Teaching Project Management through System Dynamics:

The Case of the Tamales Factory

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Why project management needs SD

- Projects usually finish late, cost more than expected, generate quality problems, or are even abandoned after substantial effort has already been invested.
- Projects exhibit dynamic complexity: delays, feedback, rework, and unintended consequences.
- Students in project management programs are commonly trained with static tools: work breakdown structures, network diagrams, milestone plans, earned-value metrics, and critical path calculations. **Traditional PM tools often overlook feedback and dynamic behavior over time**.

> *"While project-management flight simulators exist, and project dynamics ideas are taught in a few courses**, the use of system dynamics concepts to help managers understand project behavior and improve management is very limited. Perhaps the biggest need are teaching materials that can be used by both system dynamicists and by others** ..."*

System Dynamics Applied to Project Management:
A Survey, Assessment, and Directions for Future Research
David Ford, James Lyneis (2020)

We designed and built an educational artifact for a new SD course

- A new Master program in Project Management at Universidad de los Andes (Bogota).
- 8-week SD virtual elective course (on the Coursera platform).

Module	Contents	Duration
1. Systemic Thinking	Introduction to SD, dynamic complexity, feedback loops, CLDs	2 weeks
2. Modeling and Simulation	S&F models, decision rules, operational thinking	2 weeks
3. Systemic project management	Canonical SD structures, unknown rework, rework cycle, control feedback, reinforcing feedback, unintended consequences, policy resistance and leverage points.	4 weeks

} Teaching Case

3 chapters, 8 parts. Each part:

- Contextual story documents
- Challenge statements
- Simulation models
- PowerPoint templates for answers
- Evaluation rubrics
- Teaching notes

The Tamales Factory

The storyline concerns a fictional factory that seeks to mass-produce tamales under demanding delivery and growth expectations.

***William Wanka**, the founder and manager of the famous Wanka Chocolate Factories.*

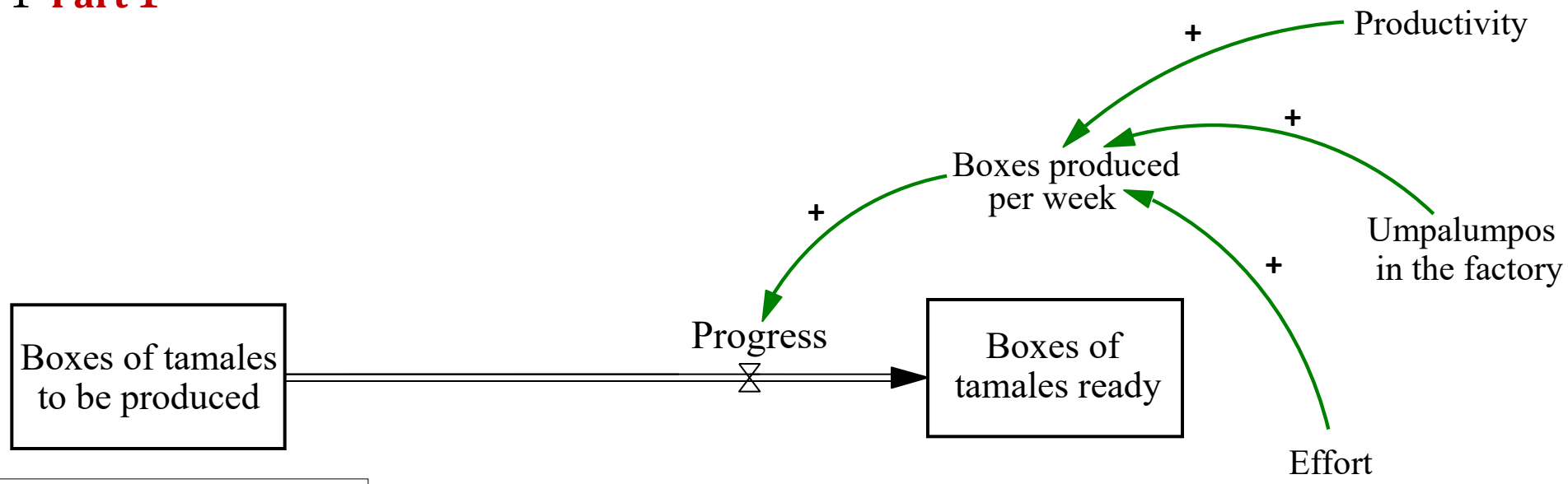
***Tamy**, a farmer devoted to her extensive cocoa and maize plantations, was invited by Wanka to become a reliable supplier of cocoa for several of his factories around the world. She accepted on one condition: if he helped her establish a factory in Colombia to produce tamales!*

