How to Design a Streamlined Macro-System With Autonomous Micro-Units?

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1. The Prevailing System Thoughts

- The failure of fragmented functional design
- The emergence of more and more system-oriented managerial tools and methods
- The rapid development of information technology
- Customer-oriented competition calls for boundaryless organizations

2. Why Need the Autonomous Units

2.1. The Practitioner's Challenges

- Violent environmental turbulences and the contingency required for real operations
- The importance of adaptability, flexibility, and learning ability
- New forms of organizational structure, ex, modular organizations, loosing coupling organizations

2. Why Need the Autonomous Units

2.2. The Academic Development

- Organizations as stable orders vs. continuously changing emergents, (Poole and Van De Ven, 1989)
- Equifinality: functional equivalence in organization design(Gresov and Drazin, 1997)
- The need for a responsive and distinctive system (Orton and Weick, 1990)

But, how to design the system as a whole while maintaining the adaptability and flexibility of micro-level units

That is …..

How to streamline the activities of autonomous units?

3. Conceptual Design of A Streamlining Systems with Autonomous Units

3.1. Non-synchronous System Type

Units act with no coordination;

⇨ Autonomous units may conflict each other

3.2. Synchronous System Type

Units act at the same pace at the same time

⇨ System can act as a whole but units' autonomy is lost

3. Conceptual Design of A Streamlining Systems with Autonomous Units

3.3. Asynchronous System Type

Units act at the same pace and act at different time

➡ Units can harmonize their activities with

their autonomy to decide most appropriate timing for them to act

➡ A streamlining design of autonomous units

3.4. Designing guideline

Each unit is set to operate toward the synchronized goals, but it keep its autonomy to determine appropriate timing to take actions

4. Using System Dynamics As A Platform to Coordinate Units

4.1. Rationality of Using SD as the Platform

- Focus on the time varying behaviors, rather than any artificial boundaries
- System models built on the micro interactions with information feedback theory
- Emphasis on the systemic performance
- Simulation tools and methodology for system design under various scenarios

4. Using System Dynamics As A Platform to Coordinate Units

4.2. Unexplored Region of SD as to the Coordination Design

- SD focus mostly on the policy design of a few rates and actions, rather than the relationships of all decision points.
- SD designs the system as a whole, but often neglects the distinctive nature of micro-level units and related relationships
- SD development is focus more on the information phase of decision rules, the action phase of rates and flows receives attentions slightly

5. Modelling a Streamlining System with Autonomous Units

5.1. Related Concepts, Theory, and Research

- Equifinality and Creativity concept(Gresov and Drazin, 1997; Fritz,)
- Theory of Constraints and DBR design

  (Goldratt and Cox, 1992; Srikanth and Podzunas, 1990; Goldratt, 1987)

  ➡ Core concepts to set a systemwide goals as the basis for critical rates
- Synchronous flow-based design of SD high leverage design

  (Young, Tu, and Tseng, 2002)

  ➡ A SD-based and flow-based design process to synchronize the actual output of each rates

5. Modelling a Streamlining System with Autonomous Units

5.2. Steps to Design

- Decide the "drum" to be the basis of rates' operational pace; That is, find out the most critical information source
- Apply the synchronization process to set the original pace for each rates (reference to Young, Tu, and Tseng, 2002)
- Create levels for each rates to identify and calculate the required workload
- Formulate decision rules for each rates based on the related level created

