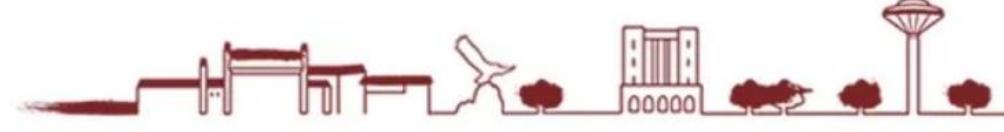




上海财经大学  
SHANGHAI UNIVERSITY OF FINANCE AND ECONOMICS



# 智能素养与计算社会科学方法论

# 社会科学中的仿真计算方法

主讲人：邵志芳

上海财经大学



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## 3-4 创建仿真模型



# 课程目标

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- (1) 熟练掌握Arena基本操作面板中的流程模块和数据模块，学会用模块建立实际系统模型。
- (2) 掌握对模型运行结果的分析方法，看懂Arena运行结果报告。
- (3) 了解对实际问题的分析过程。通过运行仿真模型，了解该生产线运行状况（生产周期、设备利用率、等待加工时间、生产能力等）。
- (4) 能够根据模型运行报告，分析该生产线存在的问题，针对该生产线的管理提出改进建议。



# 目录

---

- 背景描述
- 建立模型
- 运行模型
- 观察结果

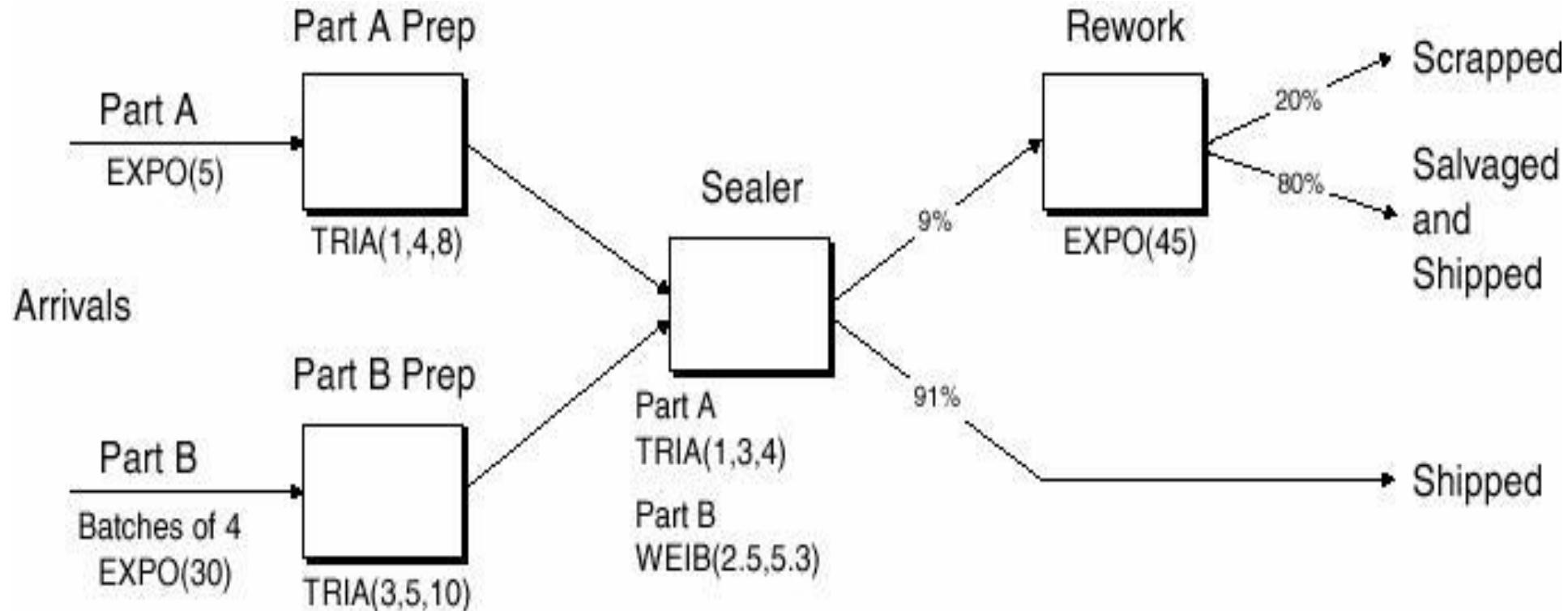


# 背景描述

---

- 该场景描述的是两种需要封装的电子产品的最后一道工序，到达产品需进行预处理，然后再装配。流程如下：
  - 分别制造两个电子元件A，B；
  - 制造过程包括预处理和装配两个操作；
  - Sealer步骤完成后进行检测，然后根据检测结果来判断是Rework还是Shipping；
  - Rework过程包括Salvage且Shipping或者是Scrapped。