*William Wanka offered to recruit **Umpalumpos** from his factories, where employees receive specialized training in large-scale food production.*

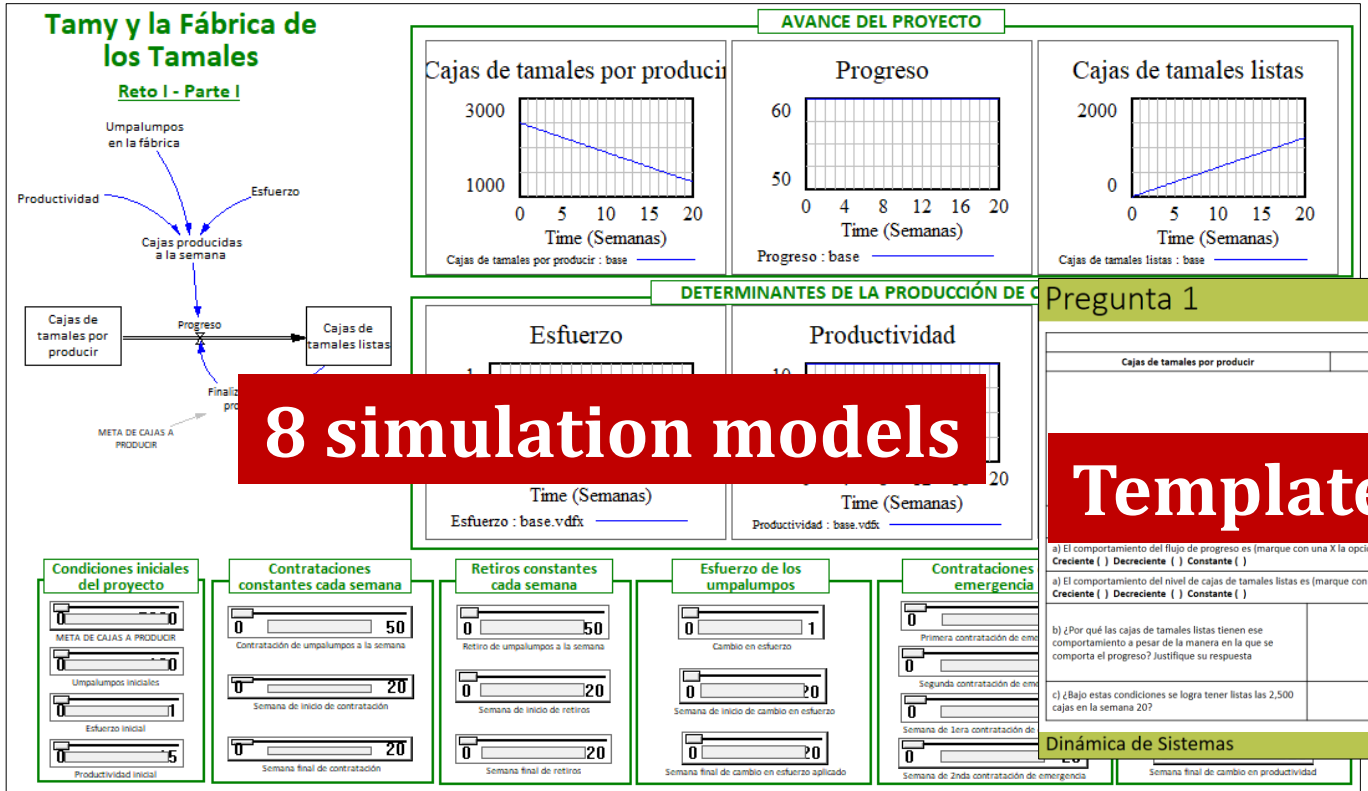
> *"Based on measurements from my other factories, each Umpalumpo can produce 10 boxes of tamales per week. This productivity depends on factors such as their skills, capabilities, motivation, and job satisfaction. Under a standard 8-hour workday, however, each Umpalumpo works at 20% effort intensity""*

