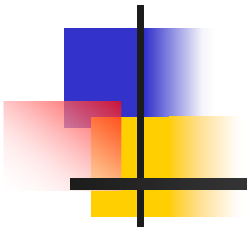
Dynamic Simulation of Grain Storage Facilities



Part # 1

Grain Facility Library Development

By

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Luís César da Silva

- Born in Viçosa – Minas Gerais State
- Brazil

Education

- B.S. Agricultural Engineering July/1985
  Federal University of Viçosa - Brazil

- M. S. Agricultural Engineering, July/1989
  Federal University of Viçosa - Brazil

- **Ph**.D, Agricultural Engineering March/2002
  Federal University of Viçosa – Brazil
  & Kansas State University, Manhattan, KS

Work Experience

West Paraná State University – UNIOESTE

- Auxiliary Professor, 1986 -1990
- Assistant Professor, 1990-2002
- Agricultural Engineering Department Head, 1992-1997
- Adjunct Professor, 2002-2004

Federal University of Espirito Santo – UFES

- Adjunct Professor, since 2005

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- **Daniel M. Queiroz**, Depart. of Agricultural Engineering, UFV, Ph. D.
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- **Evandro C. Melo**, Depart. of Agricultural Engineering, UFV, D. S.
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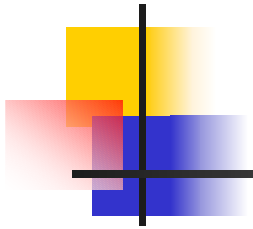
Introduction

What is simulation?



- Simulation is the operation of a developed model, which main purposes are:

  (a) to guide the decision process,

  (b) to carry on analyses and evaluations of systems, and

  (c) to define solutions for improving a system performance.

(Monsef 1997, Neelamkavil 1987, Maria 1997).

What is System?

(According to Researches Operations Fundaments)

- System is "*any sorted group of objects that perform together or inter-work in other to reach one logical goal*"

(Schmidt and Taylor 1970).

What is Grain Facility System?

Grain Storage Facility is a system designed for the appropriate receiving, cleaning, drying, storing and dispatching of grains and legumes (Flores 1988).

What is model?

(According to Researches Operations Fundaments)

Model may be defined as a representation of a system, which aims to describe system elements and their interrelationships.

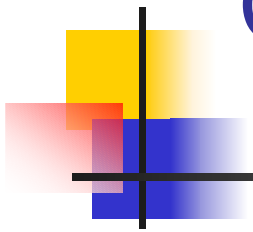
(Neelamkavil 1987, Maria 1997).

Computer Simulation Model Classification

(Law and Kelton 1991, Image That, Inc. 1997).

Criteria	Model Classification
Presence or Absence of Variable: ***Time***	Dynamic (Yes) or Static (No)
Presence or Absence of ***Stochastic*** Variables	Stochastic (Yes) or Deterministic (No)
How variable ***Time*** is incremented	Continuous (Fixed increment value) or Discrete (Aleatory increment value)

Computer Model - Implementation



- **Programming Languages**

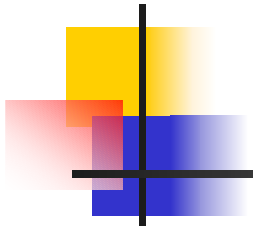
  FORTRAN, COBOL, PASCAL, C, and Visual Basic

- **Simulation Languages or Simulation Packages**

  GASP, SLAM, ARENA, ADA, EXTEND and @RISK

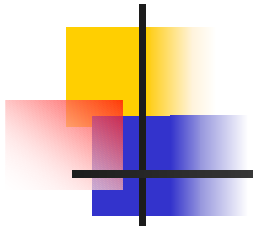
(Loza-Garay 2000, Roberts and Dessouky 1998).

Extend - Characteristics



- Commercialized by Imagine That, Inc.
- General-purpose language
- Libraries hold blocks,
- Blocks (model processes, make calculus, and plot graphics)
- *Main Libraries: Generic* and *Discrete Event*

Model Implementations and Use



Implementation Phases:

- Verification, Validation, and Testing

Model Experimentation (Use)

(a) Sensitivity analysis

(b) Scenarios analysis

(c) Optimization

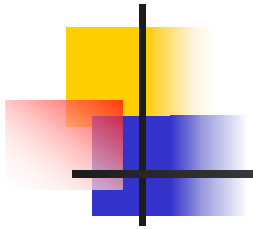
(d) Monte Carlo Simulation

Objective

Develop mathematical models to simulate the dynamics of grain storage facilities.

