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# Chicago

## *Vision for the Future: Responsive Transport*

### Charter *Revised: Sep 1, 2008*

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#### Background

Next year marks the Centennial of Daniel H. Burnham's and Edward H. Bennett's 1909 *Plan of Chicago*. Internationally celebrated then and now, what became known as the Burnham Plan redirected Chicago from an unplanned trail of disorganized industrial and commercial growth to a planned path toward the "city beautiful". Along the way, Chicago became a green city celebrating its fortunate location on Lake Michigan with a necklace of parks and boulevards recognized around the world for its beauty. The Burnham Plan challenged Chicago leaders to arrest uncontrolled development and tame the technological revolution that characterized the early 20th century. Galvanized into action by Burnham, Bennett and the Commercial Club of Chicago, the city committed its resources to creating an urban environment that could meet the challenges of the new vision, one that could be both functional and beautiful.

One hundred years later, Chicago and other major cities worldwide face different but equally portentous problems and opportunities. New and powerful forces, both negative and positive, confront cities and society. Global warming is changing climate and energizing unpredictably destructive weather. Population growth and movement to the cities is at an all-time high. Global economics are reshaping trade and disrupting established patterns of supply and demand, voracious energy needs are depleting traditional energy resources, forcing an increasingly urgent search for energy sustainability. High-tech materials, communications, computing, biological and engineering sciences are reshaping what is possible. Negative and positive, the agents of change have raised the stakes.

Cities like Chicago must evolve more quickly. Cities like China's Shenhzen, now springing up full-grown almost overnight, need to plan for change from the beginning. Both will need vision to weave new technologies into their urban fabric. Both will need wisdom to adapt their living cities to tomorrow's pressing changes. The famous dictum, "Make no small plans" is attributed to Daniel Burnham. Whether he actually said that is not certain, but in the Plan of Chicago, he came close enough:

"At no period in its history has the city looked far enough ahead. The mistakes of the past should be warnings for the future. There can be no reasonable fear lest any plans that may be adopted shall prove too broad and comprehensive. That idea may be dismissed as unworthy of a moment's consideration. Rather let it be understood that the broadest plans which the city can be brought to adopt to-day must prove inadequate and limited before the end of the next quarter of a century. The mind of man, at least as expressed in works he actually undertakes, finds itself unable to rise to the full comprehension of the needs of a city growing at the rate now assured for Chicago. Therefore, no one should hesitate to commit himself to the largest and most comprehensive undertaking; because before any particular plan can be carried out, a still larger conception will begin to dawn, and even greater necessities will develop."

Inspirational then, his words ring even more strongly true today.

## Relevant Trends

Trends initiated by emerging technologies, changing environmental conditions, and evolving social change will have real impact on urban evolution. Among such trends evident today are:

### **Water Resources**

Already in many parts of the world, water supplies are reaching levels of insufficiency. Complicated by agricultural needs for irrigation and the needs of urban centers becoming megacities, the fresh water resources of our lakes, rivers and subsurface aquifers are subsiding. In 2003, 9,500 children were dying daily from insufficient or contaminated water supplies. One-third of the world's population, by some experts' analysis, live in water-stressed countries now, with two-thirds of the world to share their dilemma by 2050. Chicago's great Lake Michigan water resource will very likely decline over the next century with impact for shipping, water supply, and even the flow of associated rivers, including the Chicago River.

### **Mineral Resources**

Mineral resources are approaching finite limits, exhausted in some locations, more difficult to extract in others. While supplies of some minerals are in no immediate danger, others are under severe pressure. Oil is a resource of vital concern, with production expected to peak in this decade or shortly thereafter. The Hubbert Curve, long-used as a predictive tool in the petroleum industry, when coupled with modern corrective tools, predicts that we are reaching worldwide peak production *now* and face a reduction in production of approximately 3% per year very soon. Not only will that oil production have to be replaced as an energy source, additional energy sources will have to be found to keep pace with the population curve.

### **Population Movement**

In an interesting paradox, the countryside is becoming less—not more—inhabited as we add to the population. The people are moving from the country to the cities. As of 2005, the world was more urban than rural for the first time. In the next twelve years 300 million rural Chinese will move to the cities. In 1950, only two cities in the world, Tokyo and New York City, were over 10 million in size. By 1975 there were 4 such megacities, and by 2003, there were 20. By 2015 there will be at least 22. In China alone there are between 100 and 160 cities with over 1 million inhabitants (America has 9, and Eastern and Western Europe together have 36). Cities are complex, sophisticated systems, but their managers will need all the skill they can command to deal with the great urban migration. The major changes will take place in the developing countries, but Chicago and cities of the developed world will feel the effects through immigration as well as local relocations.

### **Climate Change**

Climate and weather patterns are changing. Some regions are simply getting drier or wetter, but the great damage will come from sustained, severe droughts and intense, prolonged flooding. The problem is change: eco-systems confronted with (1) wetter or drier conditions for periods far longer than the environment or its inhabitants are prepared, and (2) sudden, short-term, intense weather events such as violent super tornadoes and hurricanes, cloud-bursts, blizzards and heat waves. Climate zones for cities will change; by the end of the century, Chicago will have summers similar to those now experienced by Mobile, Alabama and winters like those of today's northern Arkansas.