*Tamy planned to have 2,500 boxes of tamales ready within 20 weeks, in time for Christmas. To achieve this goal, **you** are brought in as an expert consultant because your background highlights expertise in System Dynamics.*

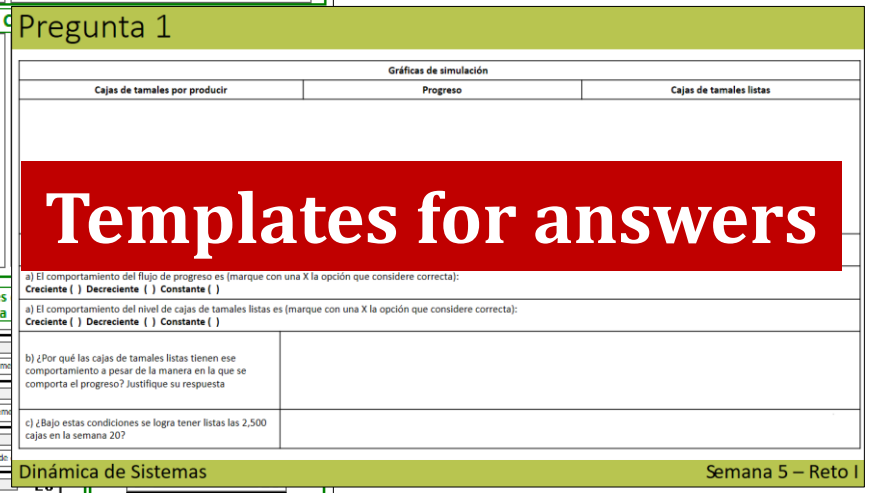
Naturally, things don't go as planned.



