

Session 2: Capacity Management

Canan Adelman

UIC Business
IDS 532: Introduction to Operations Management

August 31, 2021

UIC BUSINESS

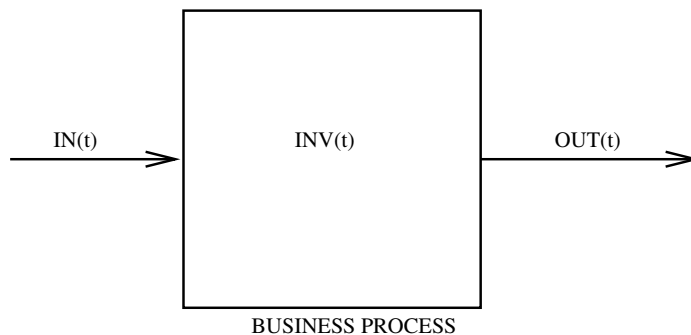
Adelman ©2021

Session 2: Capacity Management

1

Last Class

1. Operations and Marketing Reconciliation
2. Operations Quadrangle
- 3.



4. Little's Law
5. Capacity Analysis

UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

2

Agenda

1. Buildup graphs
2. Capacity expansion
3. Managing product mix
4. Linear programming

UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

3

National Cranberry Cooperative



UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

4

NCC Capacity expansion

19000 b/day, 70/30 wet/dry

# extra dryers	# extra separators	Makespan	
0*	0	22.2	$= \max \left\{ \frac{.7(19000)}{600}, \frac{19000}{1200} \right\}$
1*	0	16.625	$= \max \left\{ \frac{.7(19000)}{800}, \frac{19000}{1200} \right\}$
2	0*	15.8	$= \max \left\{ \frac{.7(19000)}{1000}, \frac{19000}{1200} \right\}$
2*	1	13.3	$= \max \left\{ \frac{.7(19000)}{1000}, \frac{19000}{1600} \right\}$
3	1*	11.875	$= \max \left\{ \frac{.7(19000)}{1200}, \frac{19000}{1600} \right\}$
3*	2	11.08	$= \max \left\{ \frac{.7(19000)}{1200}, \frac{19000}{2000} \right\}$

* constraining resource

UIC BUSINESS

What is the capacity of the NCC plant?

UIC BUSINESS

Capacity of NCC: Linear Program

Decision variables, constraints, objective function

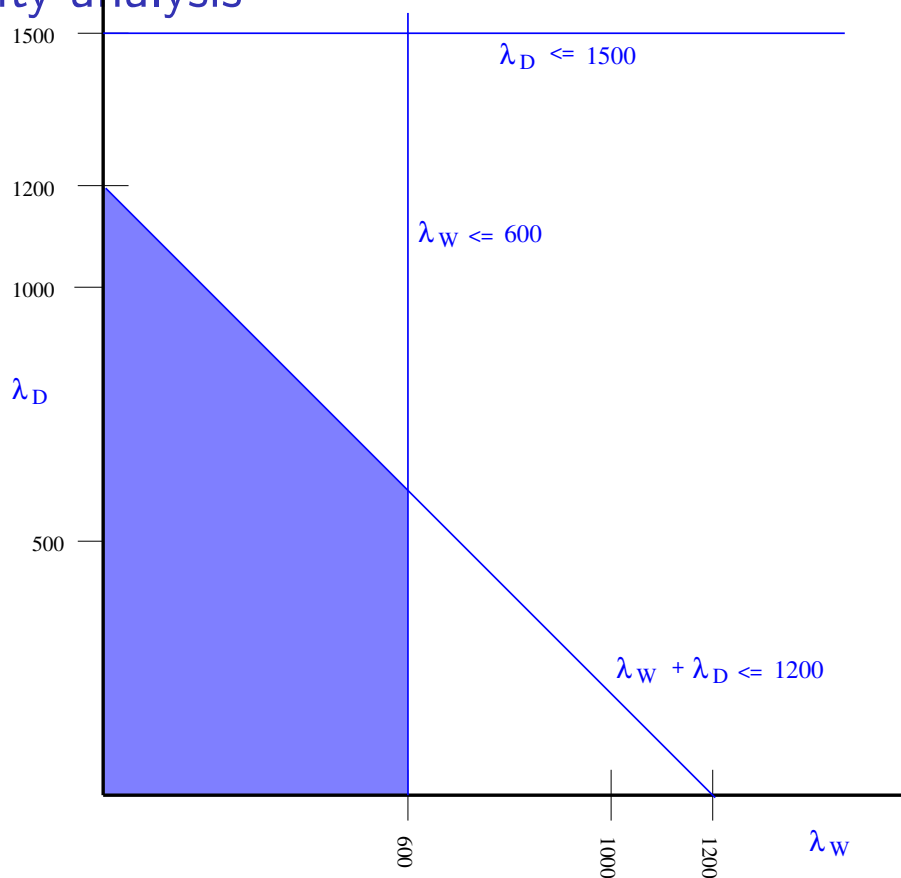
UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