### **Increasing Expectations**

The growing availability and capabilities of communications such as cellular telephones, satellite and cable TV, and the Internet across the country (and the world) are providing people with daily knowledge of living conditions, problems, products, threats and services everywhere. The media are creating growing avenues for fast communication between protectors and populace. They are also educating the populace on the state of conditions and creating expectations that both fuel demand and create willingness to change.

### **Internet Penetration**

Computer use and Internet access grow exponentially every year. Information of encyclopedic detail can be obtained more and more easily, and complex, sophisticated processes can be used remotely. Access to high-quality communications and sophisticated computer tools are increasingly available to individuals and groups anywhere. In North America, Internet penetration reached 71% in 2007.

### **Emerging Technologies**

The pace of technological change continues to accelerate, bringing new science to commercial, institutional and industrial uses at an ever quickening pace. Most notable among many fields, major technological innovations can be expected in the new disciplines of molecular nanotechnology, robotics and the biosciences. Computing capacities continue to grow at the exponential pace predicted by Moore's Law, radically increasing power and decreasing size and cost—and dramatically increasing the usefulness of digital electronics in almost every aspect of business, institutional and personal life.

### **New Relationships**

Greater public mobility and access to information is changing the nature of association for many individuals and organizations. Organizations that once operated in isolation are now players in a common environment. Sometimes the emerging relationships are competitive, sometimes cooperative. New forms of relationship can be expected to be created as conditions evolve.

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### **Focal Point: *Responsive Transport***

The automobile is approaching a major disjunction point as the cost of oil-based energy becomes untenable and a century-old transportation system meets the realities of growing urbanism and continued population growth. What kinds of transport will mesh fluently with a hyper-connected, adaptive urban environment?

### **Project Statement**

Using Structured Planning methodology, develop a vision for 21st century Chicago (and, by inference, other major world cities). Explore the changes to cityscape and urban living that could be implemented from an enlightened response to fast-changing social conditions and the application of such all-pervasive omni-technologies as bio-technology, information science, robotics and nanotechnology. In the spirit of the Centennial, use Burnham's *Plan of Chicago* as inspiration for a maximized "no small plans" approach to describing the city of the future. In particular, consider your proposal as a view toward the realization of the full potential of responsive transport.

The proposal should:

1. consider governmental, institutional, commercial and professional uses as well as uses for individuals and the public.
2. collect, incorporate and refine best projections and concepts as they have been conceived by organizations, publications and planning experts throughout the futures community.
3. accommodate concepts developed by other project teams to extend and enhance the effectiveness and reach of responsive transport.
4. integrate formats for report and presentation with those of other project teams to present a coherent, holistic set of concepts.

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**Goals**

*As general guidelines the proposal for responsive transport should:*

- Explore a full range of possibilities, paying especial attention to the products of emerging technologies successfully advancing through research and development.
- Include ideas for any processes, tools, systems and products needed for services—including procedures, policies, events, activities, organizational concepts and any relevant relationships among them.
- Explore revolutionary as well as evolutionary ideas.
- Accommodate all users of the system, from implementation to adaptations and provide for them in the design. Thoroughness is a step toward system integrity.
- Consider potential costs thoughtfully; the proposal should not incorporate frivolous concepts, but it should not ignore potentially breakthrough ideas simply because they may be expensive.
- Treat the design problem as design from the inside out; users' needs come first, with every attempt possible made to satisfy them in some way, even when tough design decisions must be made.
- Conceive the properties and features of systems and their operations as means to build trust and cooperation with the community and its institutions.

*Overall, the solution should:*

- Assume that the proposal can be acted upon as it is conceived. Do not under-propose on the assumption that a concept might be politically difficult to achieve.
- Demonstrate what might be achieved. The value of the proposal is in its ideas, not its certain attainability. Ideas that might not be fully attainable under today's conditions may be achieved tomorrow—if they are known.

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**Resources**

Resources for the project will be:

**Physical:**

- The facilities of the Institute of Design, including Room 514 as general meeting space at the beginning of each class session, and 2nd, 3rd and 5th floor for team activities.
- Computing support from the fifth floor computer facilities.
- Equipment as necessary from ID resources.

**Financial:**

- (to be determined)

**Human:**

- *Planning Team:*

**Andy Conrad**                      **William Huang**  
**Prashant Desai**                    **Jennifer Lee**

- *Project Advisors:*

**Charles L. Owen**                  Distinguished Professor Emeritus  
**John Pipino**                        Adjunct Professor

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**Schedule**

The project will be conducted from August 26 to December 5, 2008.