# 模型数据



电子装配与测试系统流程图



# 运行条件及输出要求

---

- 开始启动为Empty&Idle， 运行4个8小时/班
- 对于每个工作区， 统计
  - Resource Utilization
  - Number in Queue
  - Time in Queue
- 对于每个退出点(Shipped, Salvaged, Scrapped)， 统计系统中总停留时间(cycle time)。
- 统计每个退出点的产品数量



# 目录

---

- 背景描述
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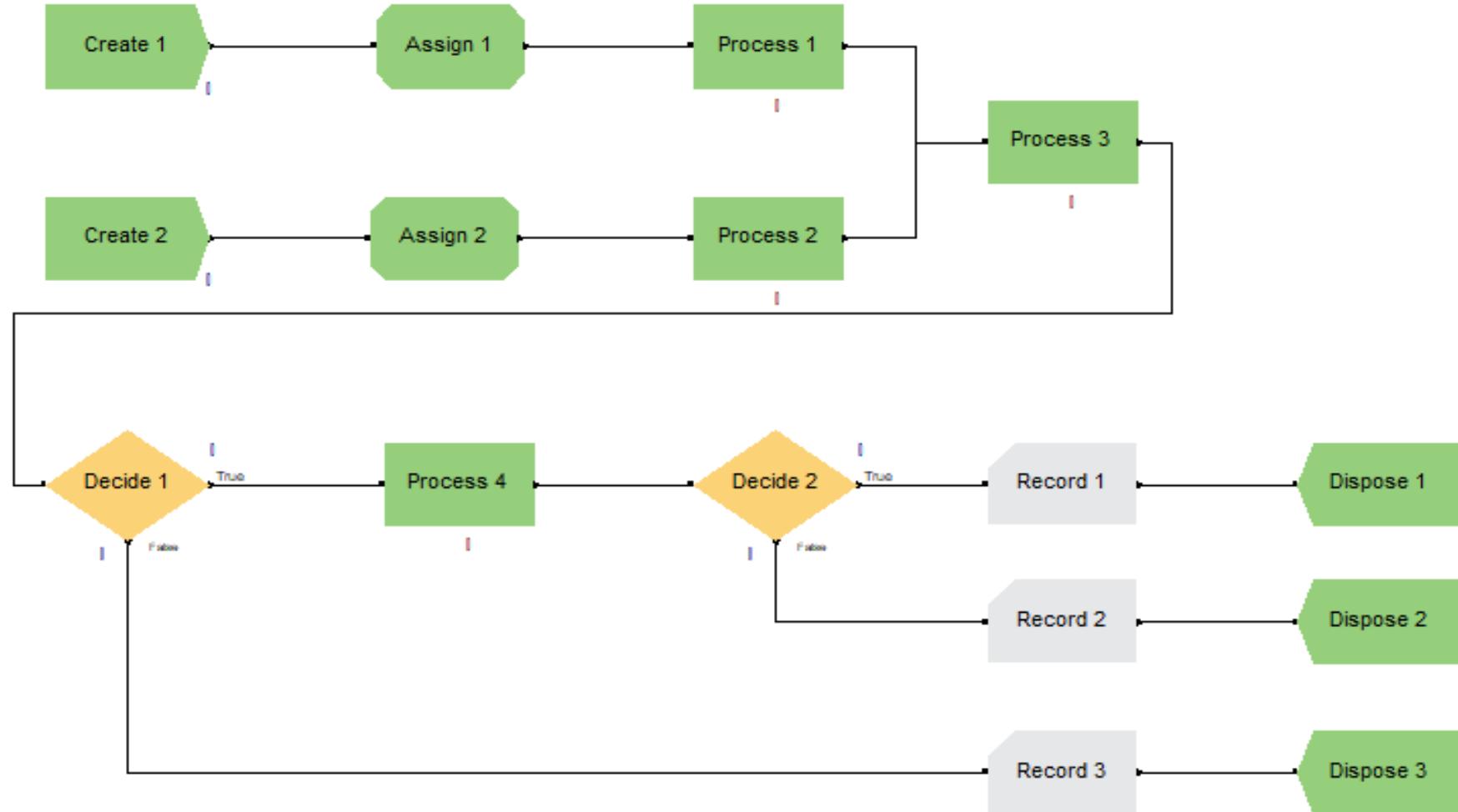
# 建立模型