Note: Developed model are classified as ***dynamic, stochastic and discrete.***

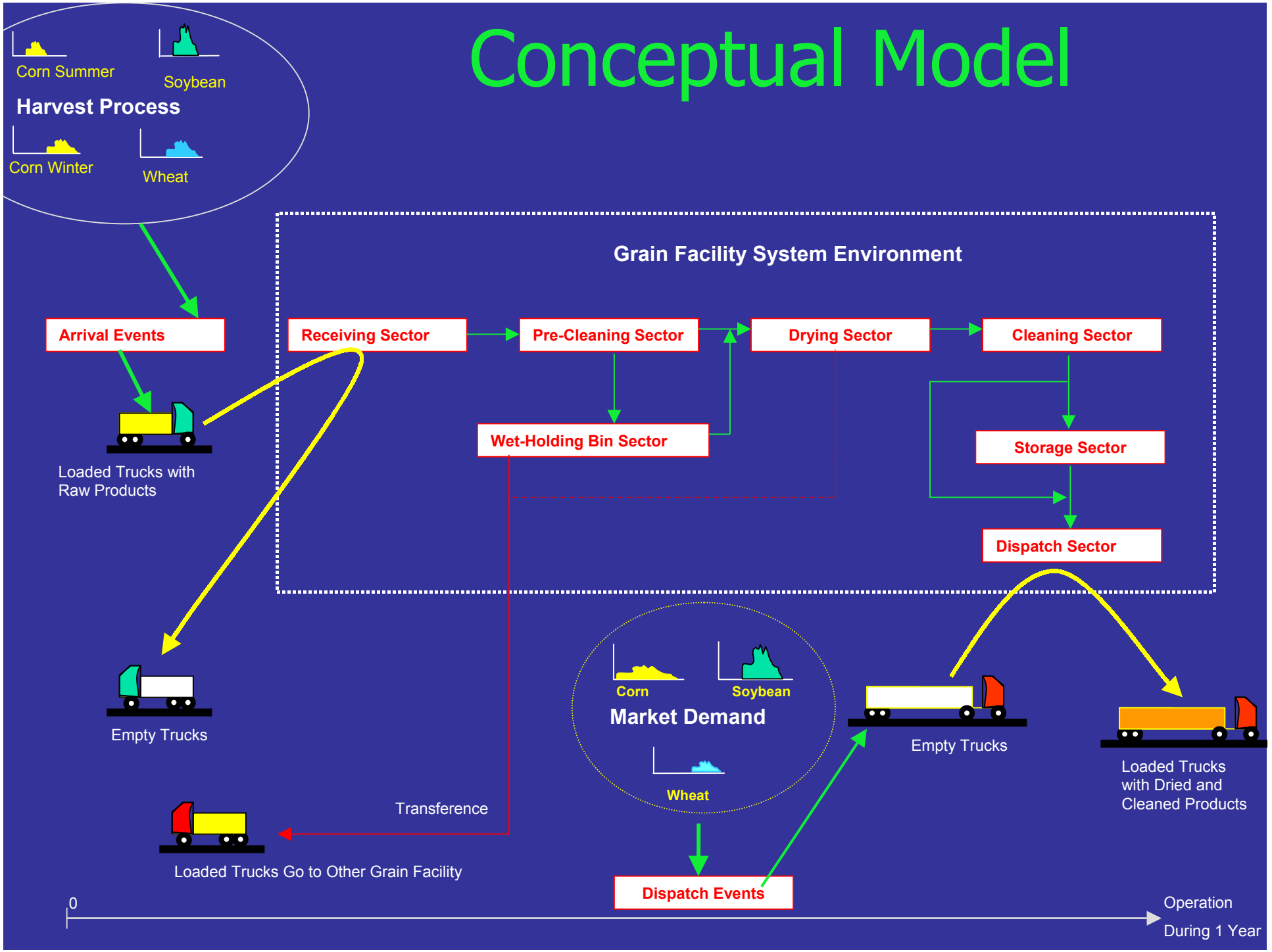
Specific Objectives



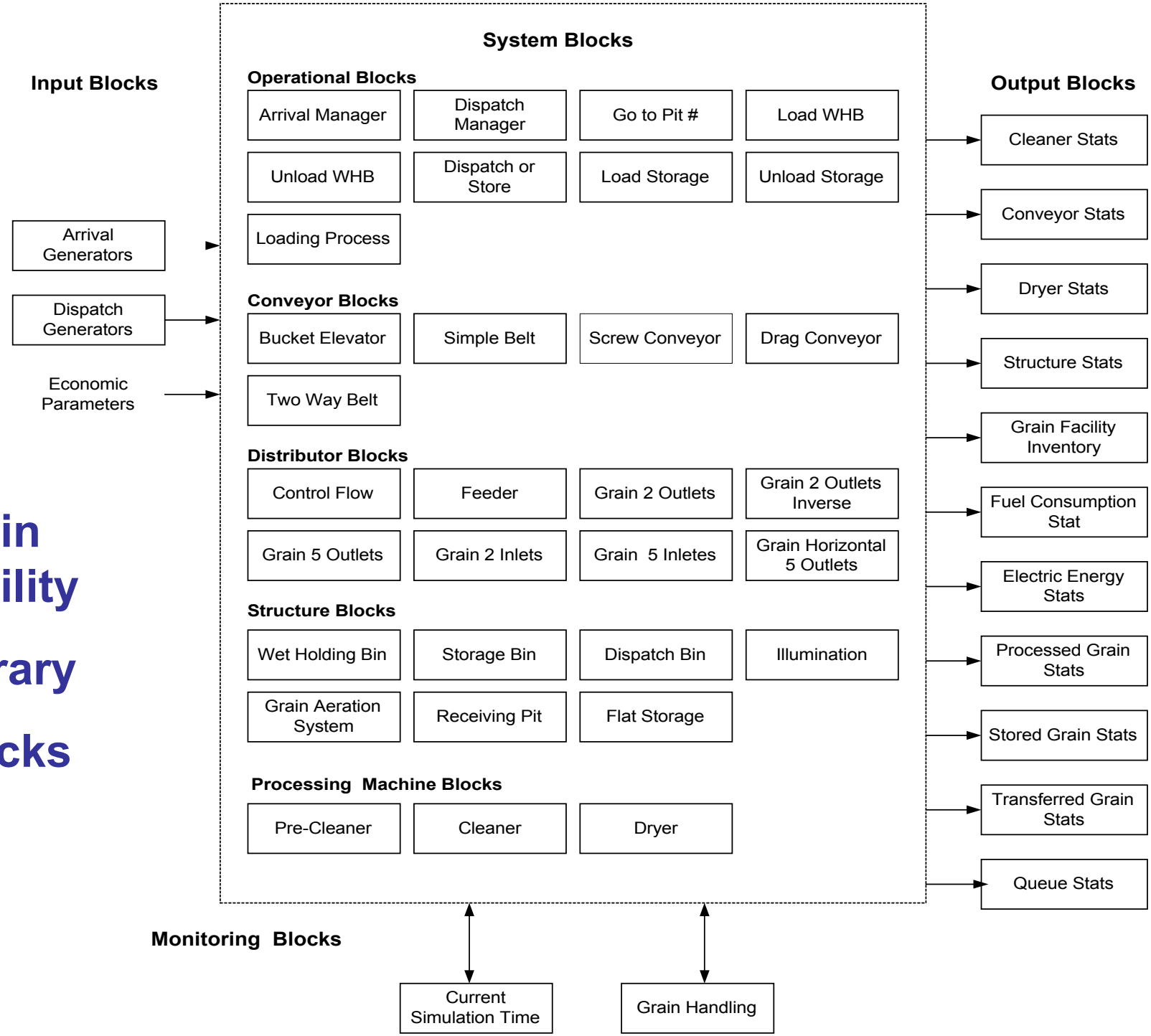
- Develop an Extend library to simulate processes and unitary operations related to grain storage facilities.
- Validate the model using real data.

Model Philosophy

Conceptual Model

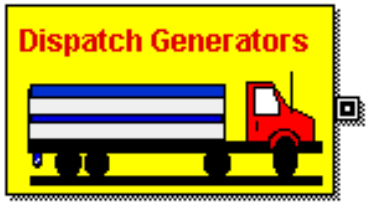


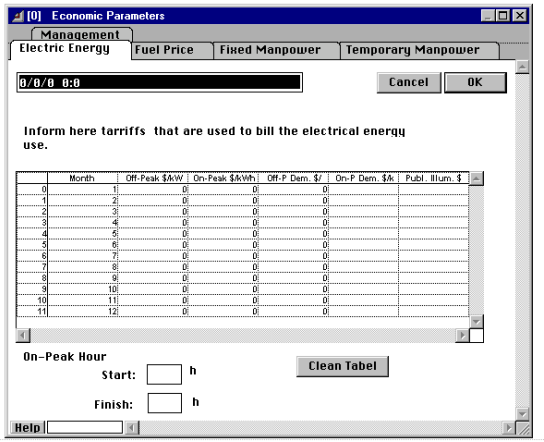
Grain Facility Library Blocks

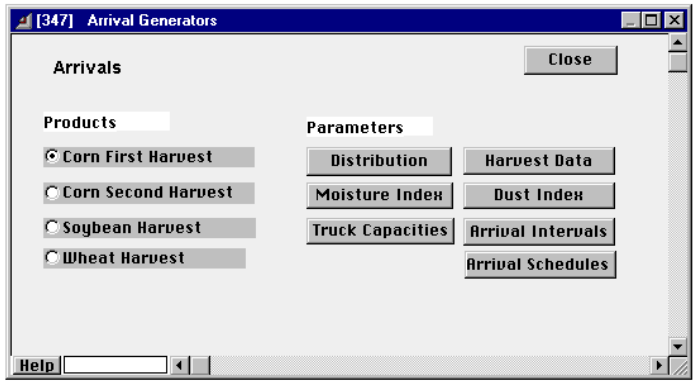


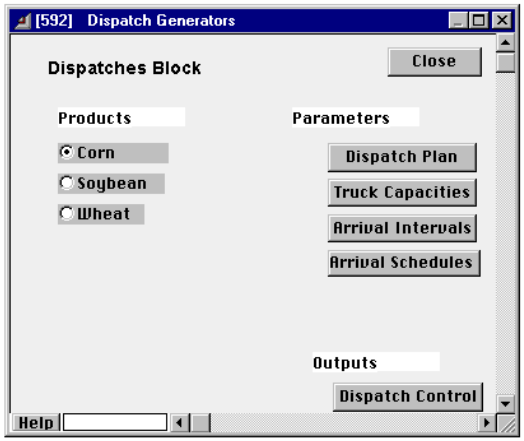
Input Blocks

(These blocks define global system operation conditions)



