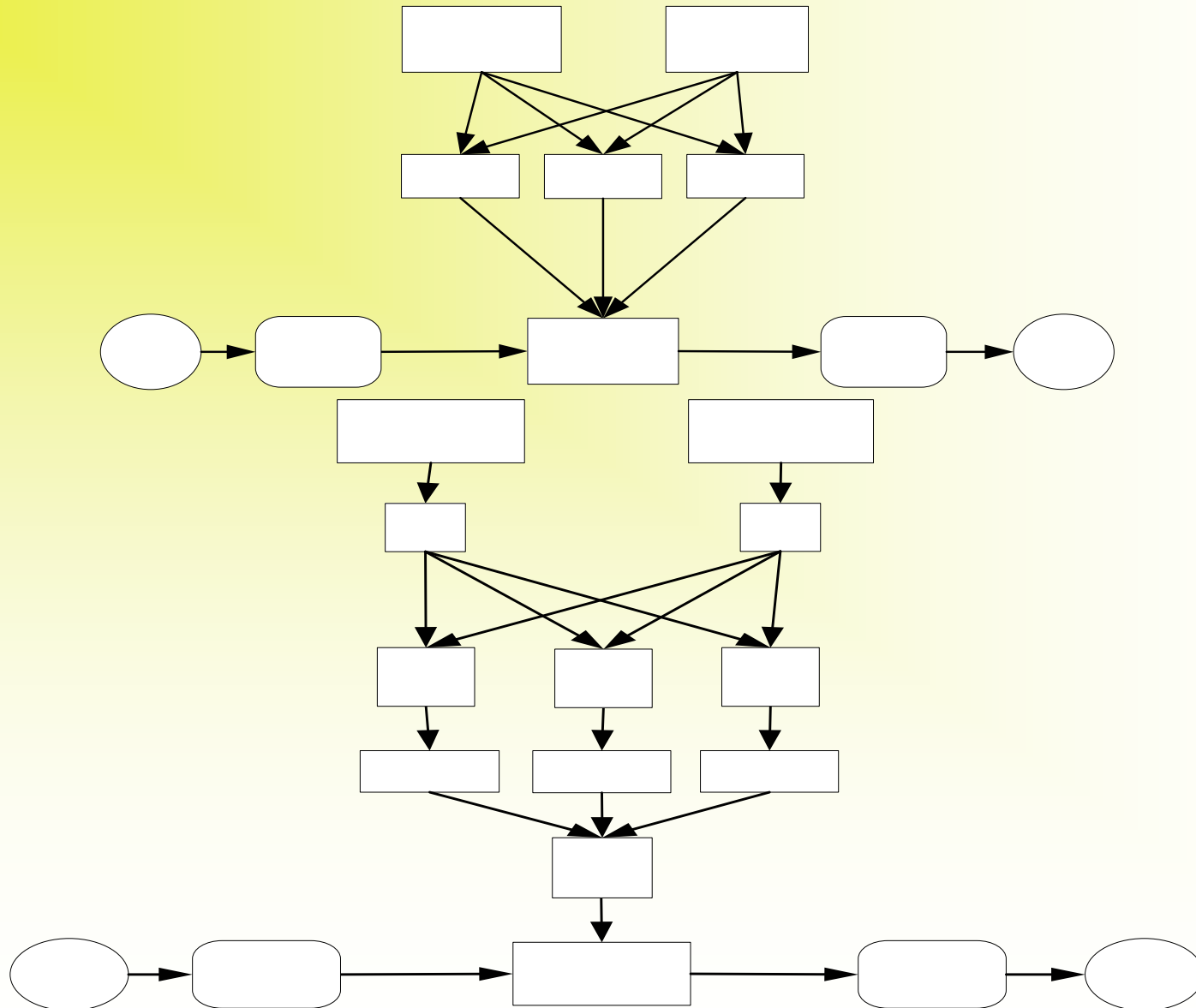
**AND(S)**

**A synchronous “And” branch element**

**OR(S)**

**A synchronous inclusive “Or” branch element**

# Simulation Activity Diagrams (SADs)



# Simulation Activity Diagrams (SADs)

## ■ Link Types:

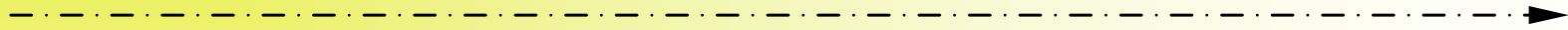
- Entity link – An entity link represents the physical flow of a product, actual or virtual, through a discrete event system along with the relations between instances of elements used in the physical transformation of such products within a model;
- Information link – An information link represents the flow of information through a discrete system along with the relations between instances of elements used in the transformation of such information within a model;
- Activity link – An activity link type represents the relations between various SAD elements used in the execution of each SAD activity.