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- 分析“系统、系统边界、实体、资源”等系统要素
- 从Arena软件Project Bar找到相应模块构建模型
- 通过数据模块为模型赋数据
- 为模型设置运行条件
- 运行模型



# 建立电子组装测试系统流程图





# 为Create 模块赋值

Create

Name: Entity Type:

Part A Arrive Part A

Time Between Arrivals

Type: Value: Units:

Random (Expo) 5 Minutes

Entities per Arrival: Max Arrivals: First Creation:

1 Infinite 0.0

Comment:

OK Cancel Help

Create

Name: Entity Type:

Part B Arrive Part B

Time Between Arrivals

Type: Value: Units:

Random (Expo) 30 Minutes

Entities per Arrival: Max Arrivals: First Creation:

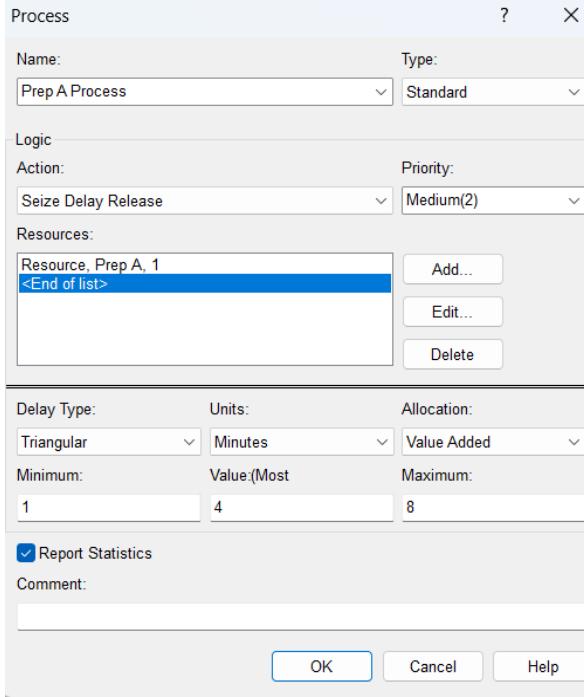
4 Infinite 0.0

Comment:

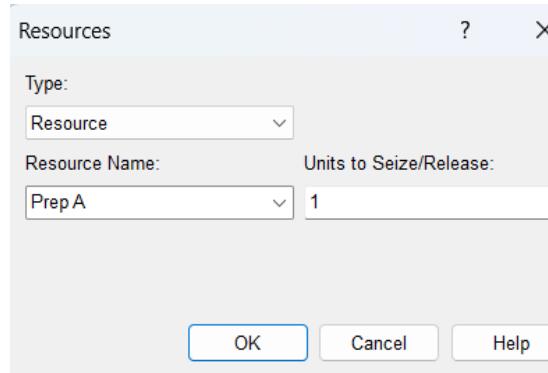
OK Cancel Help



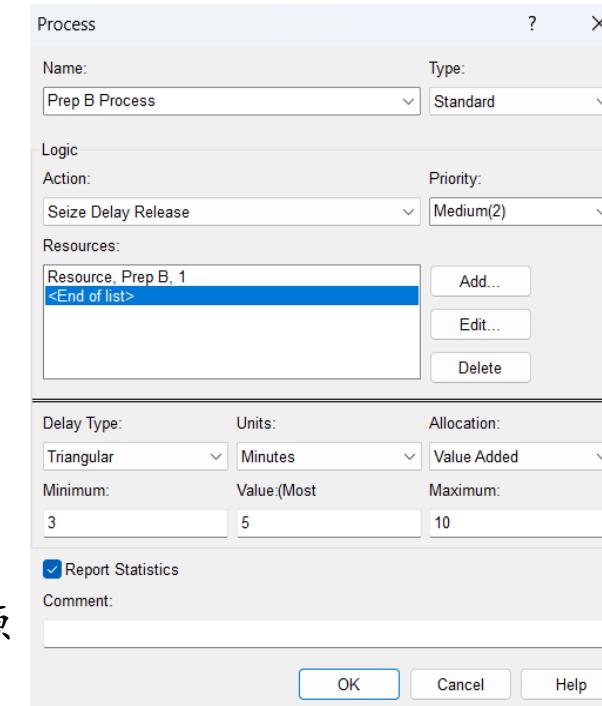
# 为Process模块赋值



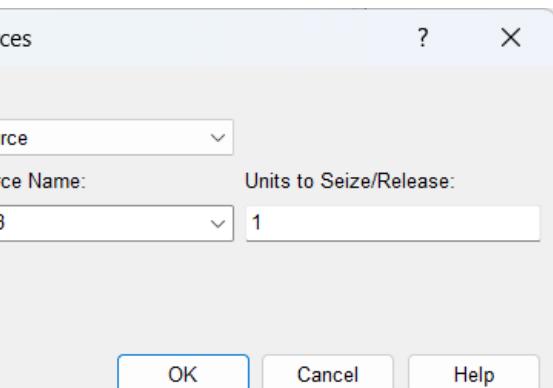
A的预处理过程



添加A的预处理过程占用资源



B的预处理过程



添加B的预处理过程占用资源



# 封装操作的处理

Process

Name: Sealer Process Type: Standard

Logic

Action: Seize Delay Release Priority: Medium(2)

Resources:

Resource, Sealer, 1 <End of list>

Add... Edit... Delete

Delay Type: Expression Units: Minutes Allocation: Value Added

Expression: Sealer Time

Report Statistics

Comment:

OK Cancel Help

Resources

Type: Resource

Resource Name: Sealer Units to Seize/Release: 1

OK Cancel Help



# 返工操作的处理过程

**Process** ? X

Name: **Rework Process** Type: **Standard**

Logic

Action: **Seize Delay Release** Priority: **Medium(2)**

Resources:

Resource, Rework, 1  
<End of list>

Add... Edit... Delete

Delay Type: **Expression** Units: **Minutes** Allocation: **Value Added**

Expression: **EXPO(45)**

Report Statistics

Comment:

OK Cancel Help

**Resources** ? X

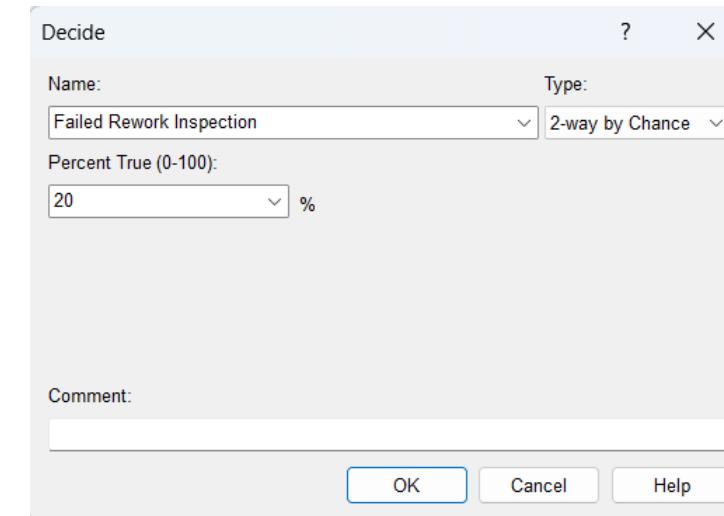
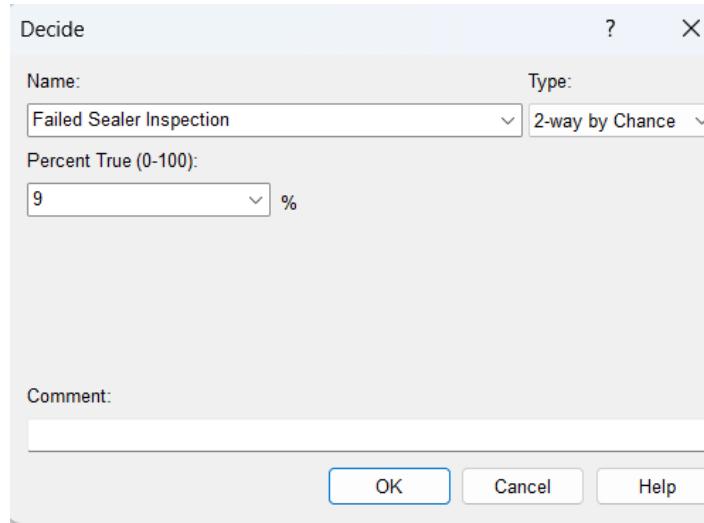
Type: **Resource**