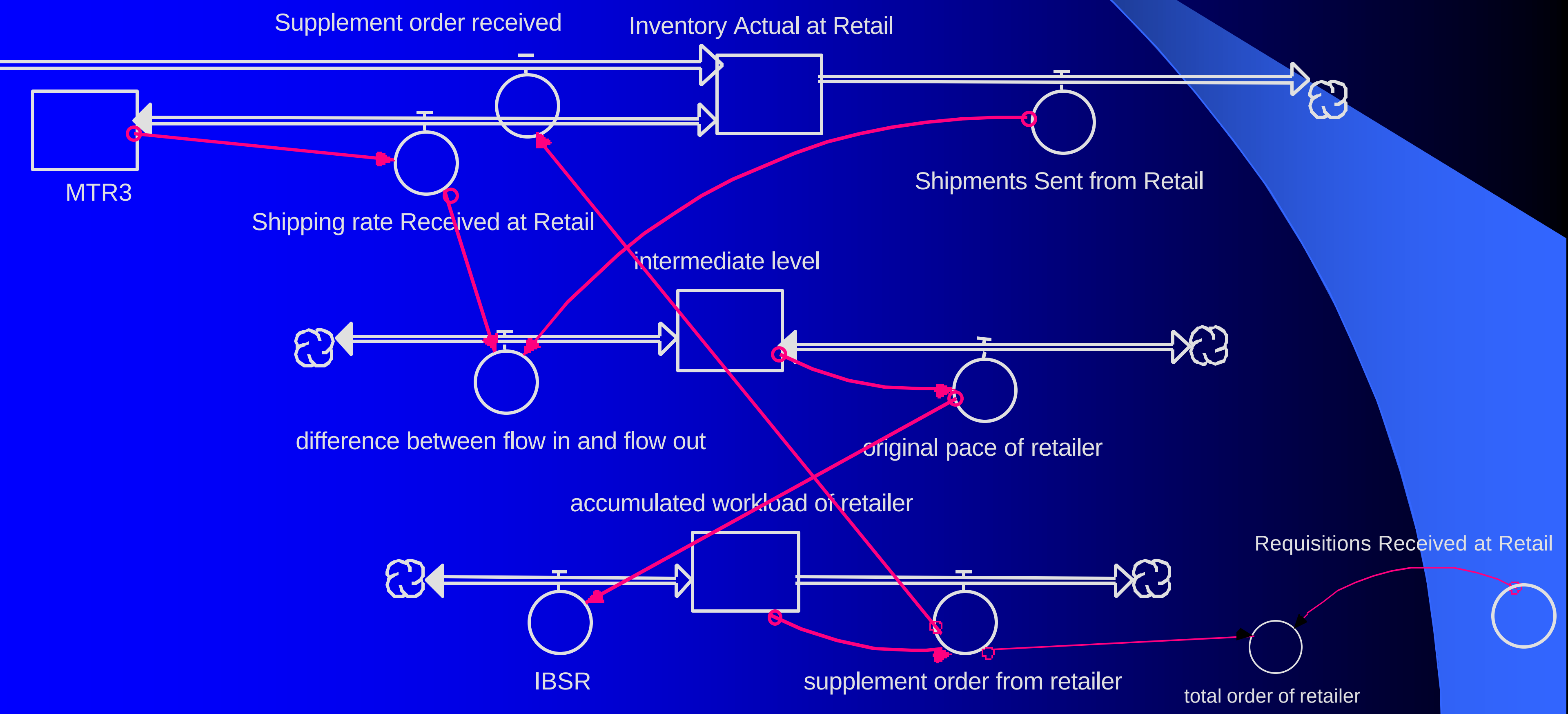
6. Example: A Supply Chain System

6.1. Descriptions of the Experimental Model

- ❑ Forrester(1961): Industrial dynamics
- ❑ The so-called bullwhip effect or forrester effect
- ❑ 3 major decisions: inventory policies of retailer, distributor, and manufacturer
- ❑ The most critical information source: customer's order