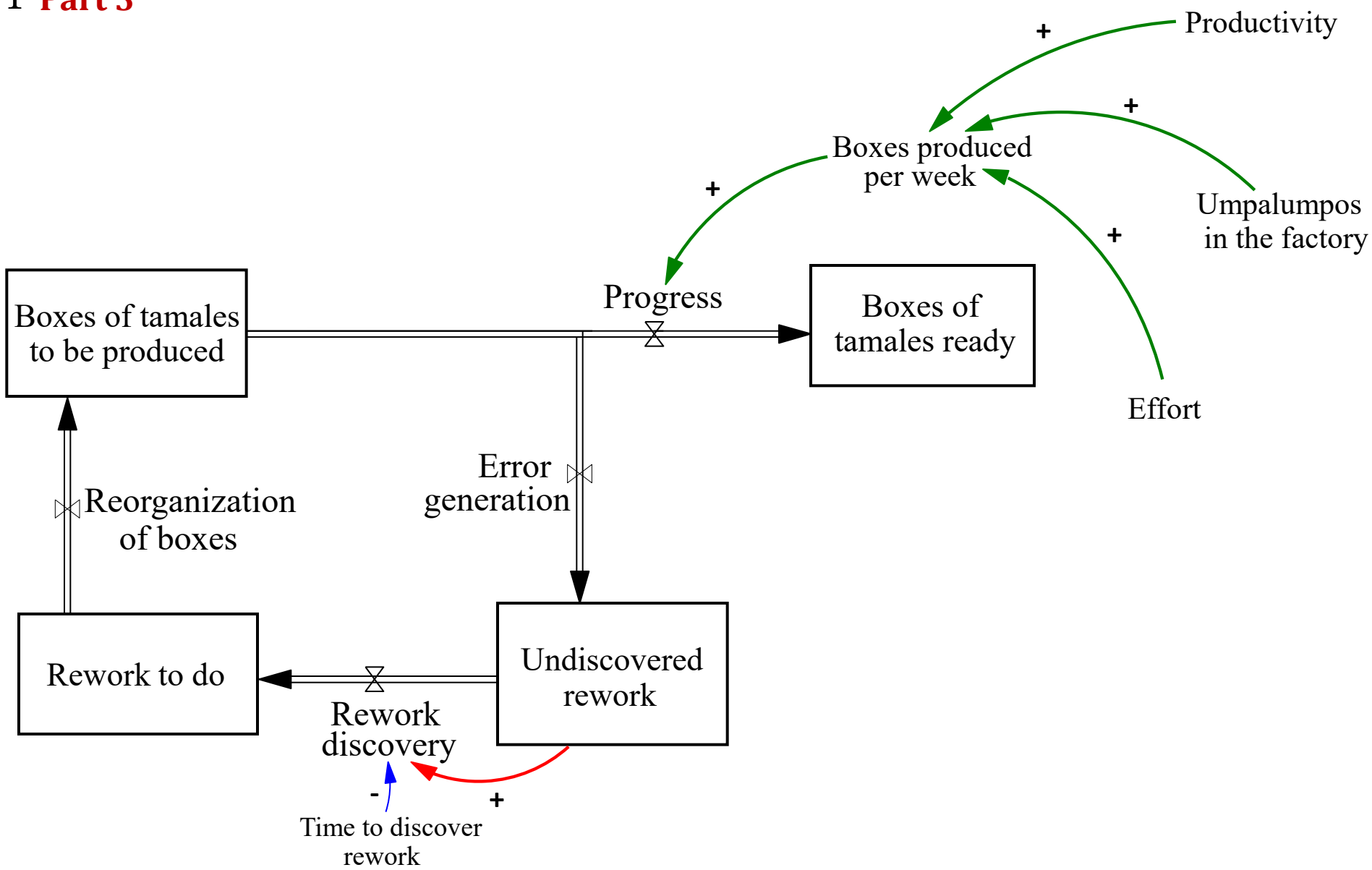
Storylines & challenges



8 simulation models

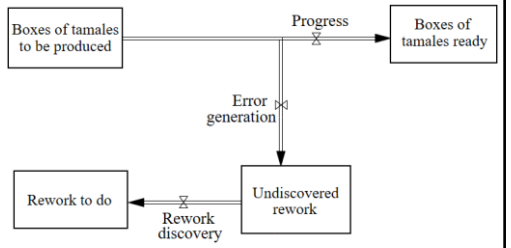
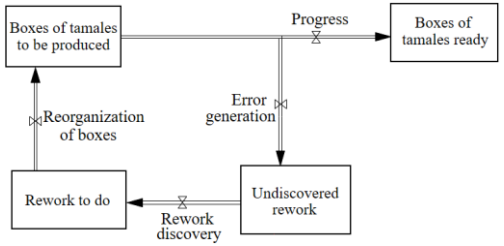