7

Capacity analysis



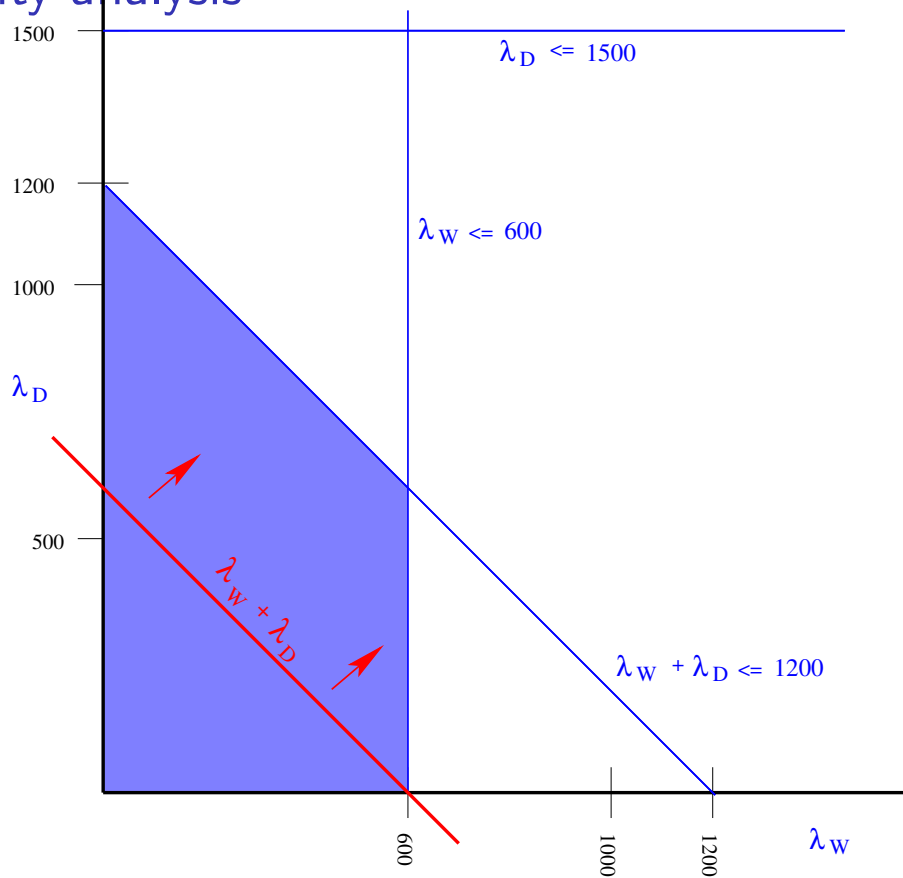
UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