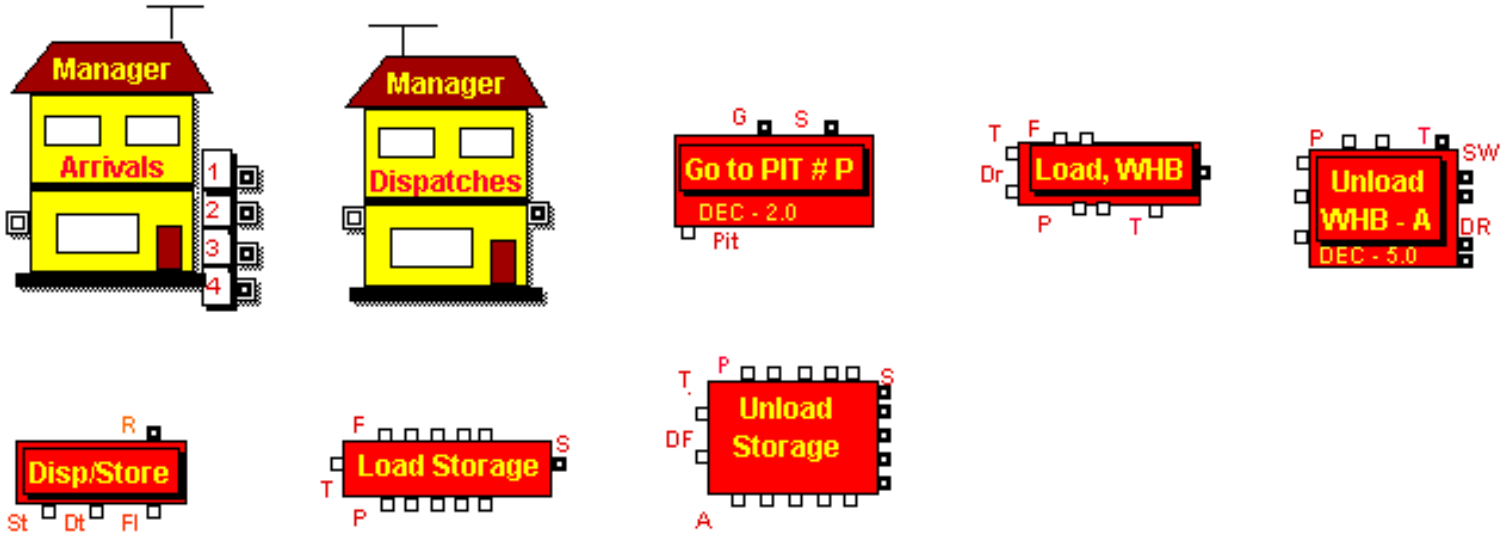






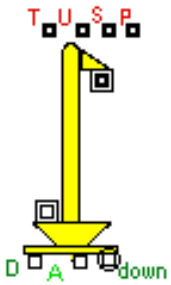
Operational Blocks

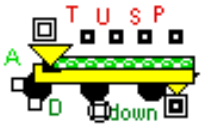
These blocks were developed to simulate management decision-making in grain storage facilities and to specify the constraints that establish the system logic.

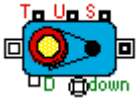


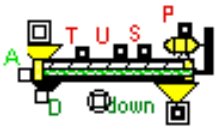
Conveyor Blocks

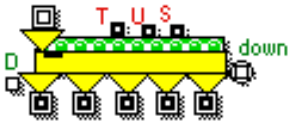
They were developed using the Extend™ block called Machine . It was implemented new line codes and modified icon appearances.