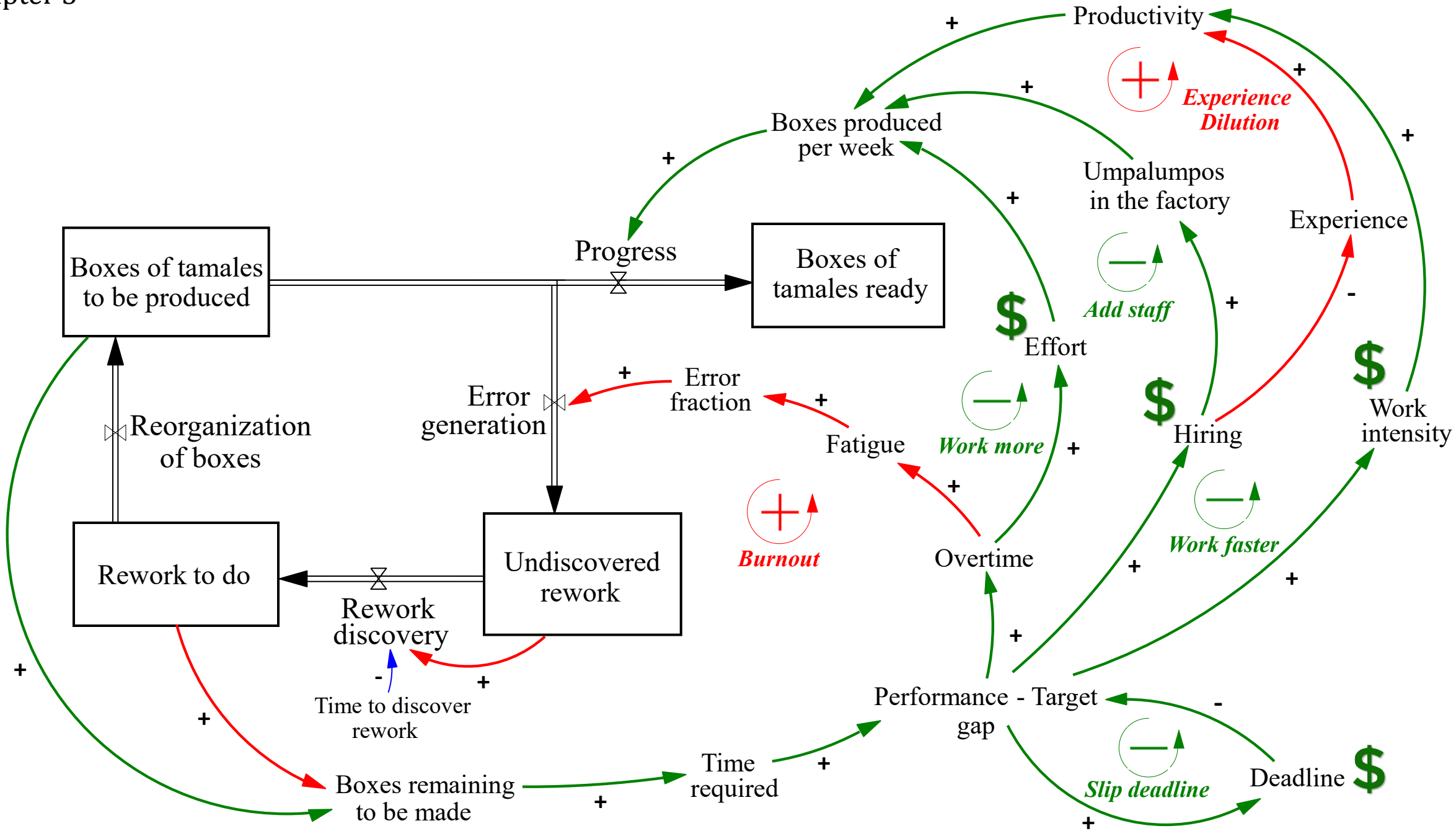
Templates for answers



(based on Ford & Lyneis, 2020)