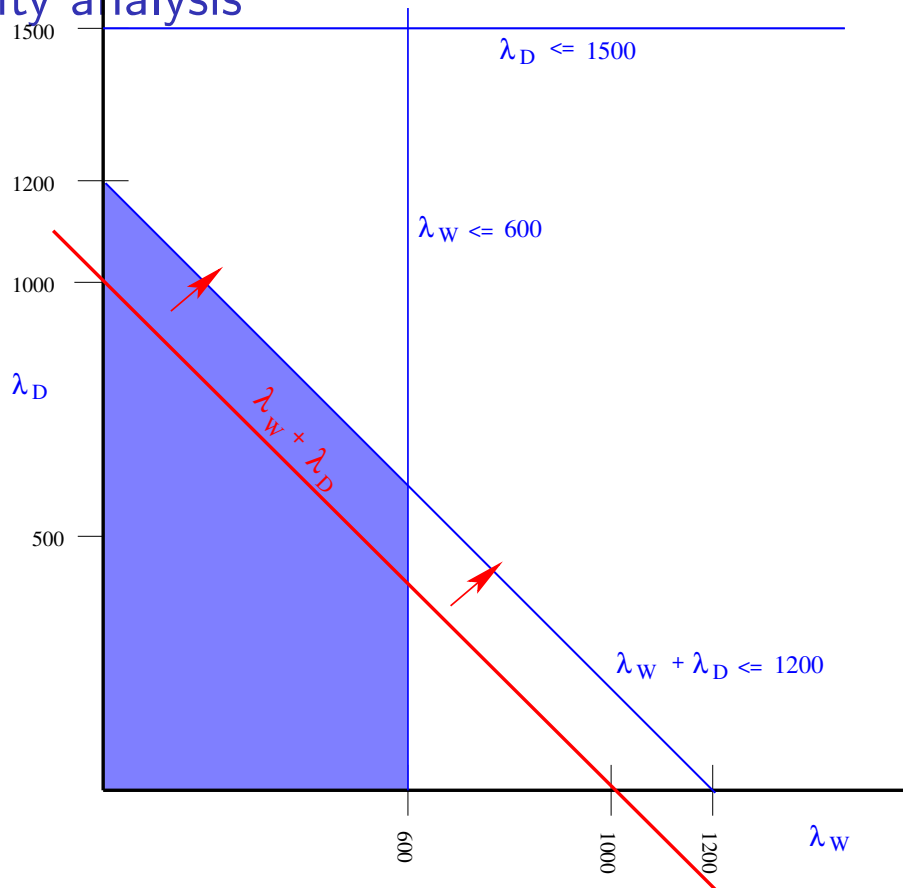
8

Capacity analysis



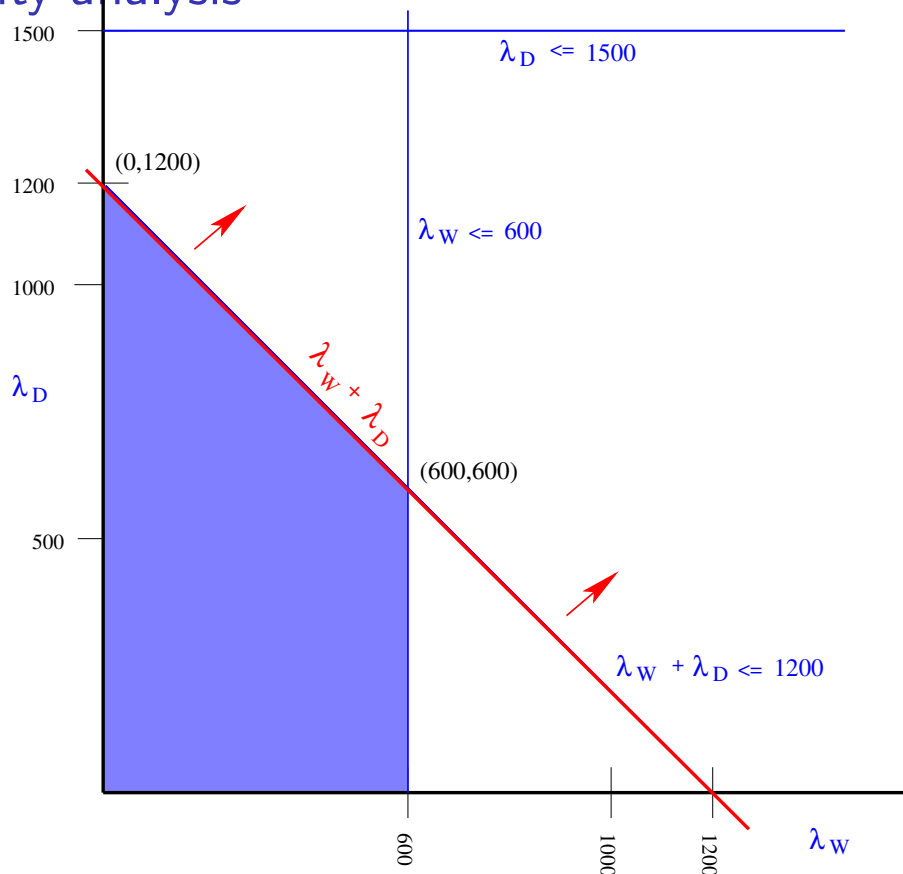
UIC BUSINESS

Capacity analysis



UIC BUSINESS

Capacity analysis



UIC BUSINESS

Capacity analysis

The 70/30 Product Mix Constraint

$$\frac{\lambda_W}{\lambda_W + \lambda_D} = .70$$

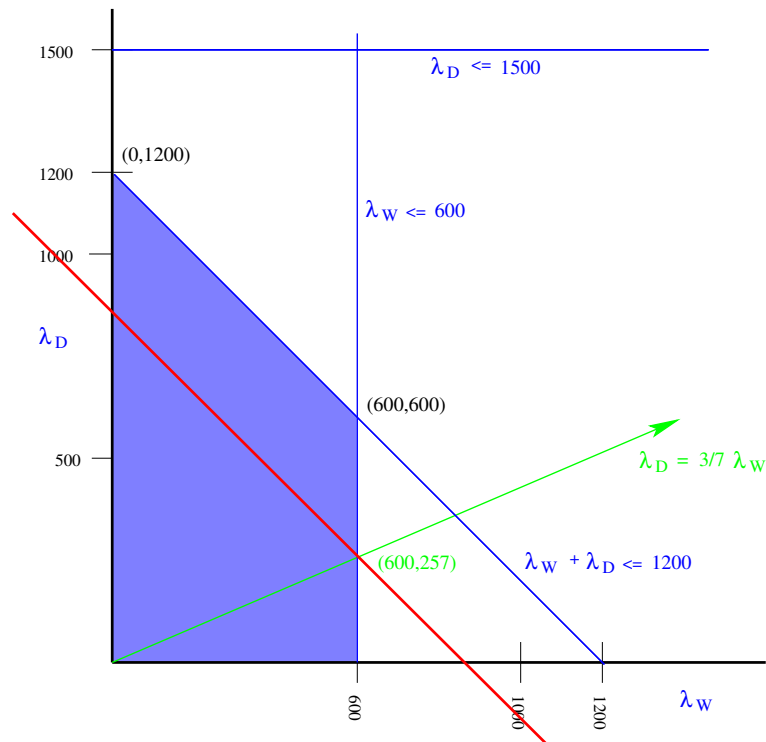
$$\lambda_W = .70 \lambda_W + .70 \lambda_D$$

$$.30 \lambda_W = .70 \lambda_D, \text{ or,}$$

$$\lambda_D = 30/70 \lambda_W$$

UIC BUSINESS

Capacity analysis



UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

13

Capacity analysis

Product Mix Constraints in General

$$\lambda_D = (\% \text{ DRY} / \% \text{ WET}) \lambda_W$$

Year	% WET	% DRY	% DRY / % WET	λ_W	λ_D	Capacity
1	70	30	30/70	600	257	857
2	75	25	25/75	600	200	800
3	82	18	18/82	600	132	732
4	88	12	12/88	600	81	681
5	93	07	7/93	600	45	645

UIC BUSINESS

Adelman ©2021

Session 2: Capacity Management

14

Merton Trucks

What is the main issue facing Merton Truck?

UIC BUSINESS

Merton Trucks

Contribution towards Fixed Costs is (Revenue - Var Costs)

UIC BUSINESS

Contribution if only produce Model 101

- ▶ How much can we produce?

Contribution if only produce Model 102

Current Policy

1000 M101's

1500 M102's (As many as possible)

- ▶ Are they operating at their capacity with this policy?
- ▶ Is this the best policy?