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<b>Week</b>		<b>Phase</b>	<b>Activity</b>	<b>Product</b>
<b>1</b>	<b>Aug 26</b>	Introduction	Introduce project, process & Charter (L)	
	<b>Aug 29</b>	Project Definition	Issues and Defining Statements (L)	
<b>2</b>	<b>Sep 2</b>		Develop Issues & Defining Statements	
	<b>Sep 5</b>		<b>In-Progress Review</b>	Issues DefStates 1
<b>3</b>	<b>Sep 9</b>		Function Structure (L) Modes and Activities	
	<b>Sep 12</b>		<b>In-Progress Review</b>	DefStates 2 Fn Struc 1
<b>4</b>	<b>Sep 16</b>	Information Development <i>Action Analysis 1</i>	Activity Analyses, Design Factors and Solution Elements (L)	
	<b>Sep 19</b>			
<b>5</b>	<b>Sep 23</b> <b>Sep 26</b>			
<b>6</b>	<b>Sep 30</b>		<b>In-Progress Review</b>	DefStates complete Fn Struc 2 DesFacs 1 SolnEls 1
	<b>Oct 3</b>	Information Development <i>Action Analysis 2</i>	Complete Functions, Design Factors and Solution Elements	
<b>7</b>	<b>Oct 7</b>		Interaction analysis; RELATN program (L)	
	<b>Oct 10</b>		Interaction analysis; VTCON program (L)	Fn Struc complete DesFacs complete SolnEls complete
<b>8</b>	<b>Oct 14</b>	Information Structuring <i>Interaction</i>	Score Soln Elements vs Functions	
	<b>Oct 17</b>	<i>Structuring</i>	Structuring;	RELATN input

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Week	Phase	Activity	Product
9 Oct 21 Oct 24	Concept Development	Means/Ends Analysis (L)	Inf Structure
10 Oct 28 Oct 31		Ends/Means Synthesis (L) System Elements; System Element Interaction (L)	Inf Structure named
11 Nov 4 Nov 7			
12 Nov 11		<b>Presentation</b>	Initial System Elements
Nov 14	Communication	Plan, Report, Overview, Communication Structure (L); Refine final SysEIs; write report; complete illustrations	
13 Nov 18 Nov 21			
14 Nov 25 Nov 28	<i>Thanksgiving</i> vacation		
15 Dec 2 Dec 5		<b>Final Presentation</b>	Illustrated Report

## Methodology

The project will be conducted using Structured Planning (See articles on the subject by Charles Owen at <http://www.id.iit.edu> under the *Publications* section of *Our Research*.)

1. *Context for Creativity*, 1991.
2. *A Critical Role for Design Technology*, 1993.
3. *Design, Advanced Planning and Product Development*, 1998.

Also, see the book by Charles L. Owen. available at the Institute of Design: **Structured Planning. Advanced Planning for Business, Institutions and Government.** 2007),

## Issues

Consider the following topics as initial issues to be investigated. Supplement them with additional issues as information is developed during the first phase of the project.

**Technology.** What approach should be taken toward the incorporation of available and emerging technologies?

**Adaptivity.** How should elements of the system be prepared to respond to evolving social, political, technological and environmental conditions?

**Partnerships.** What approach should be taken toward partnering with other governmental organizations, institutional organizations, suppliers of funding, educational institutions, etc.?

**Disaster Contexts.** What provisions should be made for extreme environmental conditions and the changes that can be expected with climate change?

**Means of Introduction.** How should the system be introduced to facilitate acceptance and implementation?

**Inter-institutional Relationships .** How should relationships with potentially competing or cooperating governmental entities be developed?

**Cost.** How should costs and funding of system elements and their operations be approached?

**Geographic Focus.** How narrowly or broadly should the vision for the city be drawn—local, metropolitan, regional?

**Mission.** What balance should be sought among commercial, governmental, institutional, general public and private sector services?

**Sustainability.** How should elements of the system approach tradeoffs between functional effectiveness and sustainability?



# Defining Statement

Issue  
Integration of Natural Features

83

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Contributors

## Sources

Chicago Historical Society and Newberry Library. *Chicago and Water. Encyclopedia of Chicago*. <http://www.encyclopedia.chicagohistory.org/pages/10536.html> (accessed September 12, 2008).

Spirn, Ann Whiston. *City and Nature*. In **The Sustainable Urban Development Reader**, edited by Stephen M. Wheeler and Timothy Beatley, 113-115. New York: Routledge, 2004.

## Question at Issue

To what extent should Chicago's natural environmental features (e.g., the river, the lake) be integrated into the system?

## Position

- Constraint
  - Objective
  - Directive
- The system ought to integrate natural environmental features where there is opportunity and benefit, while being careful to avoid adverse secondary impact on such features.

## Alternative Position

- Constraint
  - Objective
  - Directive
- With its transport system historically tied to geographical features, the city must highlight natural environmental features as a major part of its transport design.
- Constraint
  - Objective
  - Directive
- The system should minimize integration of natural environmental features so as to avoid continued destruction, preserving what little nature in the city still exists.

## Background and Arguments

Chicago's economic activity has long been shaped by its role as a transportation center for the entire country – an advantage afforded by its natural features and strategic geographic location – first on water and later by rail. Not only did Chicago manage to establish itself as the central railroad hub between the eastern and western regions of the United States early on, but Chicago has always taken advantage of its connections to both the Great Lakes and the Mississippi River systems not only for basic needs, but also as an economic resource.