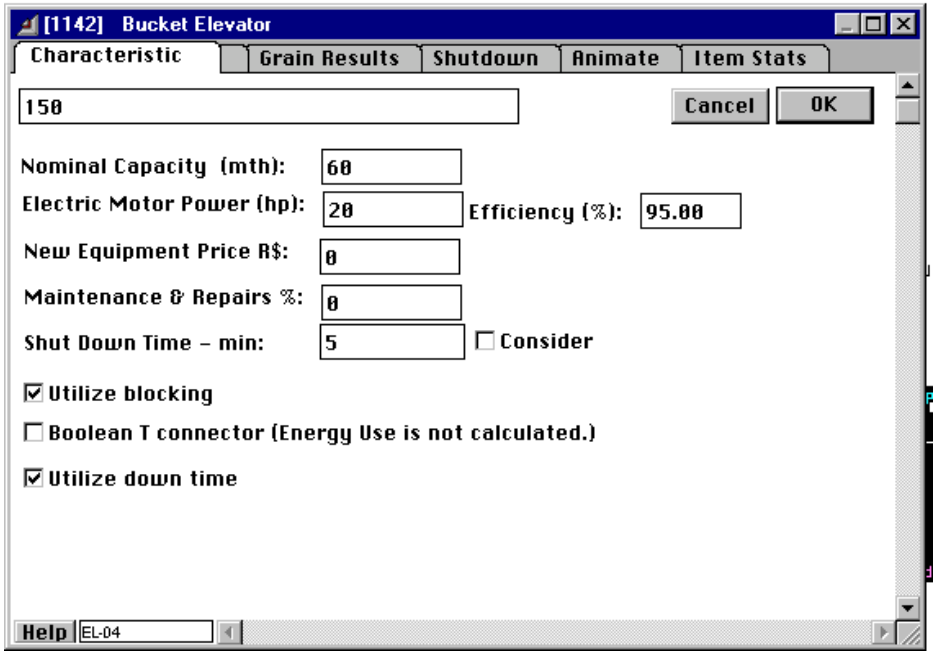




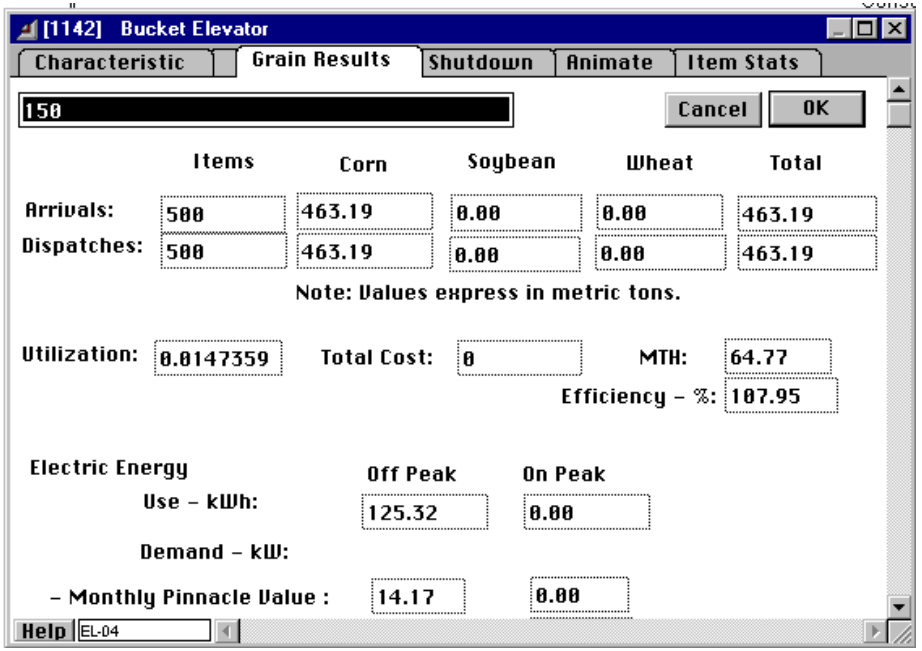




Input Window

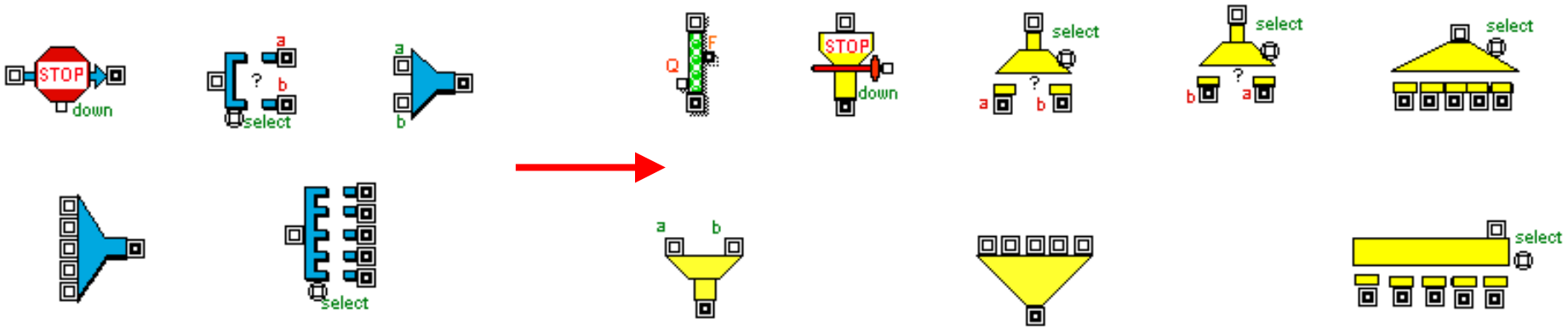


Output Window



Distributor Blocks

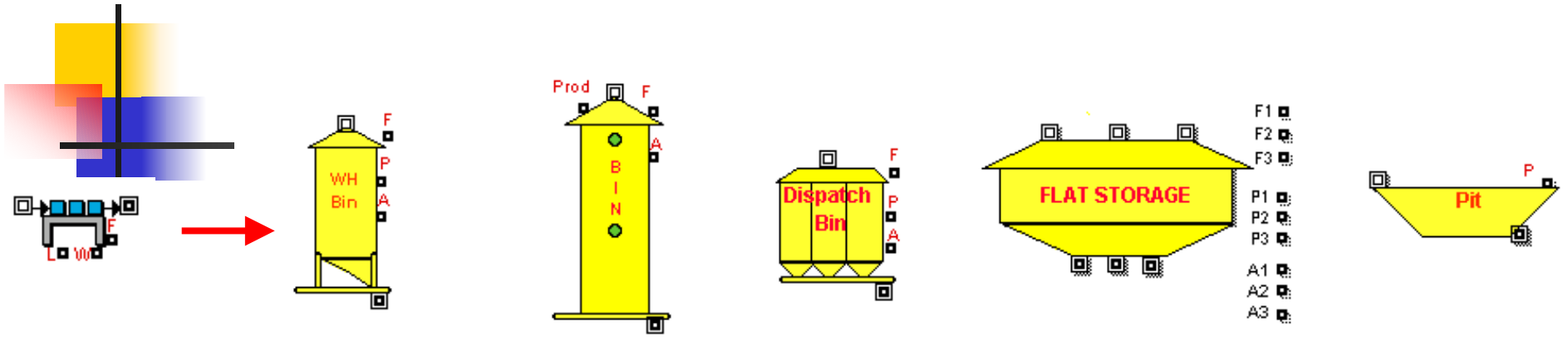
(Function: define and control grain flow direction)



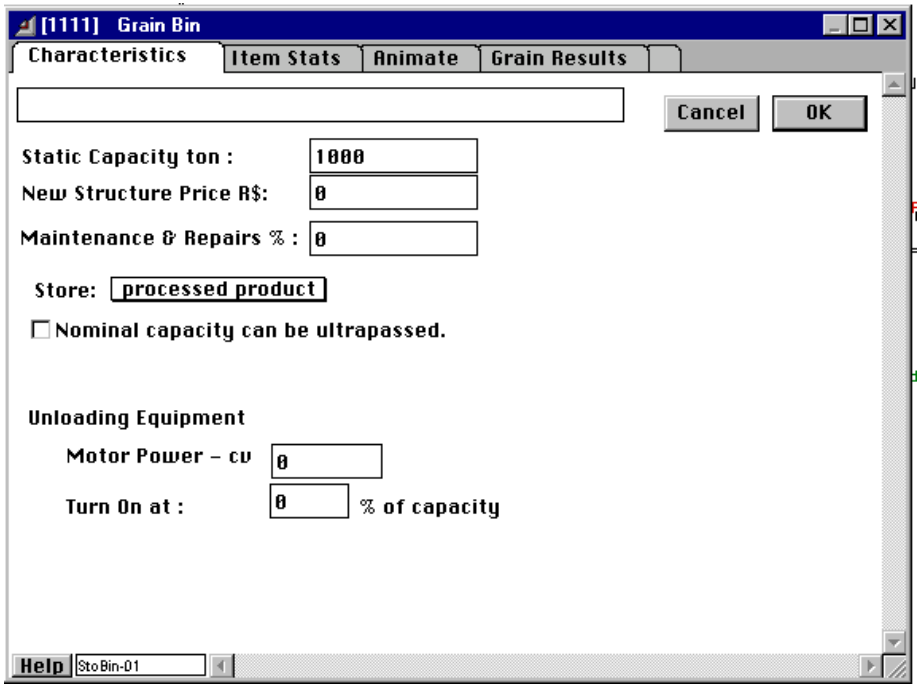
The six Extend™ blocks (left) had their icon appearances modified, as shown in right side, to ease their identification in the grain storage facility models