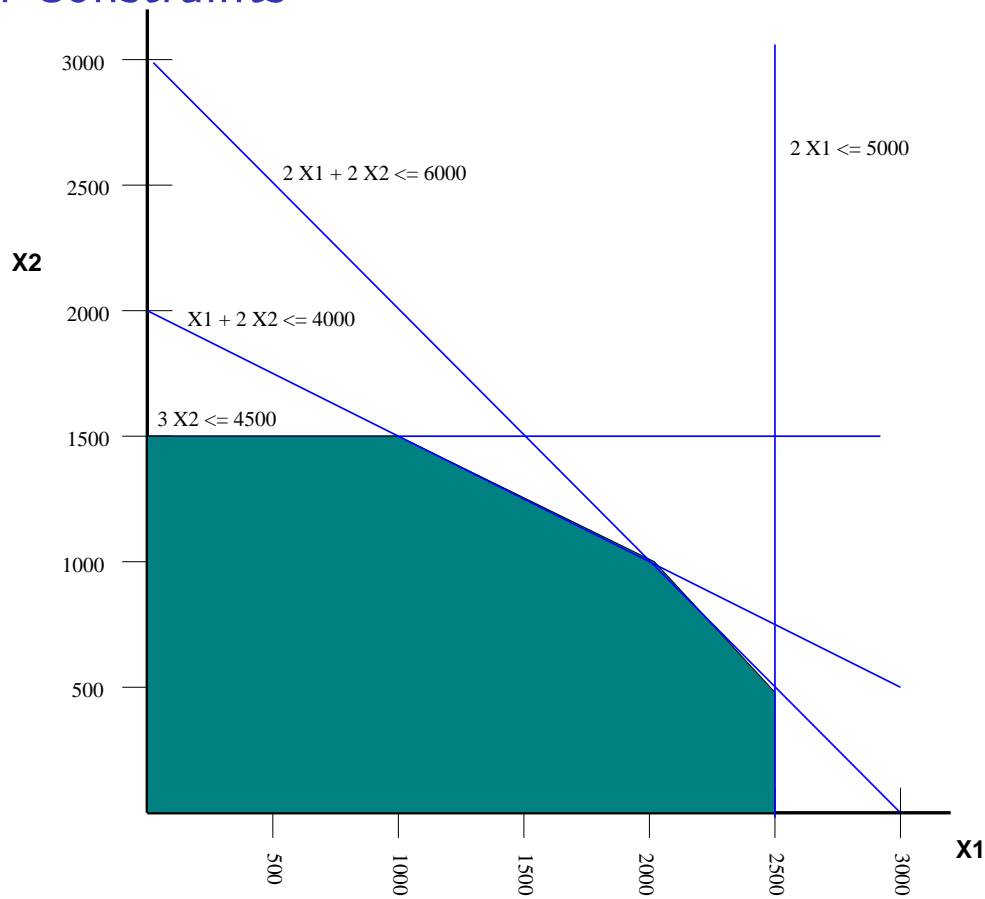
Is there a better policy?

A Framework for Capacity Planning

There are many product mix solutions that Merton might choose.