As a result, Chicago's history, growth, and survival are inevitably intertwined with its environment surroundings. This would seem to imply that Chicago's future transport system must highlight the city's natural features as a significant part of its design — and indeed these features ought to be incorporated where advantageous — but nature is only one of many key factors that has contributed the city's evolution. Nature is important, but it cannot necessarily take precedence over the social, cultural, economic, and political factors that have played equally critical roles in shaping Chicago and its landscape over time.

On the other hand, it would likewise be a mistake to disregard the benefit that Chicago's natural features might have to offer a future transport system. Nature is powerful. "In themselves, the forces of nature are neither benign nor hostile to humankind. Acknowledged and harnessed, they represent a powerful

resource for shaping a beneficial urban habitat; [but] ignored or subverted, they magnify problems that have plagued cities for centuries, such as floods and landslides, poisoned air and water" (Spirn 2004, 114). In its own history, the city has continually negotiated its relationship with nature while transforming the lake shore several times over, polluting and cleaning up its water sources, and even reversing the direction of the Chicago River for the sake of sanitation.

It is essential to minimize damage to our delicate environmental ecosystems so that the city can continue to benefit from nature's offerings into the future, but it also must be kept in mind that "nature is a continuum, with wilderness at one pole and the city at the other...The city is neither wholly natural nor wholly contrived. It is not 'unnatural' but, rather, a transformation of 'wild' nature by humankind to serve its own needs, just as agricultural fields are managed for food production and forests for timber" (Spirn 2004, 114). It is with this balanced approach that a future transport system should work to support and be supported by the future vision of plans for infused nature and featured environment systems in Chicago.

# Defining Statement

Issue  
Distribution of Local Services

84

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Question at Issue

How should the transport system determine service distribution within the local metropolitan area?

## Contributors

## Position

- Constraint
- Objective
- Directive

Local services should be distributed according to the patterns of movement emerging from economic and social demands.

## Sources

Federal Highway Administration. *Frequently Asked Questions Applying 2000 Census Data to Urbanized and Urban Areas*. United States Department of Transportation Federal Highway Administration. <http://www.fhwa.dot.gov/planning/census/faq2cdt.htm> (accessed September 11, 2008).

Fidel, Kenneth. *The Emergent Suburban Landscape*. In **The New Chicago: a Social and Cultural Analysis**, edited by Koval, John P. et al., 77-81. Philadelphia: Temple University Press, 2006.

Johnson, Elmer W. **Chicago Metropolis 2020**. Chicago: University of Chicago Press, 2001.

Rodrigue, Jean-Paul, Claude Comtois, and Brian Slack. **The Geography of Transport Systems**. New York: Routledge, 2006. <http://people.hofstra.edu/geotrans/eng/ch6en/conc6en/ch6c1en.html> (accessed September 11, 2008).

## Alternative Position

- Constraint
- Objective
- Directive

Local services should be distributed according to a set distance from city center.

- Constraint
- Objective
- Directive

Local services should be distributed according to political boundaries.

- Constraint
- Objective
- Directive

Local services should be distributed according to population density.

## Background and Arguments

According to the United States Census Bureau, urban areas are defined as “core census...blocks that have a population of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile” that may not necessarily coincide with municipal or other politically determined boundaries (Federal Highway Administration 2006). With keen awareness of the ever growing and changing nature of urbanized areas, federal regulations currently require that Metropolitan Planning Areas (MPAs) be established to plan for transportation, with each MPA boundary covering not only the existing urbanized area but also “the contiguous geographic area(s) likely to become urbanized within the twenty year forecast period” (Federal Highway Administration 2006).

Such definitions and governmental efforts demonstrate the significant role that population density and growth play in urban planning over more static boundary determinants such as set distance or political boundaries. However, as the economic and social patterns of local metropolitan populations continue to evolve, an emerging settlement pattern demonstrates why it is insufficient to rely on population density as the primary determining factor of transport development and planning.

The relationship between Chicago and its suburbs has changed dramatically over time; “this settlement pattern is termed ‘the

edgeless city,’ and it more closely resembles the Los Angeles model of suburban sprawl than the older urban model of suburbs surrounding a dominant central city” (Fidel 2006, 77). In 1990 only four out of ten Americans living in metropolitan areas lived inside the limits of a main central city, and “only half as many Americans nationwide were making the traditional suburb-to-city trip as were traveling from home to workplace without leaving the suburbs (Johnson 2001, 156). In Chicago specifically, “more than one-third of metro area residents work more than 10 miles from the city center, and almost half of all commutes take place between a suburban home and a suburban job,” according to data from 2000 (Fidel 2006, 80). Polycentric, or multinucleated, urban areas have become increasingly common as jobs have migrated out to the suburbs along with new affordable housing; suburb-to-suburb commuting has become a significant transportation demand, and what takes priority for travelers is no longer distance to destination but rather proximity to highways (Fidel 2006, 77) and travel time to destination. So while population density may be an important indicator of transport needs, it is no longer enough; a closer look at the travel patterns and demands of users should help to inform the scope and distribution of the local transport system and its services.

# Defining Statement

Issue  
Transportation Modes

85

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Question at Issue

How should the use and variety of transportation mode options within the system be determined?

