Two Models for Decision-Making Support in Computer Assisted Exercise

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- Model for Prognoses and Management of the Relief Supplies during Crises

- Model for Estimation of the Area and the Health Impact Caused by a Dirty Bomb Explosion

Prognoses and Management

of the Relief Supply

Background

In a critical situation, or more general, in a sequence of critical events, the natural equilibrium of the cycle demand-supply of a stable economic system is violated for many material products, resources or services. After an extremely short period of time there is necessity to plan the system behavior due to the increased demand of a certain resource, product, or service.

The variety might be overwhelming; this could be life-saving medicaments, food products, water, protective equipment, clothing, instruments, sheltering, fuel, transportation services, money etc. For those whose responsibilities imply the neutralization of the crisis and its consequences, it is important to quickly evaluate the increased demand of any resource, product, or service, and to suggest ways to meet it.

Model Setting

It is assumed that in a certain populated region, or a city, there are some quantities of a critical resource available: water, food, medicaments, protection equipment, tents, blankets, instruments, clothing, fuel, transportation means etc, but they would eventually deplete after the crisis develops. In the model, the quantity of the resource in need is calculated or equivalently, the flow of the demand as a time function of the impact of the critical events is found.

Model Setting

It is also supposed that the times for acquiring the critical resource from other places, cities or countries, as well as the times for its distribution among those who need it are known for all different choices.

The main goal is to make an optimal strategy for managing the quantity of this resource, product or service during the crisis.

Categories of the Resource

In the model the resources are separated into two categories:

- Life-saving – for example, water, medicaments, protection equipment, food etc., and
- Life-preserving – for example, clothing, tents, blankets, instruments etc.

Dynamic Systems Approach

The simulation model is implemented in the program environment of **PowerSim Studio 2005,** following the methodology of Jay Forrester.

Heuristic Method

K is the critical period, M is the impact during the crisis, m is the impact of a critical event, p is pulse function, w is wave function

$$K = \bigcup_{1}^{n} e_i$$

$$m = p + w$$

$$M(K) = \sum_{1}^{n} m(e_i) = \sum_{1}^{n} (p(e_i) + w(e_i))$$

Phases of Modeling

- Prognosis for the Necessity Flow
- Estimation of the Supply Flow(s)
- Simulation, Optimization, Risk Assessment
- Management of the Critical Resource Quantity

Input Data:

- City (or populated region)
- Type of the critical resource
- Category of the critical resource.
- Supply times for acquirement from outside.

Input Data:

- Delivery (distribution) times.
- Constants for the material delays (obtained by real time data, expert choices, statistics or probabilities).
- Constants for the various information delays (obtained by real time data, expert choices, statistics or probabilities).
- Capacity restrictions or preferences.

Output Data:

- Graphical display and numeric representations of the demand curve and the supply curve of a certain type of critical resource.
- Graphical display and numeric representation of the percentage of the delivered quantity with respect to the necessary quantity.
- Graphical display and numeric representation of the percentage of the on

  time delivered with respect to the necessary quantities

Model Presentation

Estimation of the Area and the Health Impact Caused by a Dirty Bomb Explosion

Situation Assumptions

- Radioactive material is dispersed by small particles (Cs pearls)
- The most significant quantity of the material does not evaporate
- Explosion made by no targeting device

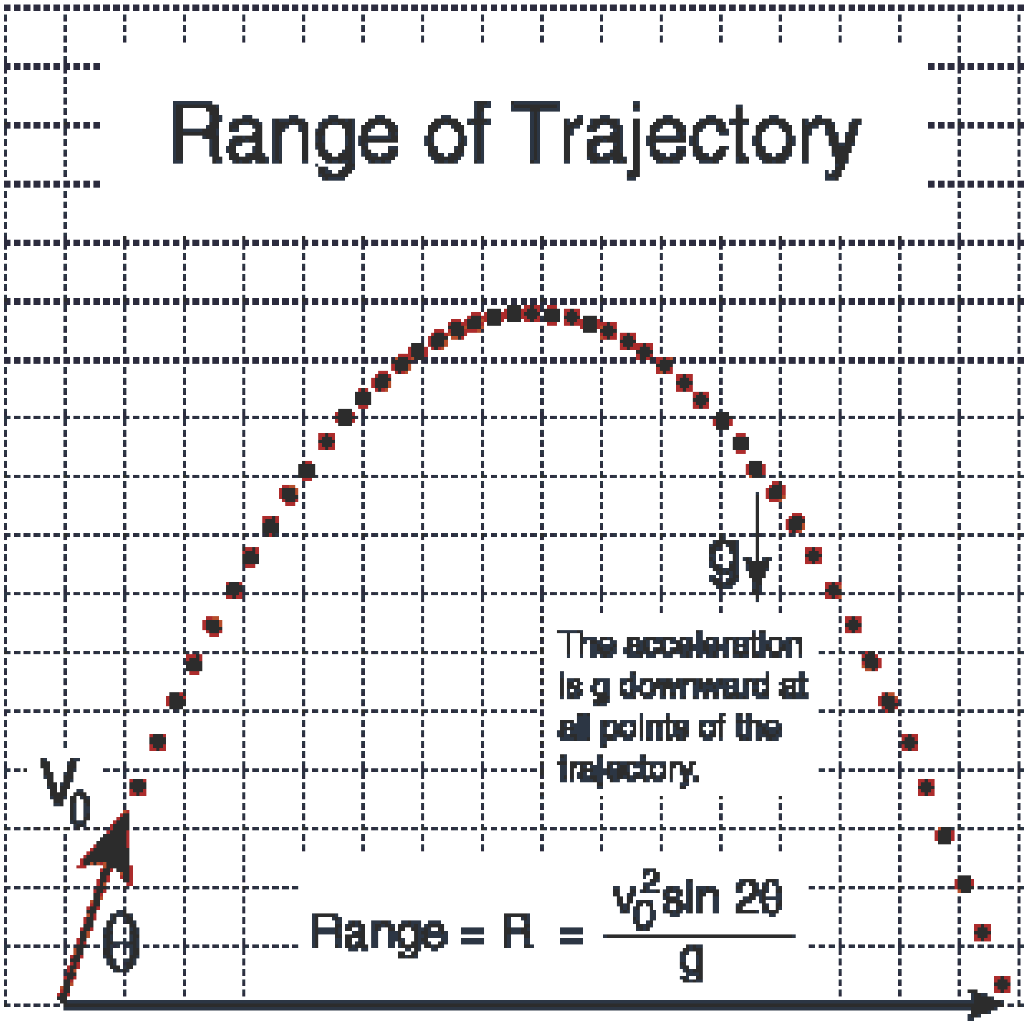
Additional Assumptions

- Dispersion of the radioactive material is in open area without significant obstacles
- Uniform distribution for radiants (the initial trajectory vectors) of the pearls

The Problem is Reduced to

a Geometrical One

Range of Trajectory



The basic **motion equation**

$$x = v_{0x} t$$

can be used to find the range. By symmetry, the total **time of flight** is equal to twice the time at the peak

$$t_{range} = 2t_{peak} = \frac{2v_{0y}}{g}$$

This gives:

$$R = \frac{2v_{0x}\, v_{0y}}{g}$$

$$R = \frac{2v_0^2 \sin\theta \cos\theta}{g}$$

$$R = \frac{v_0^2 \sin 2\theta}{g}$$

Calculation

using the **trig identity**:

$$\sin 2\theta = 2\sin\theta \cos\theta.$$

Calculation Method

- Interpolation over 2850 knots along a spiral curve

End of Presentation