The NU Industries problem is a Linear Programming (LP) problem. It requires determining the optimal production and distribution strategies for three products over five periods to maximize profit. This optimization will consider constraints on production capacities, labor availability, raw material availability, storage space, and advertising budget.

To solve this problem, we would typically follow these steps:

1. Variables: Define decision variables that will capture the quantity of each product manufactured in each period at each plant, the number of hours of regular and overtime labor used in each period at each plant, the quantity of each raw material purchased in each period at each plant, and the advertising spending for each product in each period.
2. Objective Function: Construct an objective function to maximize profit. This will sum up the revenues from selling the products minus the costs of raw materials, labor, advertising, storage, and transportation.
3. Constraints:

* Production constraints based on available labor and raw materials.
* Raw material purchase constraints based on vendor limits.
* Storage constraints based on inventory capacity at each plant.
* Advertising budget constraint.
* Production requirements to meet demand for each product in each period.
* Constraints to ensure that demand in a given period is met by production in that period or inventory from a previous period.
* Constraints for labor costs increase after period 2 for both plants.

1. Solving the LP Model: Using software solvers in Python libraries like PuLP or SciPy, we would solve this LP model to get the optimal solution.
2. Sensitivity Analysis: After solving the baseline case, we would conduct a sensitivity analysis to understand the impact of changing certain parameters (like the advertising budget or raw material availability) on the optimal solution. This will provide insights into which parameters are most influential on profit and can guide business recommendations.
3. Integer Programming: The problem also suggests solving it as an integer problem. This means that instead of allowing fractional values for the decision variables (like producing 2.5 widgets), we would require integer values. This might make the problem more complex and might provide slightly different results. Comparing the results from the LP and Integer Programming solutions will provide insights into how much rounding off or ignoring fractional production affects the solution.
4. Business Recommendations based on the sensitivity analysis might include:

* Increasing the advertising budget if it has a high positive impact on profit.
* Negotiating with the raw material vendor for increased supply if raw material constraints are tight and limiting profit.
* Investing in expanding storage capacity if inventory constraints are frequently binding.

This problem can be referred to as a multi-period or dynamic LP problem. Solving it requires considering decisions across all periods simultaneously, as decisions in one period can impact available options and profitability in subsequent periods.

**Requests for the instructor:**

1. Variables Definition: There is a need to define decision variables for various aspects like the quantity of each product manufactured, labor hours, raw material purchases, and advertising spending. However, we are a bit uncertain about how to structure them, especially when considering multiple periods and plants. Any insights or examples you could share would be immensely helpful.
2. Objective Function Formulation: While we have grasped the basic concept of maximizing profit by considering revenues and costs, we are unsure about translating this into a precise mathematical formulation. Could you provide some guidance or references on this?
3. Please help with these Constraints Clarification:
4. How to account for labor cost increases after period 2 for both plants.
5. Ensuring demand in a given period is met by production in that period or inventory from a previous period. Any clarification on these constraints would be invaluable.
6. Software Solvers: We would like to use PuLP and SciPy as potential solvers for this LP model. Do you have a preference or recommendation on which one might be more suitable for this problem?
7. Sensitivity Analysis: Please specify the most critical parameters to focus on for the sensitivity analysis. Are there any common pitfalls or considerations we should keep in mind?
8. Integer Programming vs. LP: Please elaborate a bit on the practical implications of solving this as an integer problem.
9. Business Recommendations: Lastly, once the analysis is complete, we would appreciate any tips on how to translate the findings into actionable business recommendations.
10. For the labor costs, it is indicated that there will be an increase of 5% following the second period. What assumptions should we make regarding the labor costs for periods 4 and 5?
11. Please clarify if it is reasonable to presume that the inventory held over from one period will be entirely sold off in the subsequent period?
12. Please point us toward any resources or literature that provide guidance on this type of scheduling within the context of linear programming.