## Contributors

## Position

- Constraint
  - Objective
  - Directive
- The system should offer a varied set of transport options as determined by factors such as land use and population density.

## Sources

Richards, Brian. **Future Transport in Cities.**  
New York: Spon Press, 2001.

Richards, Brian. **Moving in Cities.** Boulder, CO:  
Westview Press, 1976.

## Alternative Position

- Constraint
  - Objective
  - Directive
- The system should keep transportation mode options to a minimum for the sake of simplicity, lower cost, and increased efficiency.

## Background and Arguments

The existence of any given mode of transportation requires the implementation and development of its respective infrastructure. In a system offering an increased variety of transport modes, the system's infrastructure and components will most likely increase in complexity as well, contributing to a correlating increase in cost of system maintenance and operations. It would therefore seem wise to keep the variety of transportation modes within a system to a minimum for the sake of fiscal and operational efficiency.

However, urban areas are diverse in terms of population density and land use; as the context of use for the system changes across zones, the effectiveness of any particular transport mode also changes. For example, fixed-route buses may be a viable option in high density population areas, but in low density areas it is unlikely that buses will run with enough large passenger loads to make the service economically viable (Richards 1976, 92). Likewise, privately owned cars are often the transport mode of choice in low density zones where longer distances may be quickly and conveniently covered, but high density zones often present drivers with parking and congestion challenges that in fact make these very same vehicles quite inconvenient and costly to use in this other context (Richards 2001, 2).

Land use is another factor that determines suitability of transportation mode; residential areas need to focus on

transport of people, industrial zones need to prioritize transport of commodities, and commercial zones need to achieve a careful balance of both. Appropriately effective transportation modes are quite different for these and other varied uses.

Taking into account such variation in transport needs and uses, minimizing the variety of transportation modes in a system is not necessarily the most economically viable solution; on the other hand, offering all mode options in all areas is neither practical nor effective. It is therefore important that the system accommodate each urban zone with an appropriate set of transport options according to its particular context.

# Defining Statement

Issue  
Urban Growth and Development

86

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Question at Issue

What role should the transport system play in addressing urban growth and development?

## Contributors

## Position

- Constraint      The system should play an active role in reducing the negative impact of urban/suburban sprawl.
- Objective
- Directive

## Sources

Clean Water Action Council. *Land Use and Urban Sprawl*.  
Clean Water Action Council. <http://www.cwac.net/landuse/index.html> (accessed September 29, 2008)

El Nasser, Haya and Paul Overberg. *Wide Open Spaces: The USA Today Sprawl Index*. **USA Today**, February 22, 2001, Nation section. <http://www.usatoday.com/news/sprawl/main.htm> (accessed September 29, 2008).

Fidel, Kenneth. *The Emergent Suburban Landscape*. In **The New Chicago: a Social and Cultural Analysis**, edited by Koval, John P. et al., 77-81. Philadelphia: Temple University Press, 2006.

## Alternative Position

- Constraint      The system ought to respond to the demands of new urban development and growth as determined by the free housing market.
- Objective
- Directive

## Background and Arguments

Characterized by spacious homes, large land lots, “big box” stores with vast parking lots, automobile dependency, and most critically, low-density populations, suburban sprawl is a phenomenon that exists in nearly every US urban area. Chicago is no exception. Currently about two-thirds of the Chicago metropolitan area’s population lives in the suburbs, and without natural barriers such as mountains to limit the spread of new development across the area, it is predicted that Chicago’s suburbs will continue to expand in the coming years, both in population and in land use (Fidel 2006, 77, 81; El Nasser et al. 2001). Free-market thinkers see this as an indication of the appeal that sprawl holds for many people.

According to Fidel, “suburban population growth is driven by natural increase and immigration to the metropolitan area, social factors such as the desire for improved housing and a better quality of life, and economic factors such as the movement of jobs to the suburbs and the lower cost of housing at the urban fringe” (Fidel 2006, 77). However, the list of problems associated with such growth is also long: loss of farmland and wildlife habitats; increased air and water pollution; increased energy consumption; social fragmentation and isolation; health problems such as asthma and obesity; and global warming, flooding and erosion (Clean Water Action Council 2008; El Nasser et al. 2001) are all associated with suburban sprawl. Another key consideration is that suburban

growth has come to depend heavily on access to highways and relatively low-cost gasoline (Fidel 2006, 80). Now that the price of gasoline is no longer stable nor necessarily affordable, it is time to rethink the viability of this lifestyle created by urban sprawl.

While the effects of existing sprawl cannot be completely undone, a new transport plan can lessen the negative impact by reducing reliance on the automobile and renewing alternative transport options that are “better able to move people between their suburban homes, their jobs, and their shopping places” (Fidel 2006, 81). Transportation infrastructure should also be redesigned to boost population density in existing suburbs. In areas of new growth, the transport system has an opportunity to actively support the development of higher density mixed-use zones that could serve to revitalize local communities and suburban downtown areas, strengthen the connection and relationship between the Chicago and its surrounding areas, and also further reduce automobile dependence. Deliberate action such as this will serve to significantly reduce the negative impacts of urban growth and development.