6. Example: A Supply Chain System

6.2. Part of the Streamlining Model



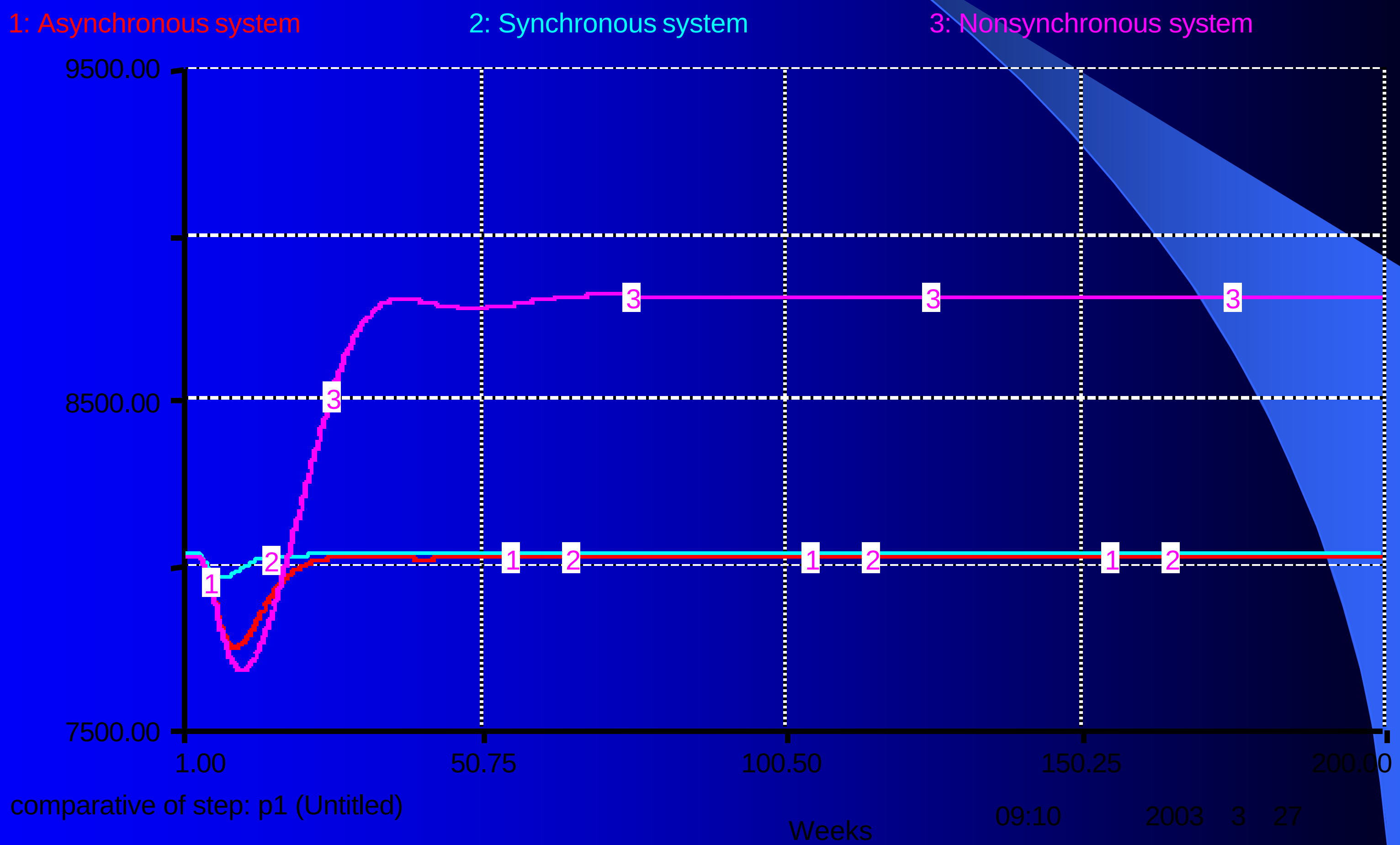
6. Example: A Supply Chain System

6.3. Simulation Results

- Non-Synchronous System: original model built by Forrester (1961)
- Synchronous System: a redesigned model with the synchronous method developed in previous paper
- Asynchronous System: streamlining the system with each rate to adjust its own action based on the synchronized pace