# Simulation Activity Diagrams (SADs)

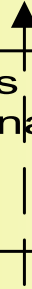
- Frame element – A SAD frame element provides a mechanism for the hierarchical structuring of detailed interactions within a discrete event system into their component elements, while also showing how such elements interact within the overall discrete event system.

# Simulation Activity Diagrams (SADs)

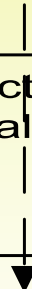
Informational system [ Shows the transitioning of the information system through its various states].



Information Actions [ Shows the various actions that make up activities involved in the transitioning of the informational system from one state to another].



Actors/Supporters [Shows the various actions and auxiliary resources involved in the execution of the various physical and informational activities].

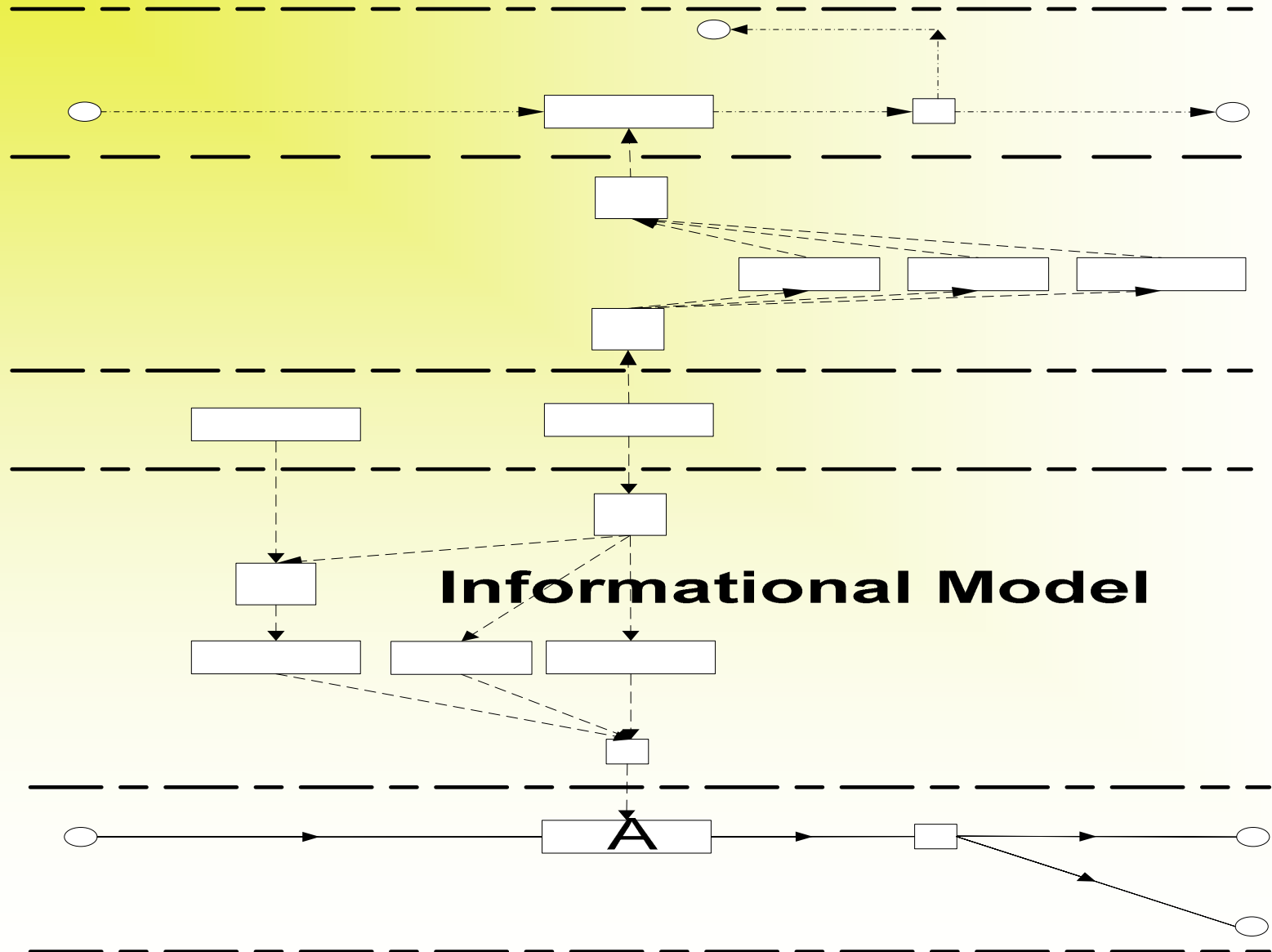


Physical Actions [Shows the various actions that make up the activities involved in the transitioning of the physical system from one state to another