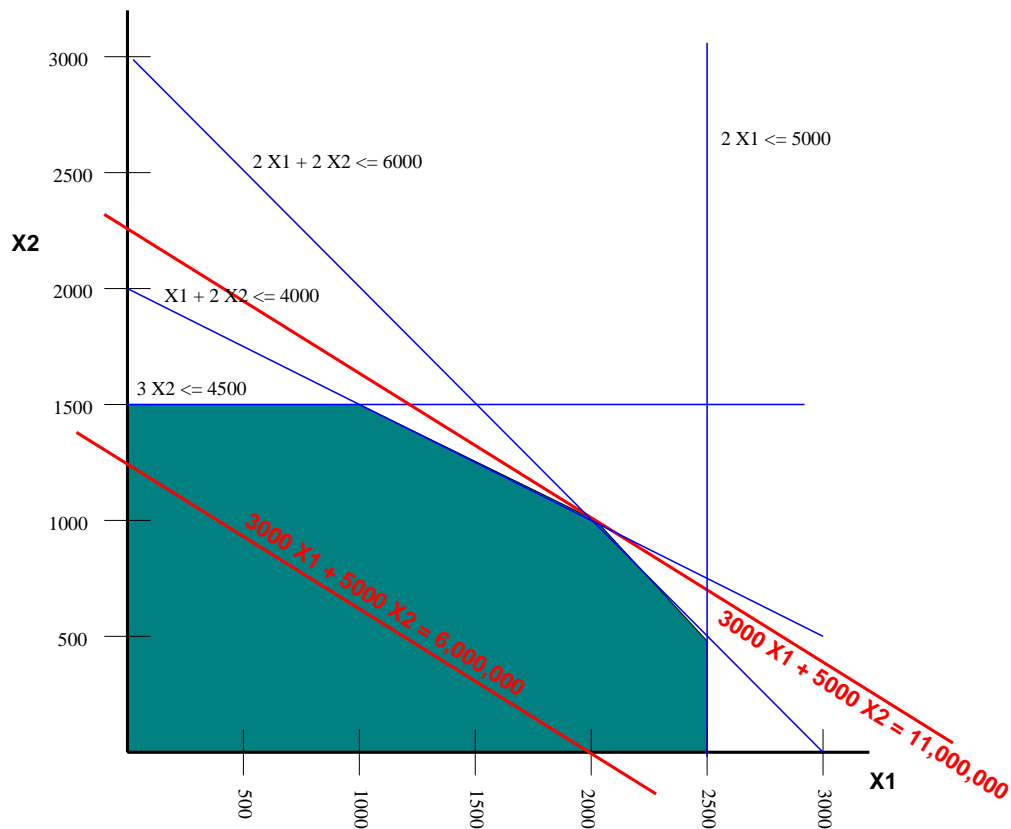
A framework

Graph Constraints



UIC BUSINESS

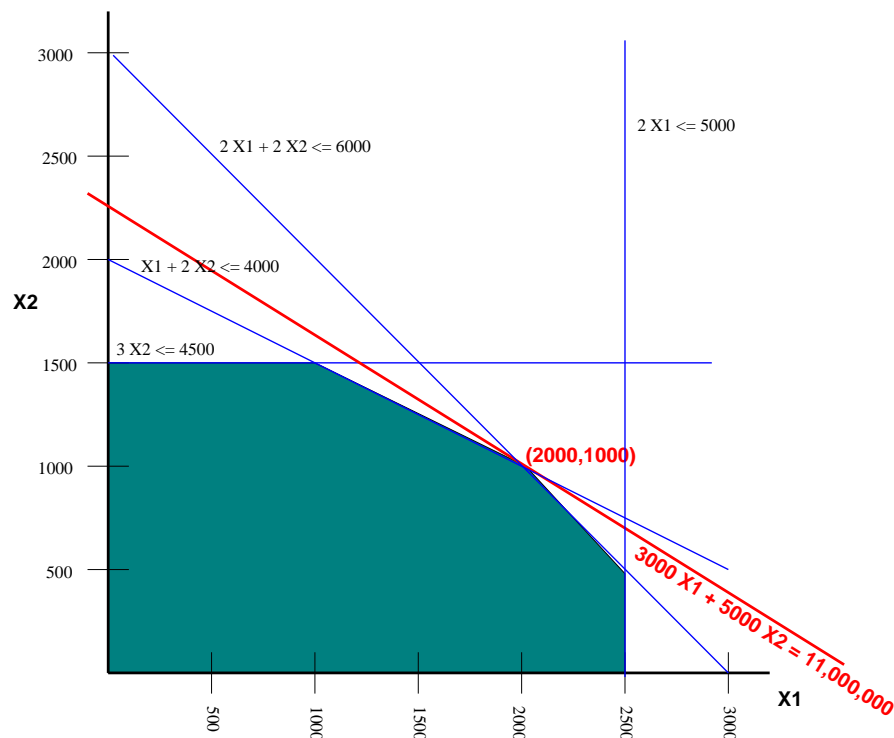
Find Optimal Solution



UIC BUSINESS

Find Optimal Solution

Find Optimal Solution



How should management structure the incentives of the sales force?

- ▶ How to solve larger problems
- ▶ Which resource(s) should I expand?
- ▶ How much would I pay for one more unit of a given resource?
- ▶ How sensitive am I to input data?

Shadow Prices

How much benefit do I get by adding an additional unit of a resource?

The Shadow Price of a Resource

- ▶ given by All Linear Program Solvers
- ▶ Shadow Price of a resource > 0 only when constraint is tight
- ▶ For example: Shadow Price on Engine Assembly is 2000
 - ▶ One more unit of Engine Assembly is worth \$2000

Practice Exercise: Insulation Problem

An insulation plant makes two types of insulation called type B and type R. Both types of insulation are produced using the same machine. The machine can produce any mix of output, as long as the total weight is no more than 70 tons per day.

Insulation leaves the plant in trucks; the loading facilities can handle up to 30 trucks per day. One truckload of type B insulation weighs 1.4 tons; one truckload of type R weighs 2.8 tons. Each truck can carry type B insulation, type R insulation, or any mixture thereof. The insulation contains a flame retarding agent which is presently in short supply; the plant can obtain at most 65 canisters of the agent per day. One truckload of (finished) type B insulation requires an input of three canisters of the agent, but one truckload of type R insulation requires only one canister.

Carla Linton, the plant manager, has calculated that, at current prices, the contribution from each truckload of type B is \$950, and \$1,200 for type R. There appears to be no difficulty in selling the entire output of the plant, no matter what production mix is selected.

How much of each kind of insulation should be produced?

Session 2: Overview

- ▶ A process flow diagram and build-up graph facilitates analysis
- ▶ Capacity can be complex, often depending on product mix
- ▶ Capacity expansion analysis
 - ▶ What is my path of expansion?
 - ▶ What are the gains along this path?
- ▶ Framework : Optimize an objective function subject to constraints
 - ▶ Use LP solver — such as included in excel
 - ▶ Shadow prices — value of a resource