Math 4/5779 Math Clinic, Fall Semester 2009
Electrical Wiring and Box Placement Problem Description
PRELIMINARY DRAFT

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July 27, 2009

1 Generic Problem Description

The Electrical Wiring and Box Placement Problem (EWBPP) is to determine where to place various devices (boxes) on the panels or decks of a spacecraft. Each box must be connected to some of the other boxes with wires of various types/thicknesses as specified by an interconnection matrix. The design goal is to minimize the amount of wiring used while satisfying a variety of design constraints.

Design Constraints: The design must satisfy a variety of constraints (depending on the particular vehicle). These may include (but are not limited to) the following:

- The center of mass must be within an acceptable distance from the center of the vehicle. (So that the vehicle is balanced).
- Some devices may create a significant amount of heat. Such devices need to be spread out to avoid excessive thermal loading.
- There may be constraints on the length of wire connecting two devices.
- Boxes with redundant functions should be physically separated so that a single event will be less likely to damage more than one of the boxes.
- There may be restrictions on the placement of the wires between boxes. For example the wires may have to follow wiring channels laid out in a rectangular grid.
- Two boxes cannot occupy the same space.
- The boxes must be placed within a fixed topology. (We assume that the shapes and sizes, and relative positions of the panels and decks of the spacecraft are fixed). Further, there may be restrictions as to where the boxes can be placed within this topology. For example, they may be limited to discrete locations.

2 Baseline Model

The ultimate goal of the math clinic is to develop a computer algorithm which is flexible enough to solve the EWBPP in for a variety of instantiations. However, as a first step, we will focus on the following specific baseline model:

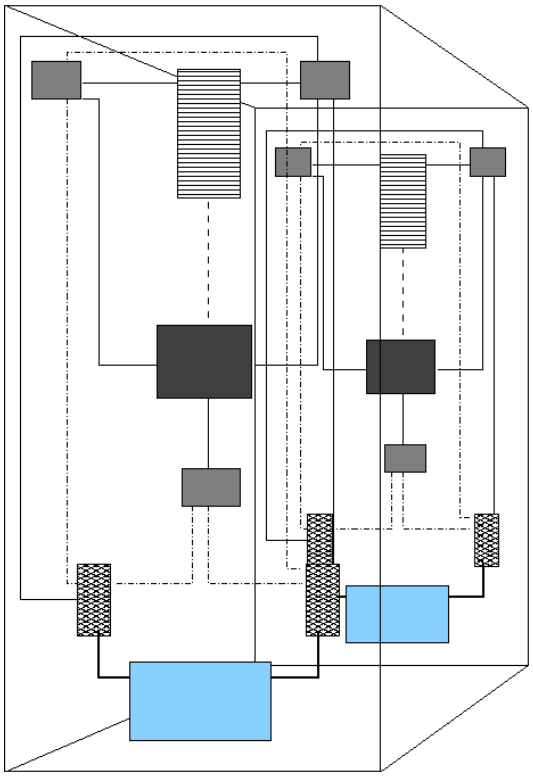

Figure 1: Diagram of vehicle layout, with some boxes wired

2.1 Vehicle Topology

The vehicle consists of four rectangular panels and two square decks laid out into a rectangular prism configuration. (See Figure 1). The height and width of the rectangles are specified as input (and the dimensions of the four rectangles are identical). The dimensions of the decks at the top and bottom of the prism are determined by the width of the rectangular panels.

We assume that boxes can be placed only at fixed locations on the panels. These locations are specified by a rectangular lattice of evenly spaced grid points. The horizontal and vertical distances between grid points is specified as input.

2.2 Box specification

We assume that boxes are rectangular prisms. The dimensions of the boxes are specified as input, but the length and width are constrained to be integer multiples of the grid spacing.

The locations of the electrical connections is also specified for the box.

2.3 Wiring Connections

An interconnection matrix specifies which boxes must be connected together by electrical wires. For each pair that must be connected, the following additional information is specified as input:

1. Type of wire used for connection.
2. Maximum length of wire connecting the two boxes.

2.4 Constraints

The following constraints must be satisfied:

- The center of mass must be within an acceptable distance from the center of the vehicle. This distance is specified as input.
- Wires must be placed in wiring channels, which run horizontally and vertically. The wiring channels are assumed to be located along the grid lines specified in the vehicle topology.
- Wires may run underneath boxes. (If time permits, we may consider the implications of requiring the wires to go around the boxes).
- There may be constraints on the length of wire connecting two devices.
- Boxes with redundant functions should be physically separated so that a single event will be less likely to damage more than one of the boxes.
- Two boxes cannot occupy the same space.