Chapter1 - Evaluation rubric

	0.0	1.0	2.0	3.0	4.0	5.0
						
Analyze the dynamics of system structures (20%)	…	…	Analyzes, with some errors, the dynamics of accumulations affected by a single flow.	Correctly analyzes the dynamics of accumulations affected by a single flow.	Correctly analyzes the dynamics of a chain of accumulations connected by multiple inflows and outflows.	Correctly analyzes the dynamics of a chain of accumulations connected by multiple flows that form a rework cycle.
Interpret the results of computer simulations (20%)	…	…	Interprets, with some errors, the results of computer simulations that produce different combinations of decisions and scenarios in accumulations affected by a single flow.	Correctly interprets the results of computer simulations that produce different combinations of decisions and scenarios in accumulations affected by a single flow.	Correctly interprets the results of computer simulations that produce different combinations of decisions and scenarios in chains of accumulations connected by multiple inflows and outflows.	Correctly interprets the results of computer simulations that produce a variety of decision/scenario combinations in a chain of accumulations connected by multiple flows that form a rework cycle.
Design courses of action for PM based on systemic elements (40%)	…	…	Proposes courses of action without correctly justifying them based on the dynamics of accumulations affected by a single flow.	Proposes effective courses of action justified by the dynamics of accumulations affected by a single flow for project management decision-making.	Proposes effective courses of action justified by the dynamics of chains of accumulations connected by multiple inflows and outflows for project management decision-making.	Proposes effective courses of action justified by the dynamics of a chain of accumulations connected by multiple flows and the rework cycle for project management decision-making.
Recognize how SD can be applied to PM (20%)	…	…	Explains, with some errors, how system dynamics concepts can be applied in a project. Mentions the advantages and limitations of using models for project management with inaccuracies.	Explains how system dynamics concepts can be applied in a project. Mentions the advantages and limitations of using models for project management.	Explains that project planning and execution require considering the generation of errors. Discusses the dynamics surrounding their discovery (accumulations, resources, time, actions) or the implications of ignoring these dynamics. Provides recommendations for managing discovered errors.	Explains how rework occurs in a project and its consequences. Reflects on how rework can be recognized, the challenges of measuring it, and whether actions are taken. Explains how rework could be avoided and the implications of ignoring the rework cycle in project planning and management, including ways to incorporate rework iterations into project planning.



(based on Ford & Lyneis, 2020)

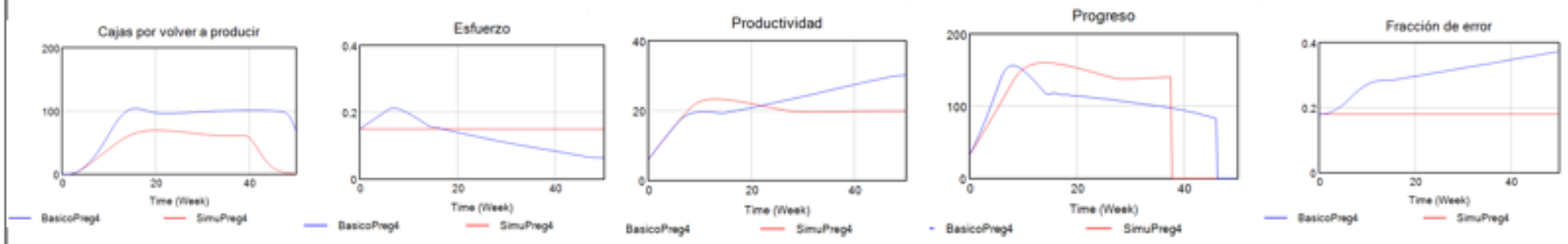
Student response example in a PowerPoint template

Question 4

a. What changes to the policies on working time and work intensity, hiring oompaloomps, and deadline extensions do you suggest in order to reach the goal of 5,000 boxes of tamales with the available budget of 11,000 PLATS (Latin Pesos) and before the project reaches 50 weeks? Consider that these policies generate ripple effects (that is, in the simulator both must be activated—don't forget this!).

Adjustment in working time: 0	Adjustment in oompaloomps: 1	Week in which the 5,000 boxes of tamales are achieved: 44
Adjustment in work intensity: 1	Adjustment in deadline: 5	Total cost of the project: 10.390

b. Choose 3 or 4 variables that you think best illustrate the impact of the changes you made to the policies in the previous question and create simulation graphs comparing an initial "base" scenario with both ripple effects activated and the model's original baseline policies against the scenario you suggest for achieving the goal. Your graphs:



Dinámica de Sistemas — Semana 7 – Reto 3

Exploration of ripple effects triggered unintentionally by control loops and driven by reinforcing feedback.