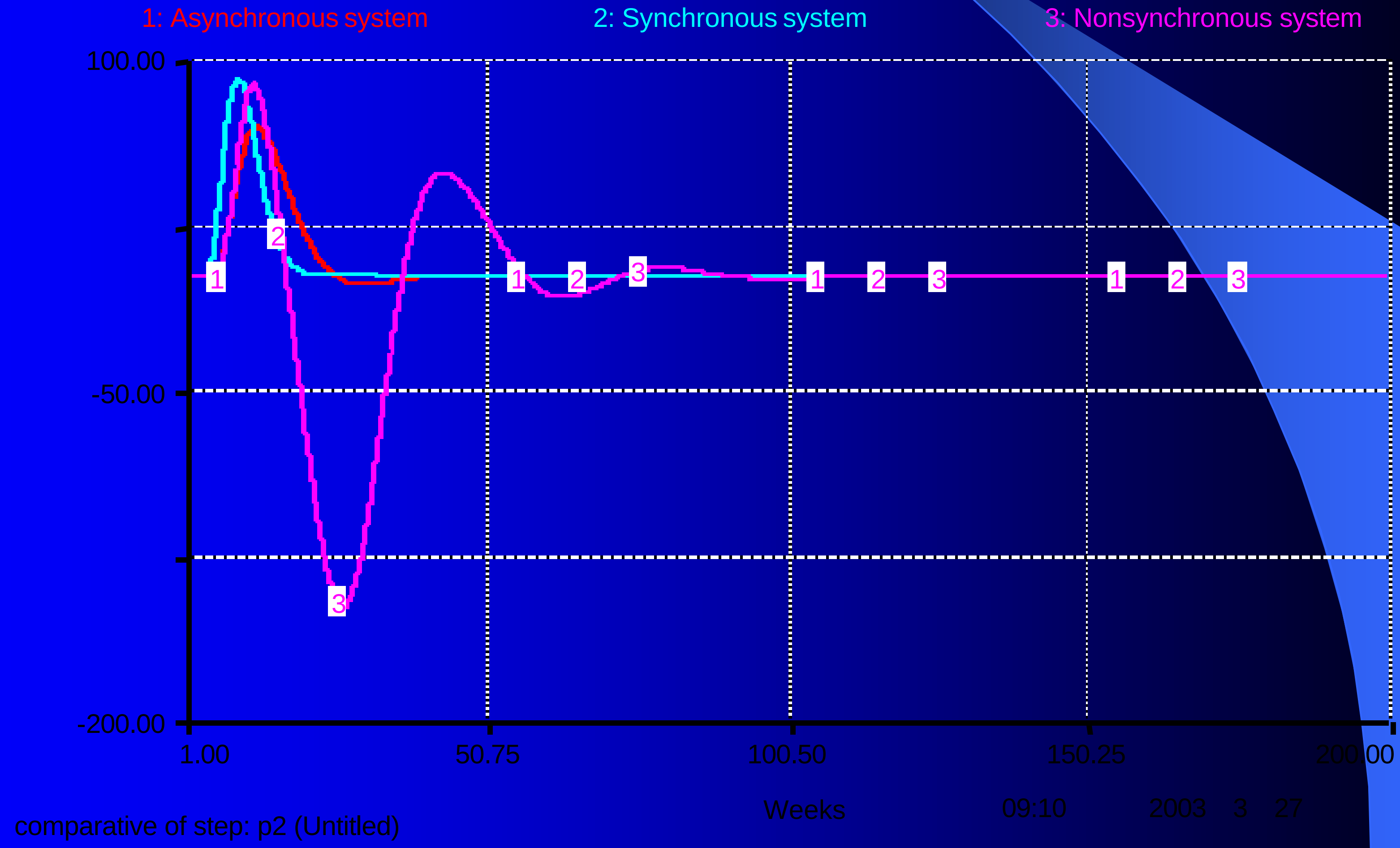
6.3.1. Customer Order: 1000+step(100, 3)