Structure Blocks

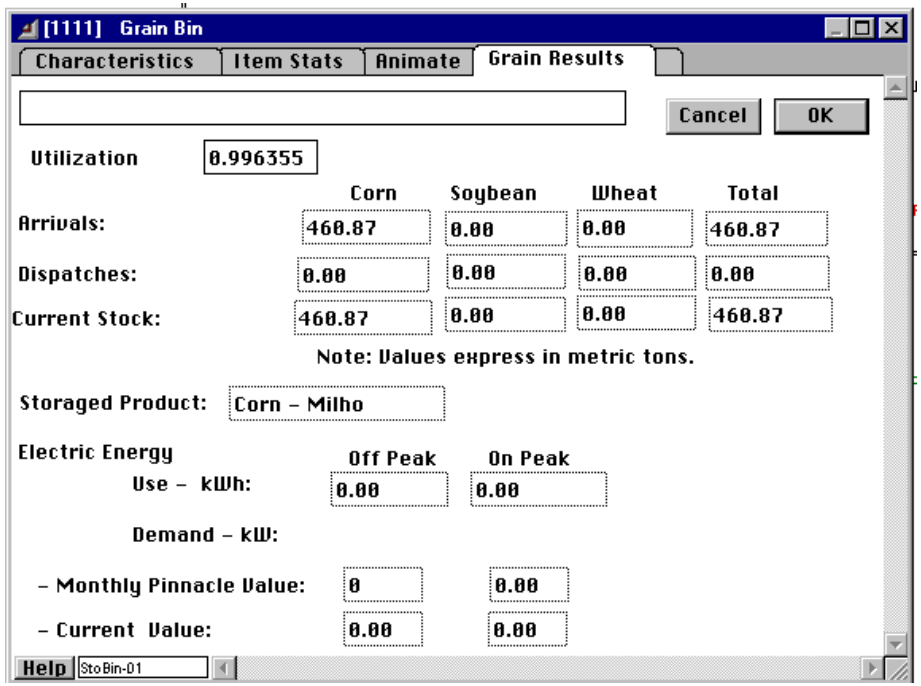
(They were developed using the Extend™ block called *Buffers*. It was implement new line codes and icon appearance.)



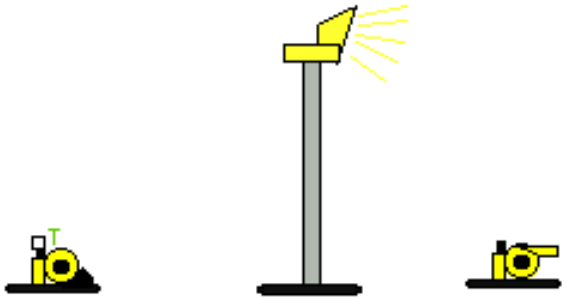
Input Window



Output Window

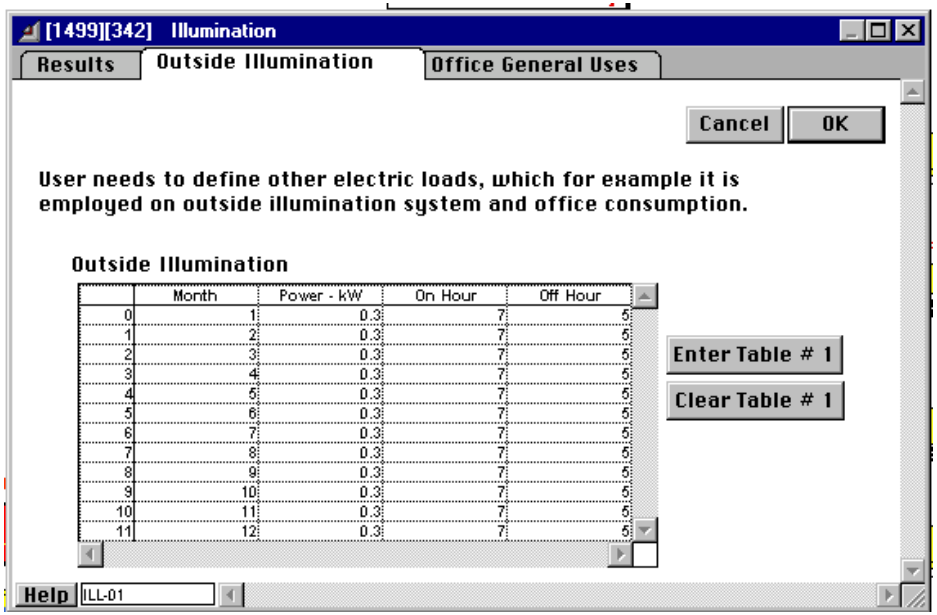


Structure Blocks: Motor, Illumination and Grain Aeration

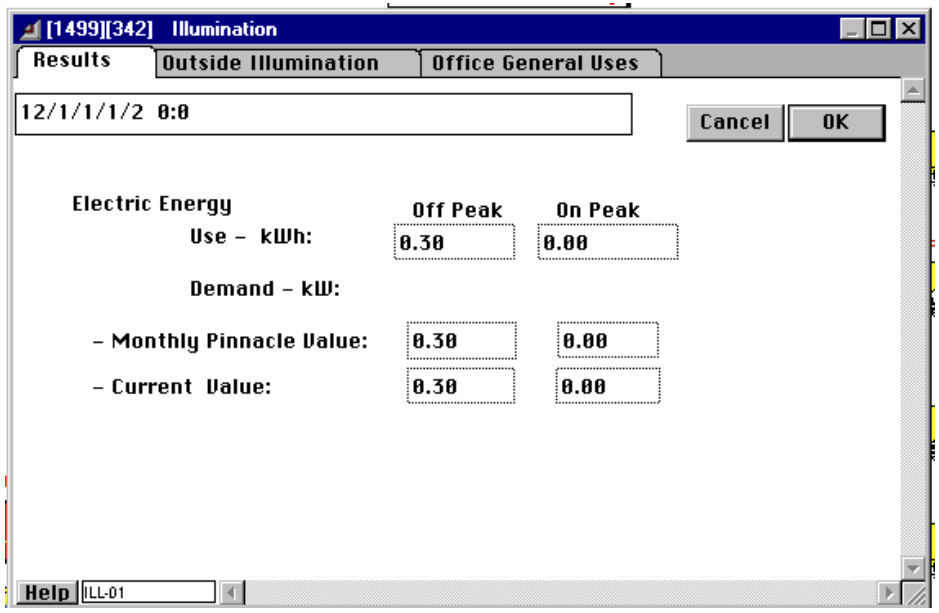


They were were developed to simulate the electrical energy use in activities such as illumination and aeration.