Physical/Production system [shows the transitioning of the physical/production system through its various states



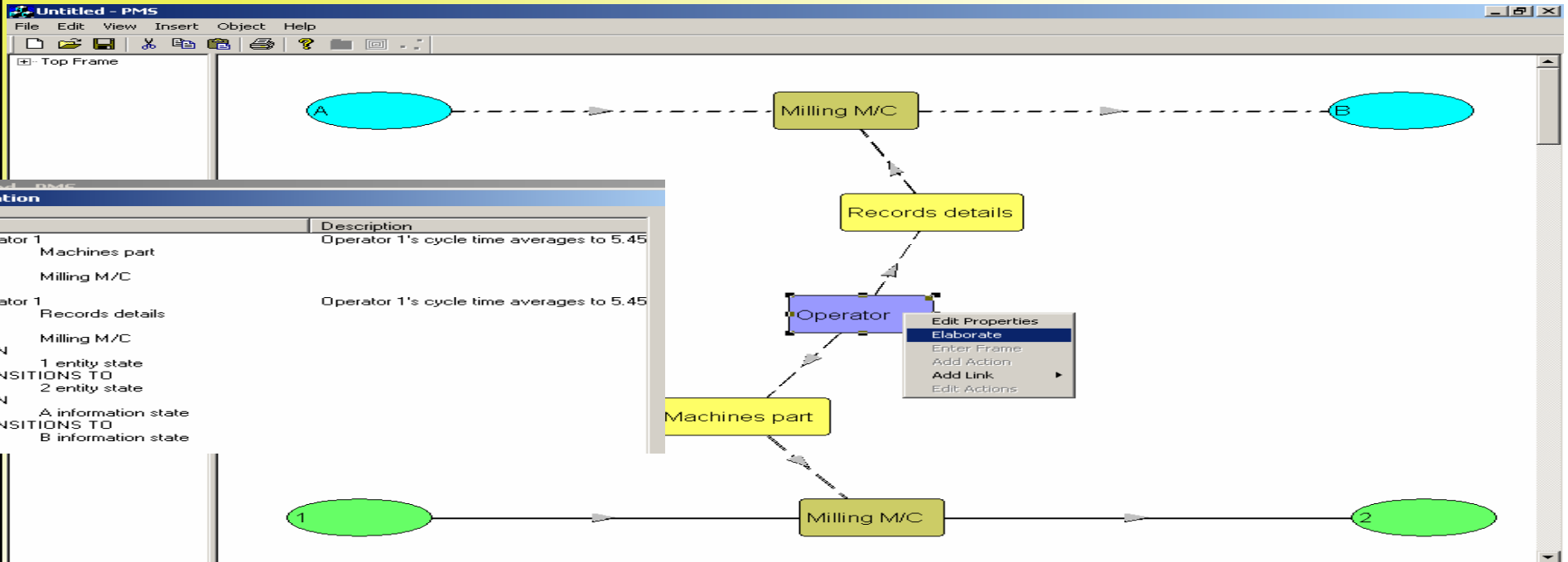
# Simulation Activity Diagrams (SADs)



# Elaboration of SAD Models

<b>Keyword</b>	<b>Description</b>
<b>USES</b>	The supporter resource may at times make use of auxiliary resources to execute an action or actions, in other words a supporter USES auxiliary resources.
<b>TO</b>	Details the action or actions that are executed by use of an auxiliary resource by a supporter resource.
<b>AT</b>	Specifies the Locations where the action or actions are executed
<b>TRANSITIONS TO</b>	Specifies the change of state of entity or information from one state to another