(1)Comparative behaviors of retailer's inventory



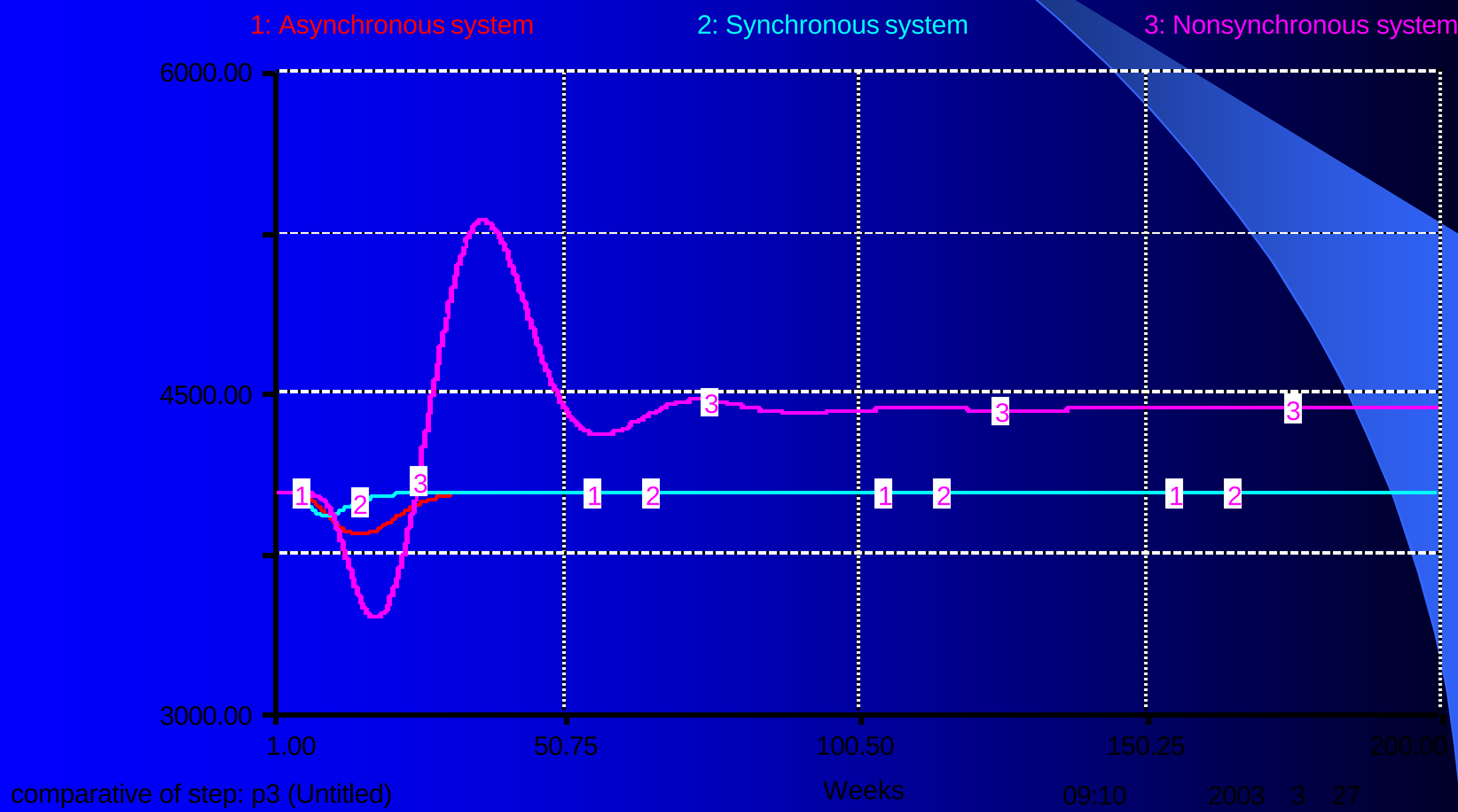
6.3.1. Customer Order: 1000+step(100, 3)