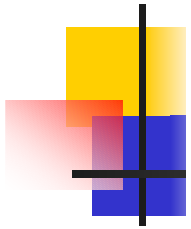
Input Window

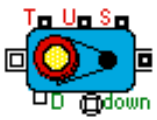


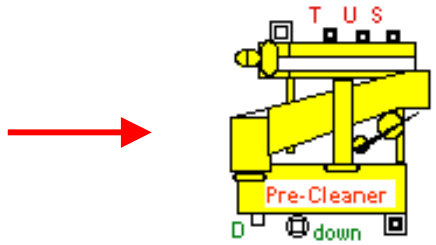
Output Window



Processing Machines: Pre-Cleaner and Cleaner

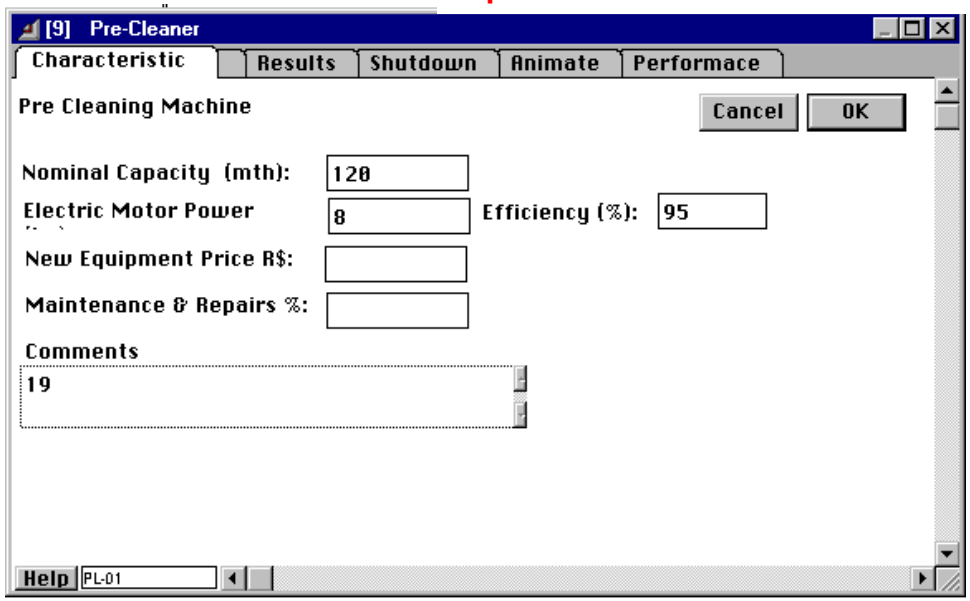




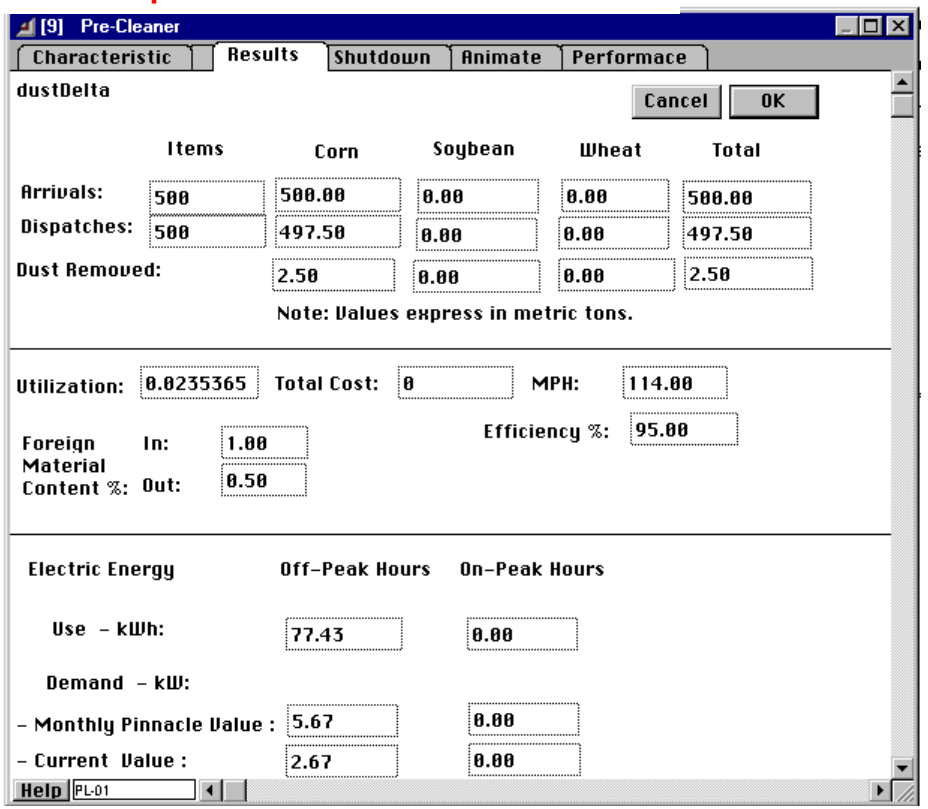


They were developed using the Extend™ block called Machine . It was implemented new line codes and modified icon appearances.