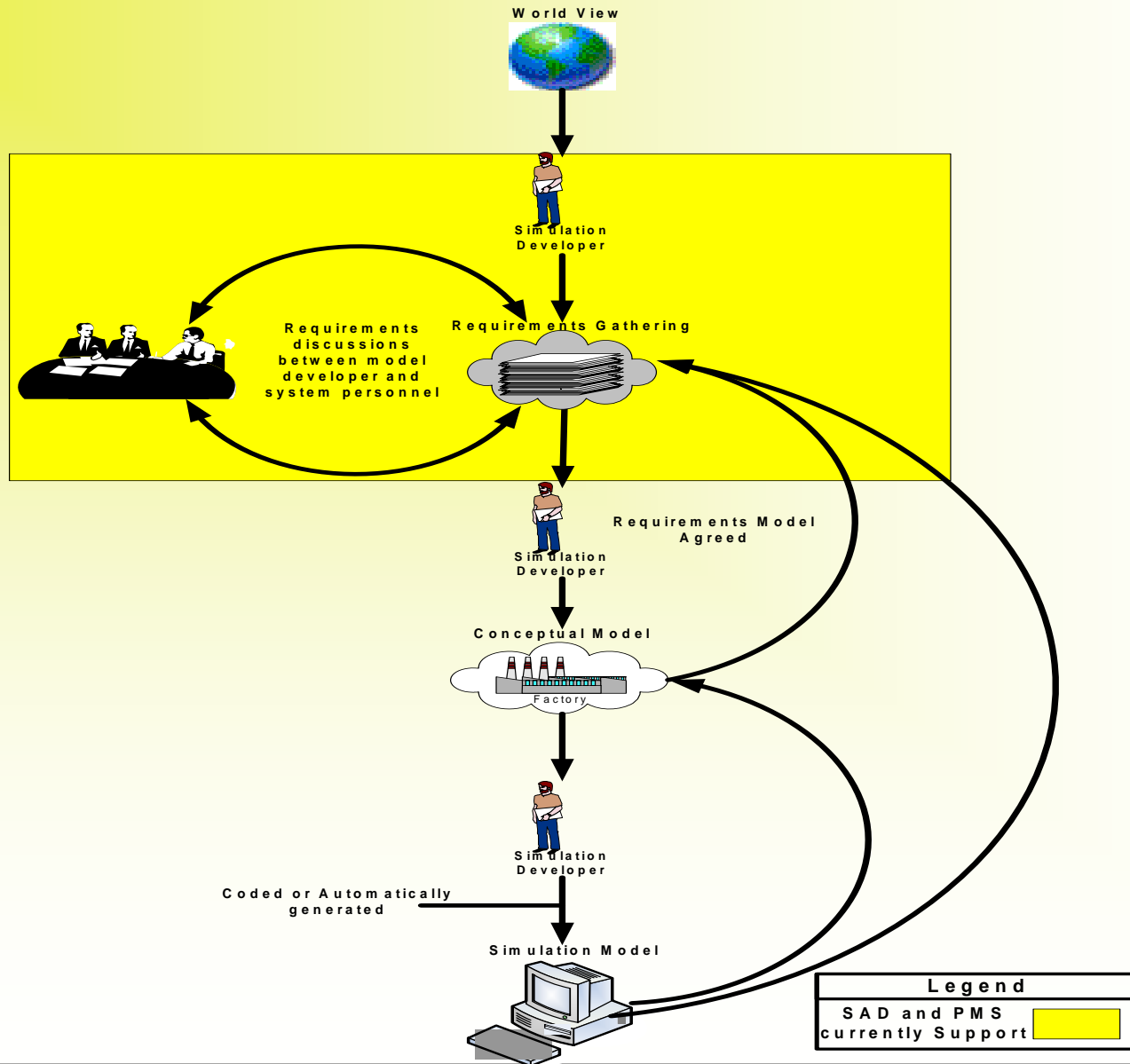
# Process Modelling for Simulation (PMS)



## **Future Work**

- Continue examining the area of pre-simulation coding with a view to developing techniques and tools specifically for the purposes of aiding a simulation model developer in the pre-coding phases of a simulation project;
- The SAD technique requires further validation;
- Further research could also be undertaken into ways in which the SAD technique could further support the pre coding phases of a simulation project – currently primarily requirements gathering, further developments may facilitate conceptual modelling;

# Future Work



## Future Work

- Further research into the development of the PMS software could be undertaken:
  - User interface – to allow for easier model development;
  - Step through/elaboration function – improve the interaction between visual elements and the elaboration language;
- The development of a neutral representation for conceptual model information to be transferred to the simulation engine or other software of choice.

# Conclusions

- There is a lack of specific support to aid a simulation model developer in the pre-coding phases of a simulation project;
- There are many process modelling techniques available to aid in modelling various aspects of a discrete event system but none specifically developed for this purpose;
- To this end the development of a process modelling technique, Simulation Activity Diagrams (SADs) attempts to specifically support the requirements gathering phase of a simulation project;
- SADs attempt to graphically represent discrete event systems in a high level and user friendly manner by attempting to represent physical, control, resource and action information in a single model.

**Thank You**