# Defining Statement

Issue  
Convenience vs. Efficiency

87

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Question at Issue

To what extent should the system prioritize convenience of individual transport over the efficiency of mass transport?

## Contributors

## Position

- Constraint
- Objective
- Directive

The system should achieve a balance of both highly convenient and efficient transport, achieving both simultaneously where possible.

## Sources

Johnson, Elmer W. **Chicago Metropolis 2020**. Chicago: The University of Chicago Press, 2001.

Miller, Leslie. *Cars, Trucks Now Outnumber Drivers*. **Salon.com** (August 29, 2003), [http://dir.salon.com/story/tech/wire/2003/08/29/cars\\_and\\_drivers/index.html](http://dir.salon.com/story/tech/wire/2003/08/29/cars_and_drivers/index.html) (accessed September 10, 2008).

Richards, Brian. **Future Transport in Cities**. London: Spon Press, 2001.

Rodrigue, Jean-Paul, Claude Comtois, and Brian Slack. **The Geography of Transport Systems**. New York: Routledge, 2006. <http://people.hofstra.edu/geotrans/eng/ch6en/conc6en/modespeedsurf.html> (accessed September 9, 2008).

University of South Florida. *State Averages for Private Vehicle Occupancy, Carpool Size and Vehicles Per 100 Workers*. <http://www.nctr.usf.edu/clearinghouse/censusavo.htm> (accessed September 10, 2008).

## Alternative Position

- Constraint
  - Objective
  - Directive
- 
- Constraint
  - Objective
  - Directive

The system should prioritize convenience over efficiency.

The system should prioritize efficiency over convenience.

## Background and Arguments

The widespread appeal of automobiles is evident in the numbers; as of 2003, the Bureau of Transportation Statistics estimated the number of vehicles in the United States at 204 million with 191 million drivers (Miller 2003). Likewise, car ownership around the world – especially in cities – is increasing at a significant pace, but this rise in car ownership inevitably translates into a rise in car-related problems.

As car use has become dominant transportation choice, infrastructure has continued to expand to accommodate it over time – sometimes at the expense of other options. Cities have spread into lower density suburbs where parking lots and distances between destinations prevent walking or bicycling from becoming appealing options and public transit loses the benefit of economy and efficiency (Richards 2001, 3-5).

According to Brian Richards, “the car has caused the most problems to city life” by causing death and injury from traffic accidents, intensifying health problems due to poor air quality from vehicle exhaust, and contributing to the climate change problem through pollution. (Richards 2001, 2) Many critics would also cite the effects of increased traffic congestion and urban sprawl as other car-related issues of concern. Furthermore, current car technology feeds into heavy dependence on non-renewable resources, and thereby plays a significant role in escalating socio-political and economic tensions around the world.

With average vehicle occupancy in the United States hovering at 1.08 passengers per vehicle in 2000 (University of South Florida, 2008), the use of mass transit options such as buses, light rails, and trains can provide benefits and reduce some of the problems caused cars in the urban setting; for example, public transit uses an average of ten times less space than individual transportation (Rodrigue et al, 2006), and mass transit allows those who are either too young or too old to drive to still travel.

However, a major transition to significantly reduce car use in favor of mass transit seems unlikely without taking into account the benefits and convenience that have lead so many people to choose cars over public transit options in the first place. “No other form of transport can compete with the private motor vehicle in terms of door-to-door mobility, freedom to time one's arrivals and exits, protection from inclement weather, and comfort, security, and privacy while in transit” (Johnson 2001, 32). Not only do cars offer a sense of autonomy to drivers, but they also enjoy a romanticized appeal in the United States where they are often regarded as a reflection of the car owner's identity.

In order to create an effective transport system, it should be of utmost importance to offer a set of options with the benefits of both individual and mass transportation that is economical, efficient, safe, convenient, and appealing to all.

# Defining Statement

Issue  
Accessibility

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Jennifer Lee

## Question at Issue

How should accessibility features be integrated into the transport system?

## Contributors

## Position

- Constraint
- Objective
- Directive

The system should apply the principles of universal design to accommodate accessibility not only to assist people with disabilities, but also to benefit the widest set of users possible.

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## Alternative Position

- Constraint
- Objective
- Directive

The system must include special accommodations to allow access for people with disabilities.

## Background and Arguments

By the year 2010, one in three Americans will be over the age of 50 (Lewis 2007). “With age, people change physically, mentally and psychologically. For most people these changes involve multiple, minor impairments in eyesight, hearing, dexterity, mobility and memory. At present, such changes...are challenging common assumptions about how products and services should be designed if they are to meet the needs of the majority” (Coleman 2007). As a result, providing accessibility in a future transport system becomes increasingly significant.

The necessity of accessibility is also apparent in the creation of legislation such as the Americans with Disabilities Act of 1990 (ADA), which requires accessible design solutions in public buildings that “eliminate obstacles or make special accommodations to the physical environment” in order to provide access to people with physical disabilities (Steinfeld 2008, 1). While intent of the law is good and has resulted in positive changes, retrofitting environments and providing the required accommodations has been expensive. Moreover, some would argue that the requirements outlined by the ADA is overly prescriptive and limited in scope.