Teaching Notes

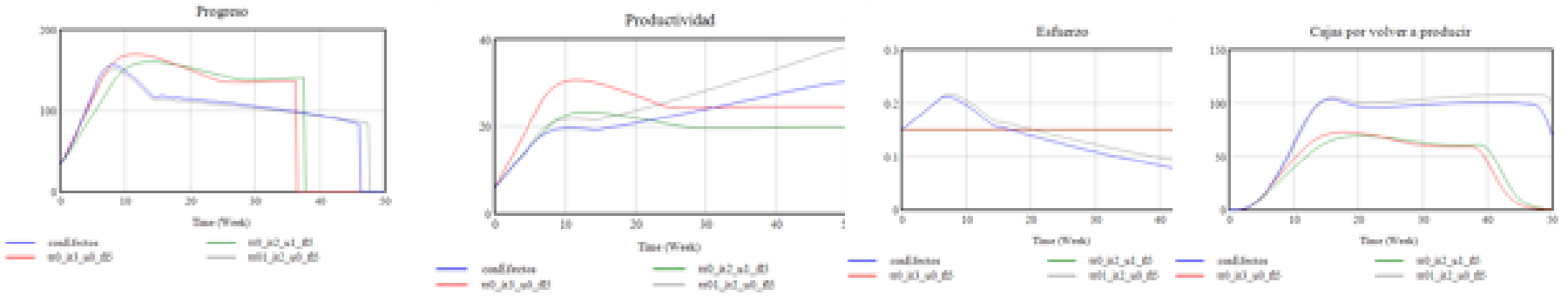
Pregunta 4

Diferentes escenarios con variaciones en los parámetros de las directrices, cualquiera de estos tres escenarios funciona, el primero es el más rápido y más barato (37 semanas, 4500 PLATS, con parámetros en 0, 3 0 y 5).

a. ¿Qué modificaciones a las directrices de tiempo e intensidad de trabajo, contratación de umpalumpos y extensiones de la fecha límite, sugiere que se tomen para lograr la meta de las 5,000 cajas de tamales con el presupuesto disponible de 11,000 PLATS y antes de que el proyecto complete 50 semanas? Considere que dichas directrices generan los efectos dominó (es decir, en el simulador deben estar ambos activados, ¡no olvide esto!)

Ajuste en tiempo de trabajo: 0; 0; 0.1	Ajuste en umpalumpos: 0; 1; 0	Semana en la que se logran las 5,000 cajas de tamales: 37; 38; 48
Ajuste en intensidad de trabajo: 3; 2; 2	Ajuste en fecha límite: 5; 5; 5	Costo total para el proyecto: 4500; 7300; 8876

b. Escoja 3 o 4 variables que considere que mejor ilustran el impacto de sus modificaciones a las directrices de la pregunta anterior y realice gráficas de simulación en las que compare un escenario "base" inicial con ambos efectos dominó activados con las directrices originales de base del modelo vs. el escenario que usted sugiere para lograr la meta. Sus gráficas:



Dinámica de Sistemas — Semana 7 – Reto 3

Results

Institutional Assessment – First time

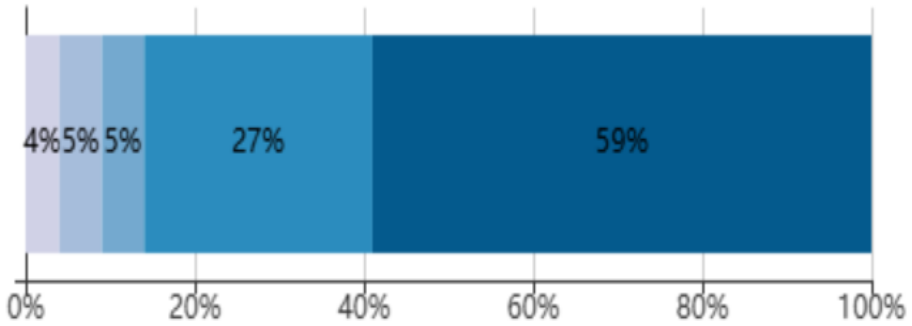
0.0 – 5.0 scale

Technical tools of the discipline	4.79
Contents	4.71
Learning activities	4.75
Learning results	4.52
Contribution of the Tamales case to the learning goals	4.71