Resource Name: **Rework** Units to Seize/Release: **1**

OK Cancel Help



# 合格品与返工品的决策





# 利用Assign模块为产品A的流程定义新属性

对Part A/Part B Attributes Assign模块进行参数修改，令其满足在Sealer模块中不同的处理时间Sealer/Arrive Time，如同对每个零件做简单的标签和描述

The screenshot displays the Assign module interface with two open dialog boxes: 'Assign' and 'Assignments'.

**Assign Dialog (Left):**

- Name:** Assign Part A Sealer and Arrive Time
- Assignments:** A list box contains:
  - Attribute, Sealer Time, TRIA(1,3,4)
  - Attribute, Arrive Time, TNOW
- Buttons:** Add..., Edit..., Delete

**Assignments Dialog (Top Right):**

- Type:** Attribute
- Attribute Name:** Sealer Time
- New Value:** TRIA(1,3,4)
- Buttons:** OK, Cancel, Help

**Assignments Dialog (Bottom Right):**

- Type:** Attribute
- Attribute Name:** Arrive Time
- New Value:** TNOW
- Buttons:** OK, Cancel, Help



# 利用Assign模块为产品B的流程定义新属性

Assign

Name: Assign Part B Sealer and Arrive Time

Assignments:

- Attribute, Sealer Time, WEIB(2.5,5.3)
- Attribute, Arrive Time, TNOW

<End of list>

Comment:

OK Cancel Help

Assignments

Type: Attribute Name: Sealer Time

New Value: WEIB(2.5,5.3)

OK Cancel Help

Assignments

Type: Attribute Name: Arrive Time

New Value: TNOW

OK Cancel Help



## 利用Record模块记录实体在系统内的停留时间

Record

Name: Record Scrapped Parts

Statistic Definitions:

- Time Interval, Arrive Time, No, Record Scrapped Parts  
<End of list>

Comment:

OK Cancel Help

Record

Name: Record Salvaged Parts

Statistic Definitions:

- Time Interval, Arrive Time, No, Record Salvaged Parts  
<End of list>

Comment:

OK Cancel Help

Statistic Definition

Type: Time Interval

Type NOTE: Records the difference between the current simulation time

Attribute Name: Arrive Time  Record into Set

Tally Name: Record Scrapped Parts

OK Cancel Help

Statistic Definition

Type: Time Interval

Type NOTE: Records the difference between the current simulation time

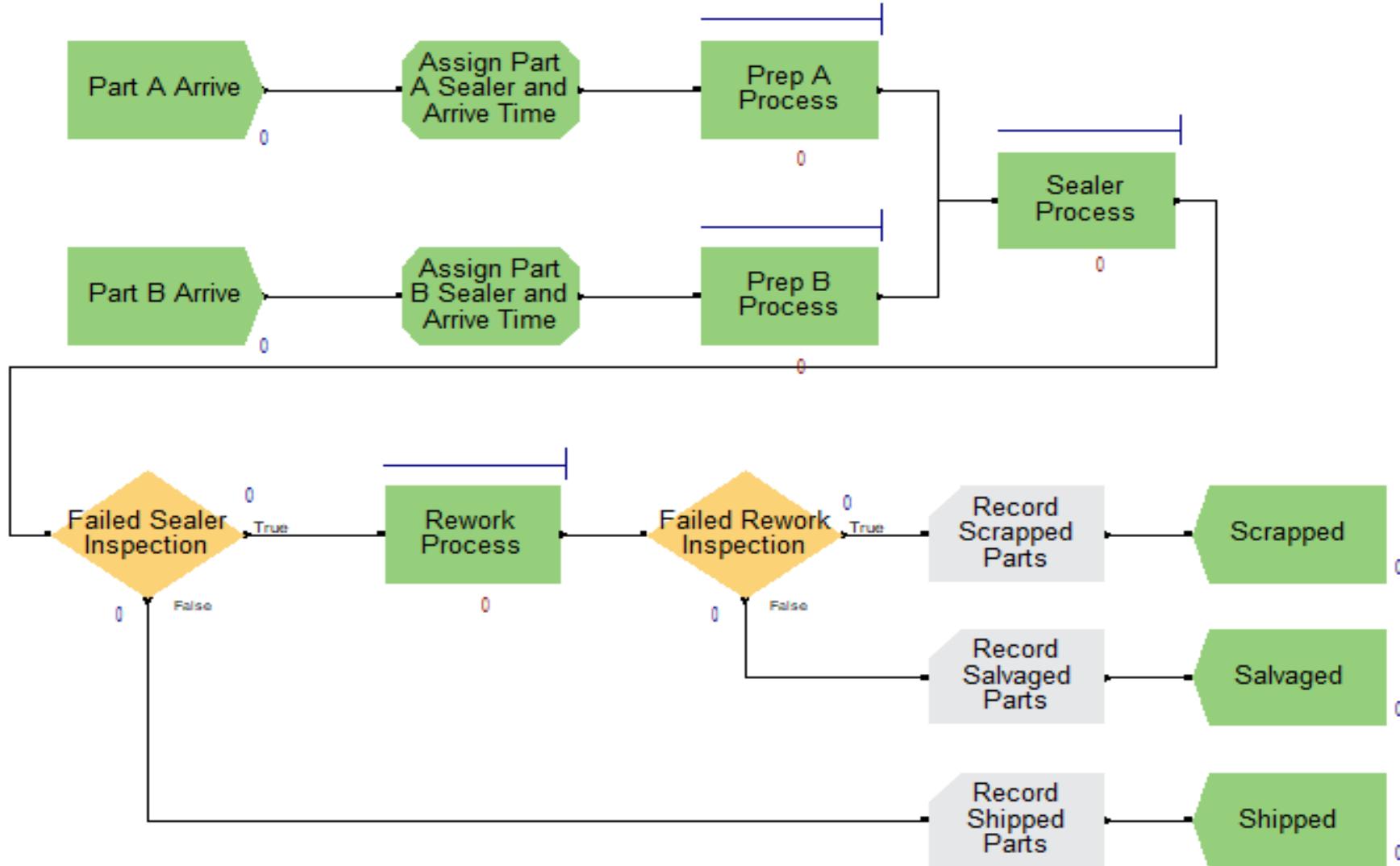
Attribute Name: Arrive Time  Record into Set

Tally Name: Record Salvaged Parts

OK Cancel Help



# 电子组装与检测系统仿真模型





# 目录

---

- 背景描述
- 建立模型
- 运行模型
- 观察结果



# 运行仿真模型

---

## □ 运行方式：如同Media player一样：

- 在运行之前先进行Check Model;
- 然后可以开始Run;
- 可以进行Speed up(>键)或Speed down(<键);
- 结束后，系统会提示是否要查看报告；
- 点击stop按钮，才能退出run模式，否则无法对模型进行修改；
- 可以在运行过程中pause



# 运行条件设置

Run Setup

Run Speed

Run Control

Reports

**Project Parameters**

Replication Parameters

Array Sizes

Arena Visual Designer

**Project Information**

Project: Electronic Assembly and Test

Analyst Name: Rockwell Automation

Project: The first version of the electronic assembly and test model, as described in Section 4.1.

**Statistics Collection**

Costing  Queues  Transporters  Tanks  Entities  Processes  Conveyors

Resources  Stations  Activity Areas

**确定** **取消** **应用(A)**

项目信息设置

Run Setup

Run Speed

Run Control

Reports

Project Parameters

**Replication Parameters**

Array Sizes

Arena Visual Designer

**Replication Parameters**

Number of: 1

Start Date and Time: 2024年10月18日 11:02:23

Warm-up Period: 0.0 Hours

Replication Length: 32 Hours

Hours Per Day: 24

Terminating

Base Time Units: Minutes

**Parallel Replications**

Run Replications in Parallel  Disable Parallel Replications Status Dialog

Number of Parallel: 16

Parallel Replication Input Data Files:

Data File **Add**

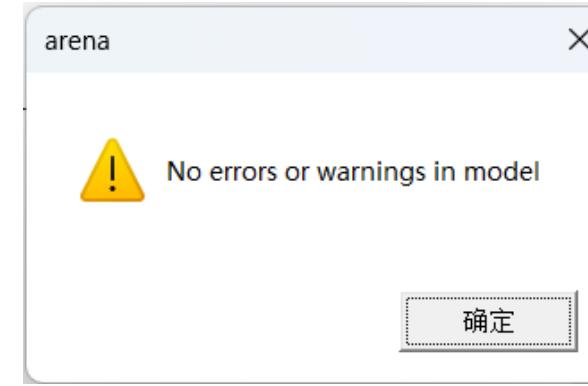
**确定** **取消**

运行条件设置

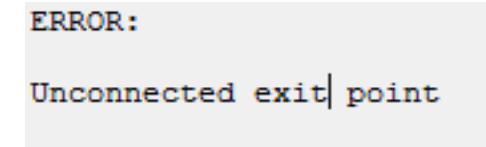
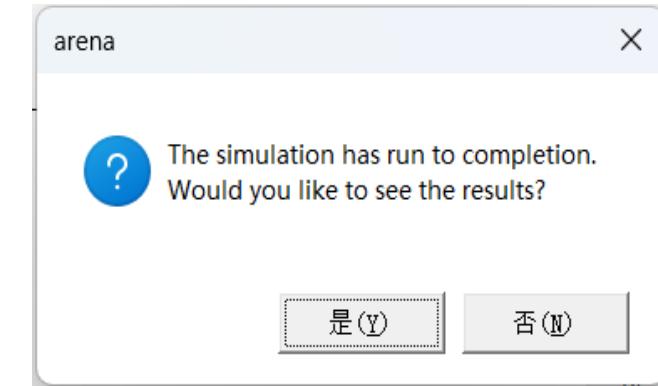
## 增加模型的动画效果

	Entity Type	Initial Picture
1	Part A	Picture.Blue Ball
2	Part B	Picture.Red Ball

## 模型检验



## 运行模型





# 目录

---

- 问题描述
- 建立模型
- 运行模型
- 观察结果

# 观察结果

## (1) 各工作区域的资源利用率

Name	Type	Source	Average Of Replication Averages
Prep A	Instantaneous Utilization	Resource	0.878815701
	Number Busy	Resource	0.878815701
	Number Scheduled	Resource	1
Prep B	Instantaneous Utilization	Resource	0.647251796
	Number Busy	Resource	0.647251796
	Number Scheduled	Resource	1
Rework	Instantaneous Utilization	Resource	0.857936345
	Number Busy	Resource	1.329420117
	Number Scheduled	Resource	1.5
Sealer	Instantaneous Utilization	Resource	0.775294358
	Number Busy	Resource	0.775294358
	Number Scheduled	Resource	1

## 各工作区域的队长 (单位: 个)

Name	Type	Source	Average Of Replication Averages
Prep A Process.Queue	Number Waiting	Queue	2.64540515
Prep B Process.Queue	Number Waiting	Queue	3.766376584
Rework Process.Queue	Number Waiting	Queue	4.340004409
Sealer Process.Queue	Number Waiting	Queue	0.850000395

## 各工作区域的排队时间 (单位: 分钟)

Name	Type	Source	Average Of Replication Averages
Prep A Process.Queue	Waiting Time	Queue	12.63477087
Prep B Process.Queue	Waiting Time	Queue	35.49886194
Rework Process.Queue	Waiting Time	Queue	150.4218898
Sealer Process.Queue	Waiting Time	Queue	2.71413317

## 产品在各区域的系统停留时间 (单位: 分钟)

Name	Type	Source	Average Of Replication Averages
Prep A Process	Total Time Per Entity	Process	16.83209959
Prep B Process	Total Time Per Entity	Process	41.73689233
Rework Process	Total Time Per Entity	Process	201.5891812
Sealer Process	Total Time Per Entity	Process	5.193354452



# 分析系统的运行情况

---

- 查看各资源负荷是否均衡
- 是否存在排队时间过长的工序、是否存在资源利用率较低或太高的工序？
- 瓶颈工序是哪里？
- 产品的加工周期是多长？
- 给出你的系统改善建议。

謝 謝!  
Thank you