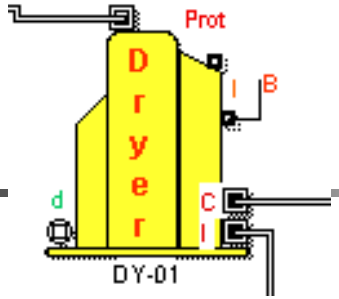
Input Window



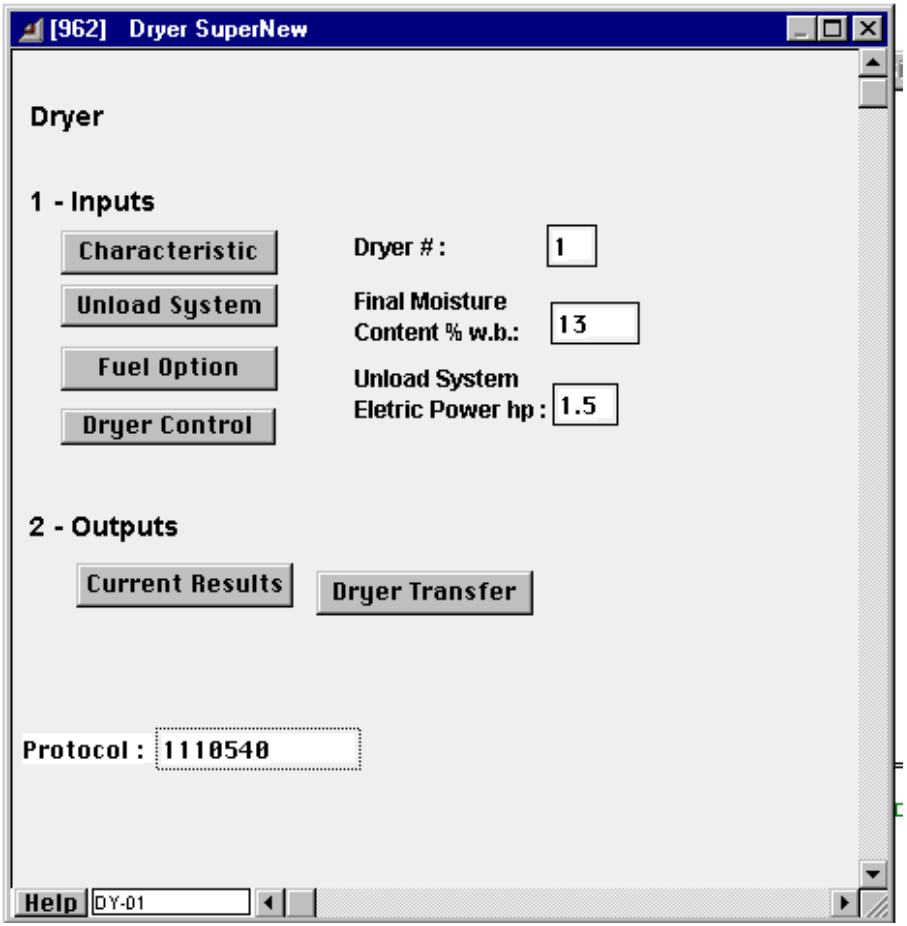
Output Window

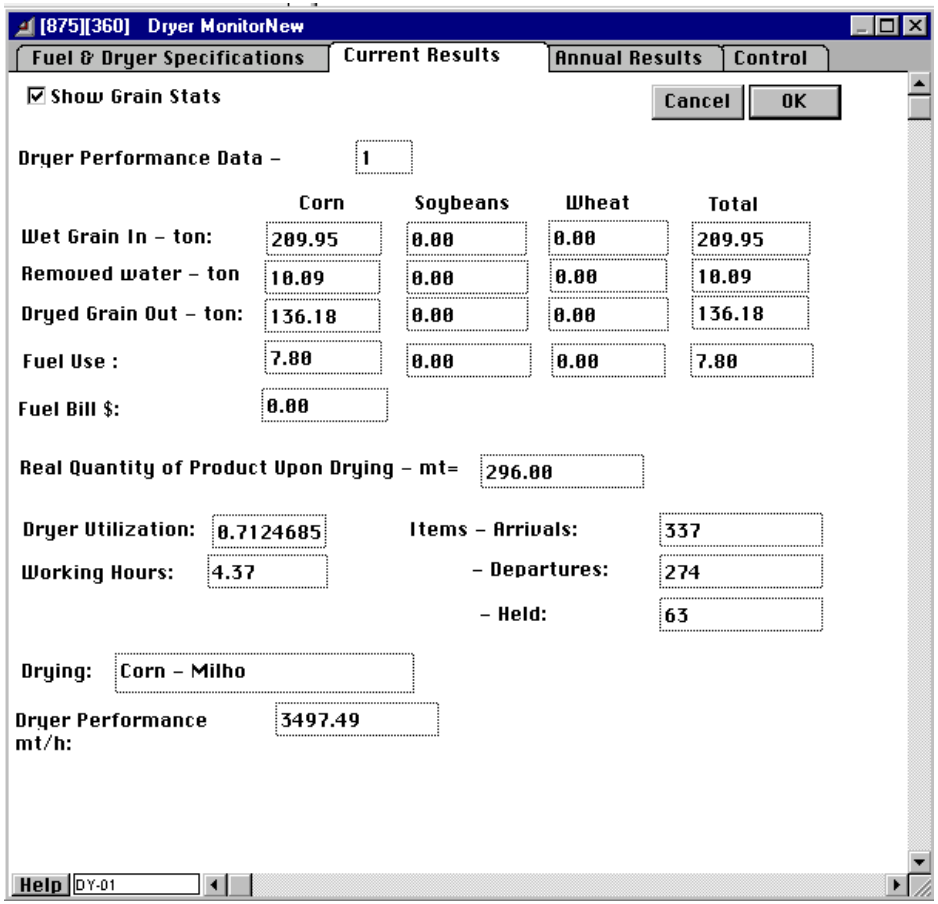


Processing Machines: Dryer



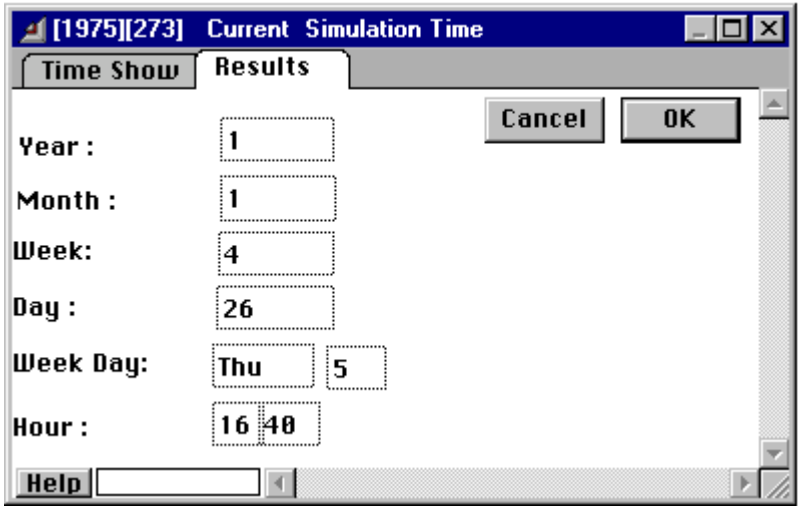
The Dryer block, classified as hierarchical, was designed to simulate the drying process in mixed flow dryers. The conceptual model fundaments is Queue Theory.