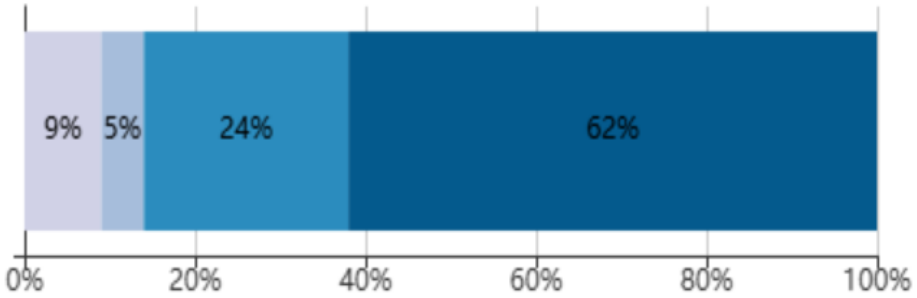
*"**The material was adequate and really good.** I think that's fundamental to the course's success, **as long as you're diligent and follow the sequence**. This helps us tremendously to understand everything the professor explains ... Overall, I think the material is well-designed and very positive."*

Results

Course evaluation – Surveys 2025



The **activities are sufficient** to gain a good grasp of all the topics in the course (86%)



The **study material is suitable** for achieving the course objectives (86%)

Results

Course evaluation – Surveys 2025

"A very good course. It teaches the use of very useful tools for professional life and for understanding the subject matter. ***The Master's program should focus on this type of hands-on, theoretical-practical course, not just theory****.*

"Very well designed, ***it guides the student step by step****."*

"A very interesting course. ***I was unfamiliar with systems dynamics, so it was very interesting and challenging for me, but I believe it is a key component of Project Management****."*

"The course ***opens the mind to systemic thinking****. We typically think in terms of finding the cause and effect of a single variable, but this course teaches us to consider all the actors and variables that can influence different scenarios."*

"The practical approach to the challenges, the use of business tools, ***allows for their application in real-life situations****."*

Results

Students Achievements

From a closer reading of students' written answers to the challenges:

Chapter 1 – Rework cycle

They learn to **recognize accumulations and undiscovered rework, analyze stock dynamics, the challenge of the rework cycle and the value of simulation for anticipating problems.** Their answers suggest that they begin to see project performance not as the result of isolated variables but as the outcome of interacting stocks, flows, and delays.

Chapter 2 – Control decisions

They **recognize control decisions as triggers of feedback loops** and their interaction with delays. Students usually find surprising that increasing effort or hiring did not automatically improve project performance (counterintuitive behavior).

Chapter 3 – Unintended consequences and ripple effects

They show **a strong capacity to identify reinforcing ripple effects, delayed unintended consequences, policy resistance and the limits of intuitive interventions**.

Some takeaways

High institutional evaluations. Case rated highly for supporting learning goals.

Explicit reasoning. The templates require students to justify their answers with graphs and structural reasoning, beyond generic managerial advice**. Students must specify why a policy works or fails**, what loop it activates, and under what conditions its side-effects become significant**.**

Students reported **stronger systemic thinking** and appreciation of feedback, delays, and rework**.**

The case is an example of **how simulation-based learning can complement conventional project-management teaching** and make visible dimensions of project behavior that static tools tend to background.

The case functions as a **pedagogical translation of established SD project management theory into a staged, role-based, simulation-supported educational artifact.**

Educational contributions

Accessibility. The storyline is concrete, culturally vivid, and easy to enter.

Progressive complexity. The case does not overwhelm students by presenting all relevant mechanisms at once. Instead, it introduces one new structural layer at a time.

Simulation as a key element in improving mental models. Explicit integration of managerial reasoning with simulation analysis. Students are consistently placed in the role of advising decision makers.

Scalability and reusability. Because the package includes the storyline, challenges, simulation models, templates, teaching notes, and rubrics, it can be adapted for different cohorts, course sizes and teaching styles.

If you are interested, we are happy to share this material!

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Thank you