(2)Comparative behavior of distributor's inventory



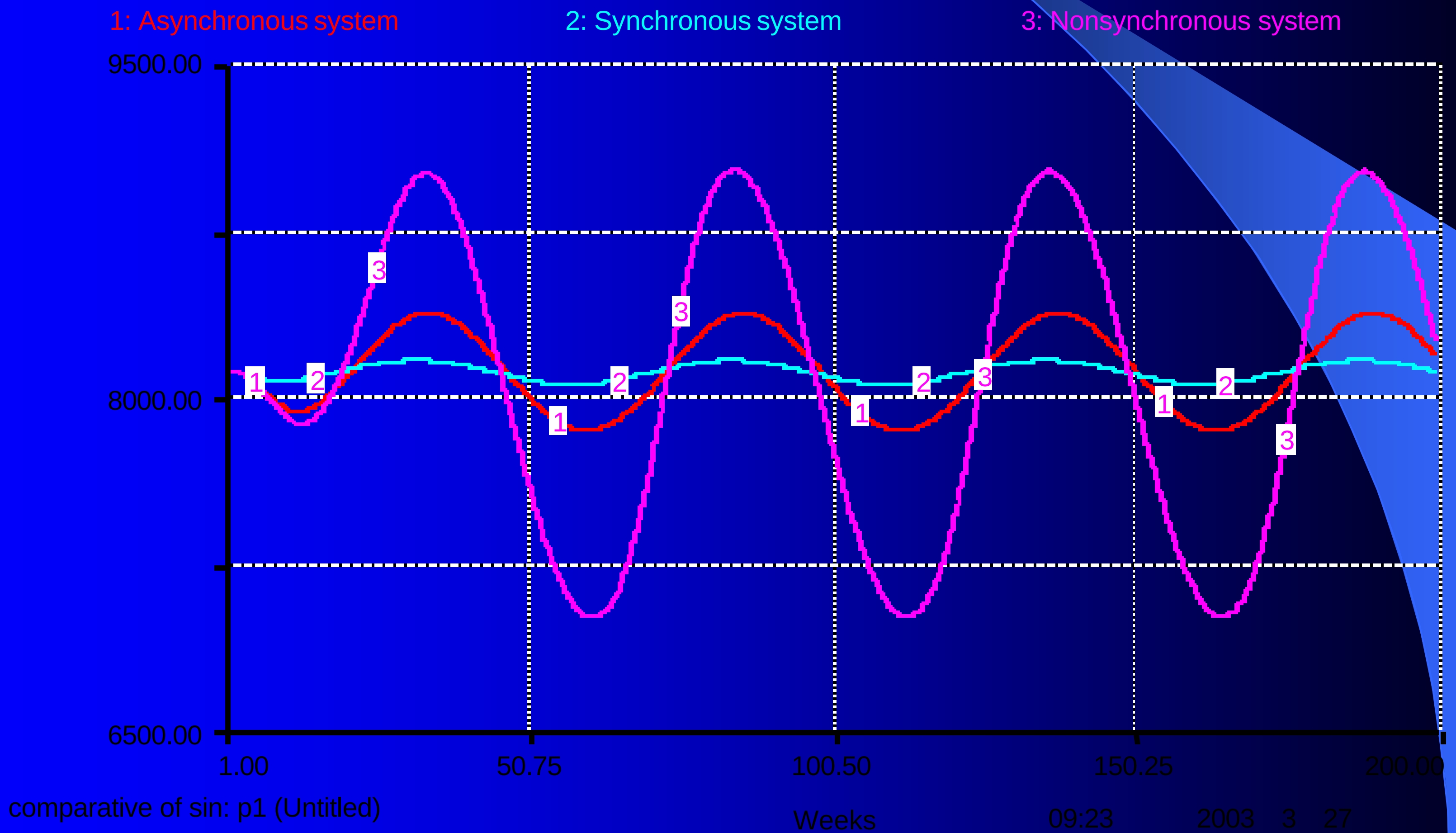
6.3.1. Customer Order: 1000+step(100, 3)

