Sustainable Development Leadership Program
Yale School of Forestry & Environmental Studies and
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Scott Hedges
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ECO-INDUSTRIAL DEVELOPMENT EXERCISE: NANJING, CHINA
This exercise is designed to encourage thought and discussion about the ways in which the principles of industrial ecology could be applied following the eco-industrial park model. It is based on a hypothetical set of industrial sites. For each of the sites basic materials flow information is given, which will allow you to develop potential materials exchanges between a network of companies and municipal facilities, including the large power station, a steel mill, an electronics factory, a sewage treatment plant, a cement factory, a scrap recycler, and residential housing. You are encouraged to suggest additional companies or facilities that would be well suited to locate in this eco-industrial project area.

DEVISE AN ECO-INDUSTRIAL DEVELOPMENT PLAN FOR NANJING
Each group will create an eco-industrial development plan for Nanjing by incorporating the basic ideas of industrial ecology, industrial symbiosis, and eco-industrial parks. Each group can use the following information describing the material flows of potential participants in the Nanjing eco-industrial development plan. In addition, be sure to draw upon the personal knowledge and experience of your group in devising additional industrial symbiosis linkages. Each group should try to quantify linkages of industrial systems whenever possible. Each group should develop a network flow diagram and should explore the economic and social aspects of the symbiotic relationships.
Figure 1 Nanjing, China Industrial Area Map

Location Key
1 Coal Power Station
2 Sewage Treatment Plant
3 Steel & Iron Co., Ltd.
4 Cement Plant
5 Metal Scrap Recycling
6 Residential Apartments
7 Electronics Manufacturing
INDUSTRIAL FACILITY MATERIAL FLOW PROFILES

1. Coal Power Station

![Diagram of Coal Power Station]

1. Coal Power Station

- Energy Requirements: N/A (Energy produce)
- Water Requirements: 20 x 10^6 L/year river water (cooling), Freshwater (purified) for steam
- Material Inputs: 8.3 Million tons/year (862 tons per hour) of High Sulfur Coal
- Products: 22 Million kWh Electricity/year
- Non-Product Outputs/Wastes: CO₂, 22.8 million tons/year, NOₓ, 85,521 tons/year, Elevated temperature wastewater 20 x 10^6 L/year, Fly Ash & Bottom Ash (800,000 tons/year), Waste solvents (cleaning), Waste or

2. Sewage Treatment Plant

![Diagram of Sewage Treatment Plant]

2. Sewage Treatment Plant

- Energy Requirements: 200,000 kwh per year
- Water Requirements: Process water from municipal water service
- Material Inputs: 1 x 10^8 L/year of sewage, 56 tons/year Total Phosphorus, 210 tons/year Total Nitrogen, 2500 tons/year Biological Oxygen Demand
- Products: 1 x 10^6 L/year of clean water
- Non-Product Outputs/Wastes: Sludge, Solvents (cleaning), Waste chemicals
3. Steel and Iron Co., Ltd.

![Steel and Iron Co., Ltd. Diagram]

**ENERGY REQUIREMENTS**
- Furnace Fuel: 960 pounds Coke per ton
- Water Requirements: 530 L/ton

**MATERIAL INPUTS**
- Iron Ore
- Scrap Iron
- Coke

**PRODUCTS**
- Steel and Iron Co Ltd.
- 1.5 million tons rolled steel

**NON-PRODUCT OUTPUTS/WASTES**
- CO₂
- Benzene
- Slag (250/ton)
- 25,000 L/ton gal heated process water
- Dust & Sludge (300/ton)

4. Cement Plant

![Cement Plant Diagram]

**ENERGY REQUIREMENTS**
- Facility Electricity (lights, conveyor, hoppers, machinery operation)
- Fuel (200 kg Coal/ton cement)
- Fuel Quality Wastes (amt. varies)

**MATERIAL INPUTS**
- Calcium Oxide (70%)
- Silicon Oxide (23%)
- Bauxite (5%)
- Iron Oxide (3%)
- Magnesium
- Sulfur
- Potassium

**PRODUCTS**
- Cement Plant
- 150,000 Tons Portland Cement (Year)

**NON-PRODUCT OUTPUTS/WASTES**
- Airborne dust
- Waste oil
- Waste solvents
- Ash & Sludge
- CO₂
5. Metal Scrap Recycling

**ENERGY REQUIREMENTS**
- Electricity for facility operation (lighting, machinery)

**WATER REQUIREMENTS**
- Limited facility water

**MATERIAL INPUTS**
- Scrap steel
- Scrap aluminum
- Scrap copper
- Solvents (cleaning)

**PRODUCTS**
- Sorted and certified scrap for re-use
- Unrecoverable mixed metal scrap
- Waste oil
- Waste solvents

**NON-PRODUCT OUTPUTS/WASTES**
- Industrial Activity: Metal scrap storage and sorting
- Footprint/Physical Size: ~1-10 acres

6. Residential Apartments

**ENERGY REQUIREMENTS**
- Electricity
- Heat (boiler, furnace, etc)

**WATER REQUIREMENTS**
- Municipal freshwater

**MATERIAL INPUTS**
- Construction materials
- Food
- Durable goods and appliances
- Solvents, paints, and household cleaning chemicals

**PRODUCTS**
- Functioning household

**NON-PRODUCT OUTPUTS/WASTES**
- Industrial Activity: Shelter of residents
- Footprint/Physical Size: ~1-10 acres
- Municipal Sewage
- Municipal solid waste
- Waste oil
- Waste solvents and paint
EXPLORE, DISCUSS, AND PRESENT GROUP FINDINGS ON THE CENTRAL QUESTIONS

Each team will explore the central questions below and will compare their findings with the other groups. Choose a group spokesperson to present your ideas to the other groups.

Central Questions for Eco-industrial Development Groups

1. What is your group’s proposed near-term (5-10 year) eco-industrial development plan for the area? Specifically, what industrial symbiosis linkages are possible for the Industrial Zone? (A network flow diagram may be useful to clarify potential linkages).

2. What might you do differently in a long-term (20+ years) eco-industrial development plan for the area? (Feel free to think about extreme changes to the urban-industrial landscape).

3. What are potential companies that you would target to invite to the area to participate in the Eco-industrial development in the near-term? In the long-term?