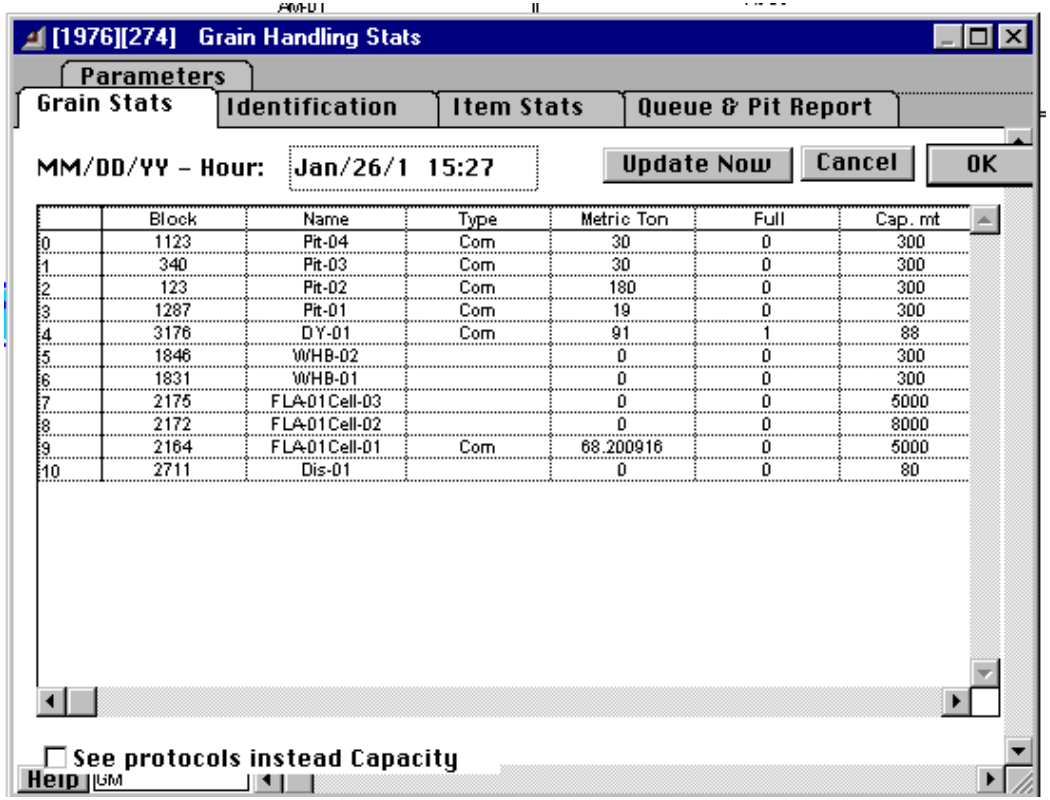




Monitoring Blocks

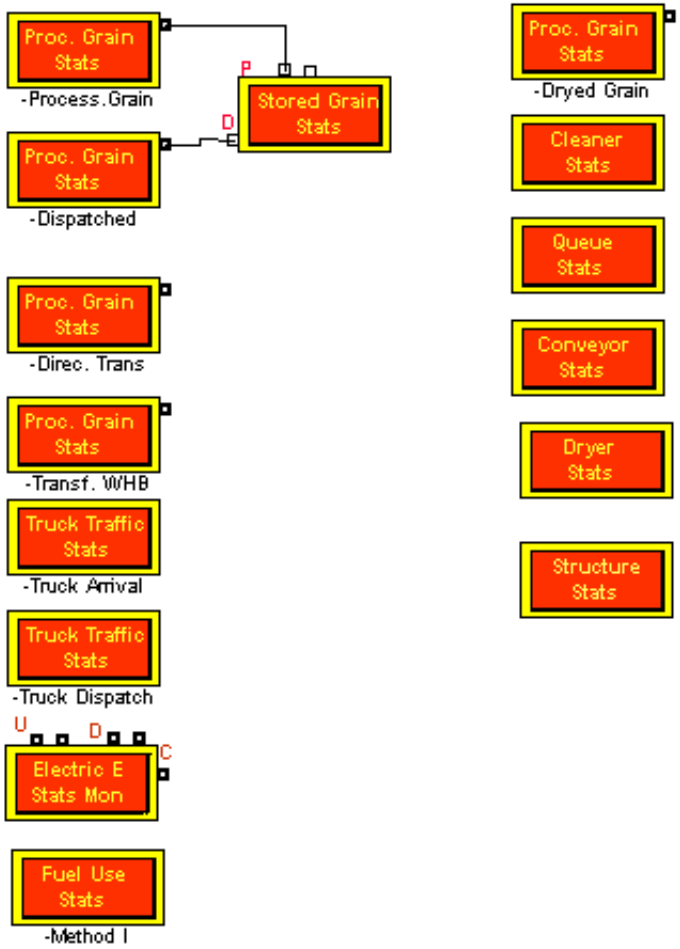
(They were developed for collecting, processing and passing information among model blocks during simulation)





	Block	Name	Type	Metric Ton	Full	Cap. mt
0	1123	Pit-04	Corn	30	0	300
1	340	Pit-03	Corn	30	0	300
2	123	Pit-02	Corn	180	0	300
3	1287	Pit-01	Corn	19	0	300
4	3176	DY-01	Corn	91	1	88
5	1846	WHB-02		0	0	300
6	1831	WHB-01		0	0	300
7	2175	FLA-01Cell-03		0	0	5000
8	2172	FLA-01Cell-02		0	0	8000
9	2164	FLA-01Cell-01	Corn	68.200916	0	5000
10	2711	Dis-01		0	0	80

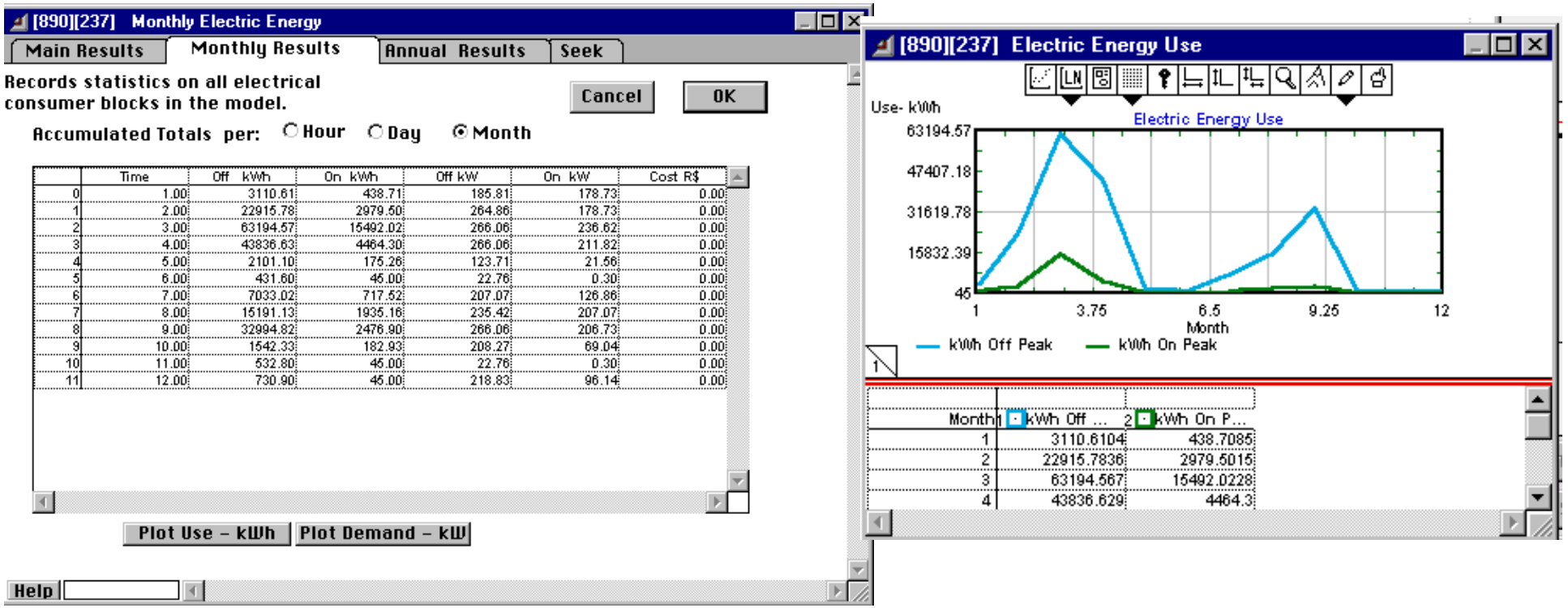
Output Blocks
(Generates 20 Types of Reports)



Blocks of this category were developed using "Activity Stats", an Extend™ block, and are intended to: (i) get information from specific blocks according to a frequency defined by the user, (ii) process this information, and (iii) elaborate reports in table or graphic format.

Output Blocks

Example: ***Electric Energy Stats*** simulates electrical energy metering equipment. It collects output data from blocks that simulate electrical energy use and elaborate reports .



End – Part # 1
Grain Facility Library Development

Please feel free to contact me:

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