(3)Comparative behavior of manufacturer's inventory



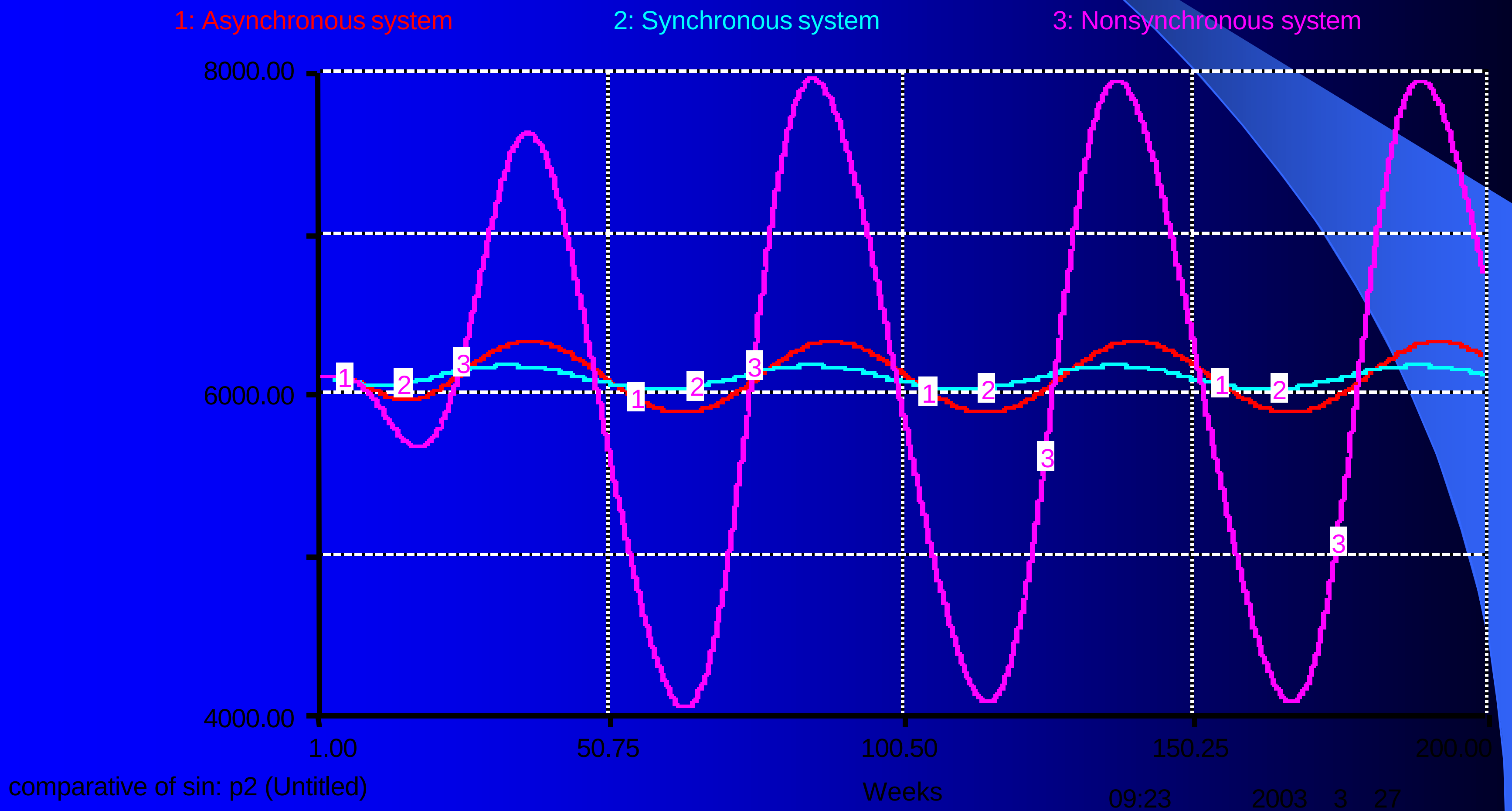
6.3.2. Customer Order: 1000+100*sin(2*Pi*Time/52)