A critique of accessible design as outlined by legislation such as the ADA has emerged in the form of universal design. Universal design, as defined by the Center for Universal Design, is “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design....The intent of universal design is to simplify life for everyone by making products, communications, and the built environment more usable by as many people as possible at little or no extra cost. Universal design benefits people of all ages and abilities” (Center for Universal Design 2008).

Universal design has been distilled to seven principles: 1) equitable use, 2) flexibility in use, 3) simple and intuitive use, 4) perceptible information, 5) tolerance for error, 6) low physical effort, and 7) size and space for approach and use (Center for Universal Design 2008). According to Edward Steinfeld, “The universal design philosophy shifts the focus of design away from disability to the issue of usability in a broader sense. Products that achieve universal design must enable people who do not have disabilities as well as those who do.” (Steinfeld 2008, 1)

Some examples of design solutions that apply these principles of universal design include the cutaway curb, lever door handles, and no-step bus systems. In the case of the cutaway curb, this solution was originally implemented to help wheelchair users negotiate street curbs, but it became quickly apparent that many other users such as cyclists, skateboarders, people with strollers or suitcases, and even walkers benefited from the design. Lever door handles offer many more ways to open a door (e.g., with an elbow or foot) than a typical doorknob. Lowered bus floors are one way to allow a wider range of riders to get on and off a bus without effort (Hannah 2008).

The principles of universal design serve as a useful framework for approaching design factors around accessibility in products and environments, but a systems-level design process must also be mindful to consider the concept of accessibility beyond just physical use to include social, cultural, economic, and other factors that exist in the urban environment. In this way, an effective and accessible transport system accommodating the most number of users possible may be achieved.

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Originator**

Jennifer Lee

**Contributors**

Charles Owen                      September 15, 2008

**Question at Issue**

To what extent should the system include provisions to accommodate for projected conditions created by climate change?

**Position**

- Constraint
- Objective
- Directive

The system should be planned adaptively to accommodate for most-likely climate change scenarios.

**Sources**

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**Alternative Position**

- Constraint
- Objective
- Directive

The system should be planned from the beginning to accommodate worst-case scenarios of climate change.

**Background and Arguments**

Concentrations of greenhouse gases in the planet’s atmosphere have increased significantly since 1750 as a result of human activities (IPCC 2007, 9). However, there are some who still assert that climate change and its predicted effects are uncertain (Oreskes 2004, 1686), or perhaps even “grossly exaggerated.” (Dyson 2007) The Intergovernmental Panel on Climate Change (IPCC) states that “warming of the climate system is unequivocal” based on observation of changes in global average air temperatures, ocean temperatures, sea level, and widespread melting of snow and ice — a position that is loudly echoed across the scientific community in the United States (Oreskes 2004, 1686).

Although there is always a degree of uncertainty in predicting the future, there is enough general consensus on the topic of climate change that it would be irresponsible and costly to the design of a future transport system to completely ignore the potential impact of our changing climate.

Current climate models for the twenty-first century indicate that it is “virtually certain” that there will be warmer days and nights and fewer cold days and nights over most land areas, as well as warmer and more frequent hot days and nights over most land areas; it is also “very likely” that the frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will also increase (IPCC, 2007, 8).

For Chicago, predictions suggest increased temperature averaging 3° to 8°F with greatest increases (up to 10°F) during summer. The number of very hot days (over 90°) is very likely to increase with more than 30 days over 100°F under higher emission scenarios. Precipitation will increase in winter and spring months while summer and fall will experience more drought-like conditions. Rainfall events of an intensive nature can be expected with implications for severe flooding. Lake and river levels will remain generally as they are under lower emission scenarios, but under higher emission models, may recede as much as an average of 1.5 feet (Kalkstein 2007, vii-xiii).

While the system will be unable to accommodate for the most extreme prospects predicted by some worst-case scenarios, a successful system should take an adaptive approach that seriously considers the predicted climate projections laid out by scientists and current climate models for Chicago and the region moving forward into the twenty-first century.

# Defining Statement

Issue  
Flow Management vs. Infrastructure Expansion

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

William Huang

## Contributors

Prashant Desai December 8, 2008

## Sources

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## Question at Issue

To what extent should the system prioritize management vs. expansion to minimize congestion?

## Position

- Constraint
- Objective
- Directive

Due to limited funding and land space, the system should prioritize management over expansion as a means to minimize congestion.

## Alternative Position

- Constraint
- Objective
- Directive

The system should prioritize expansion over management as a means to minimize congestion.

## Background and Arguments

More than half the population of the state of Illinois lives in the Chicago metropolitan area. The population density of the city itself was 12,750.3 people per square mile (4,923.0/km<sup>2</sup>), making it one of the nation's most densely populated cities. Traffic congestion is almost always urban, and related to beginning and leaving work. Automobiles are the preferred choice of transportation since it provides maximum of freedom. Ironically, maximum of freedom is not possible in a traffic stream congested with too many people trying to get maximum freedom of movement.

The being said, due to limited funding and land space, the system should prioritize management over expansion as a means to minimize congestion.