(1)Comparative behavior of retailer's inventory



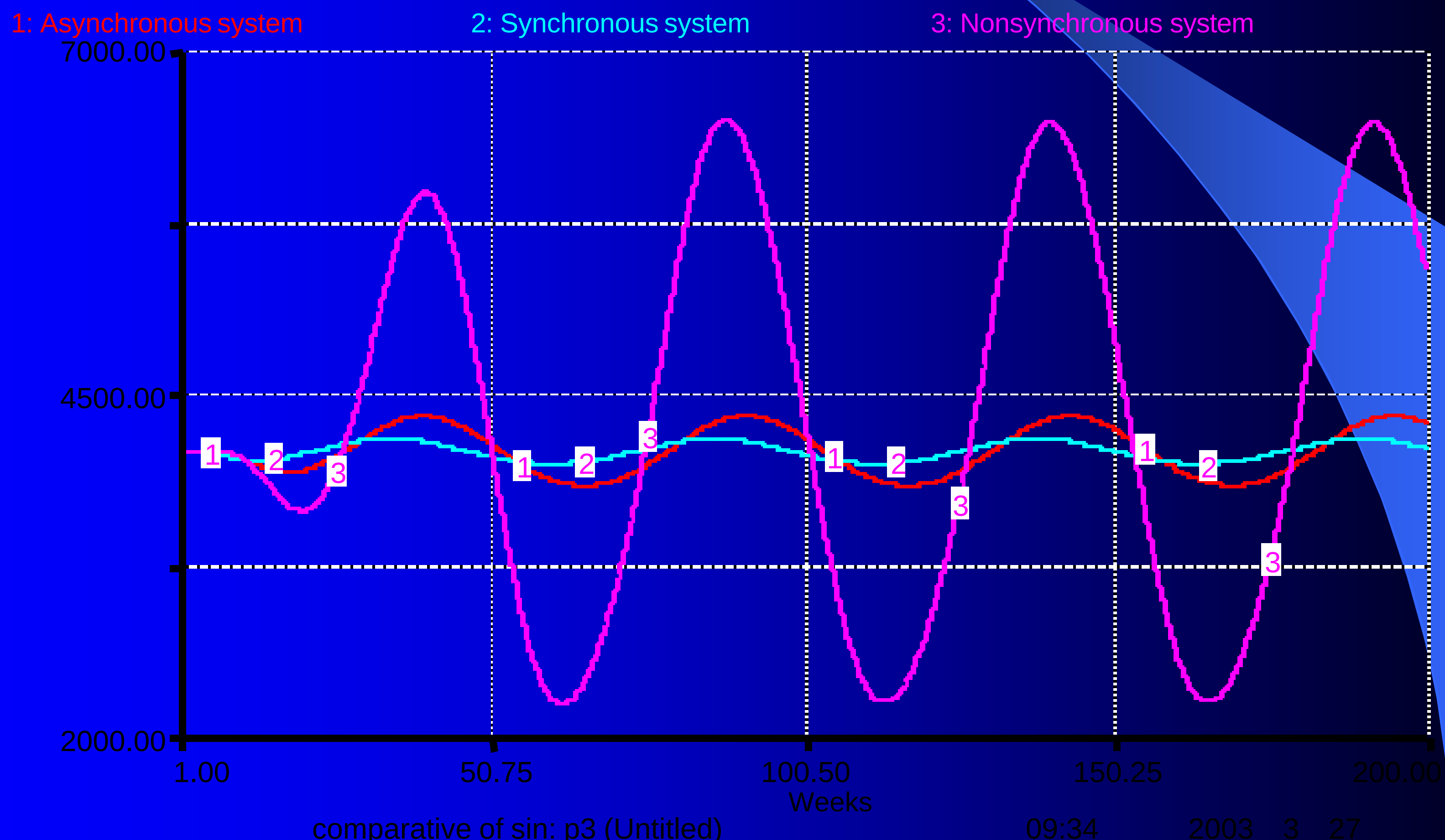
6.3.2. Customer Order: 1000+100*sin(2*Pi*Time/52)

(2)Comparative behavior of distributor's inventory



6.3.2. Customer Order: 1000+100*sin(2*Pi*Time/52)

(3)Comparative behavior of manufacturer’s inventory



6.3.3. Summary

- Both synchronous and asynchronous systems work much better than the original non-synchronous model
- Though armed with less control over the rates, asynchronous systems can behave as good as the central-controlled synchronous systems.

Customer Order: 1000+100*sin(2*Pi*Time/52)

	Average inventory of retailer	Average inventory of distributor	Average inventory of manufacturer
Non-syn.	8560	7109	5613
synchronous	8124	6113	4103
Asynchro.	8254	6215	4209

7. Discussion and Conclusion

- As environments call for more and more attention on the boundaryless systems, the trade-off design of sub-units' autonomy and systemic performance is quite important
- Asynchronous systems leave a room for rates to decide the way to implement the assigned goals, while streamlining those goals at macro-system level
- Not only adaptive to environmental changes, autonomous units have more possibilities to emerge better systemic behavior as a whole(tangible and intangible)
- Other methods and tools can be used to search various policy sets for the autonomous units

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