Due to multiple cars in most household, new roads are filled up as soon as they are constructed. Continuously adding new roads may have been an option in the past but the city is running out of space, and construction would be prohibitively expensive. Except where urban sprawl prevails, city street widening would require sacrificing sidewalks and buildings. Public opposition to additional new freeways is already great and probably will intensify (Ball 2005).

As population continues to grow in urban Chicago, traffic flow will be severely impacted if a more effective transportation management system is not implemented.

Chicago's Metropolitan Planning Council estimates that excess traffic costs the region \$7.3 billion per year. (streetblogs). Historically, the City of Chicago has

spent a significant amount of money in infrastructure expansion, and while two thousand miles of new lanes have been added to the region's highways and arterial roads over the last 20 years, average rush-hour commute times have doubled (streetblog).

Even though most traffic delays occur in Chicago, much of the traffic involved in those delays originates someplace else. About 14 percent of the total miles traveled in the Chicago region involves vehicles that started commutes in DuPage County. Twelve percent of the total vehicle miles originated in Lake County; Will County, 8 percent; Kane County, 6 percent; and McHenry County, 5 percent. (Hilkevitch 2008).

The challenge Chicago faces in the future is determining how to manage the traffic and congestion issues it faces within the infrastructure it currently has. Many Intelligent Transportation System technologies will greatly contribute to this effort. Among them are real-time traffic management via GPS & floating cellular probes, as well as more sophisticated sensing technologies (Department of Transportation).

The traffic congestions issues that Chicago faces are more of traffic management issue, then they are a "lack of infrastructure" issue, and therefore, management should be prioritized over expansion.



# Defining Statement

Issue  
Adaptivity

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Question at Issue

To what extent should the system provide adaptability?

## Originator

Andy Conrad

## Contributors

Jennifer Lee  
William Huang  
Prashant Desai

## Position

- Constraint      New designs should be more adaptable than permanent.
- Objective
- Directive

## Sources

Richards, Brian. Future Transport in Cities. 1st ed. Taylor & Francis, 2002.  
Gifford, Jonathan L. Flexible Urban Transportation. London: Pergamon, 2003.

## Alternative Position

- Constraint      Little consideration should be given to permanence versus adaptability.
- Objective
- Directive
- Constraint      New designs should be more permanent than adaptable; plan well enough that things don't need to be redone.
- Objective
- Directive

## Background and Arguments

Jonathan Gifford writes in "Flexible Urban Planning, "Transportation planning must strike a balance between stability and agility. The companion of stability is predicability, and the companion of agility is uncertainty" (Gifford, 2003). The future is certain, and change is inevitable. Due to unforeseen economic, technological, and cultural changes, the system should offer maximum adaptability. For example, Chicago may be subject not only to increased density, but also to urban sprawl. This results in the need for a transportation infrastructure that can be not only expanded but also contracted without severe consequence to its surroundings. Ideally, if demand shifts from one area to another, the unneeded infrastructure could be disassembled and reinstalled in a new location.

In addition to reversibility, the system should adapt current infrastructure rather than build more roads or other environmentally-adverse permanent installations. According to many urban planners, more roads only equal more traffic and more damage to the city and environment (Richards, 2002). Paving new major thruways is quite a gamble, considering that our current architecture has already become obsolete. Chicago planners of the past assumed that a hub-and-spoke layout would best serve Chicago's needs. However, we now see that making every train and car pass through downtown creates a considerable amount of congestion. Further, travel between outer spokes becomes exceedingly difficult. Because experts' best

predictions can still wane untrue with time, the system should prioritize flexibility in its installations.

Finally, some may argue that it is much more cost effective to build a permanent system. If one can only build the biggest, most comprehensive system imaginable, future needs will always be met, correct? Not true. Not only does this run the previously discussed risk of unpredictability, but also potentially results in a colossal waste of money. Building a system large enough to cover all future demand would mean installing infrastructure now in areas that do not currently need it. This approach also gambles that no disasters will wipe-out this titanic achievement, and that initial costs will be compensated by longterm profits. What if in the future, everyone works from home and commuting infrastructure becomes irrelevant? No matter how wise the planning, it is simply impossible to build things so well they need not be adaptable.

For these reasons, the transportation system should strive to be as adaptive as possible.

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Originator**

Andy Conrad

**Question at Issue**

How should the government approach standardization as the transportation system evolves?

**Contributors**

Jennifer Lee	October 6, 2008
William Huang	October 6, 2008
Prashant Desai	October 6, 2008

**Position**

- Constraint
  - Objective
  - Directive
- The free market should serve as a testing ground until standards emerge over time.

**Sources**

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Allen, Mike. "Crunching the Numbers on Alternative Fuels." Popular Mechanics, May 2006.

**Alternative Position**

- Constraint
  - Objective
  - Directive
- The transport industry should be standardized to allow development of an infrastructure and unify divergent attempts at developing solutions.

**Background and Arguments**

In the race to new transportation energy sources, who will jump first? Customers won't buy electric or hydrogen cars if they can't refill their tanks at the local fueling station, but fueling stations won't install new pumps if they don't have the customer base to support it. Further, when a technology is in a state of competitive and developmental unrest, neither customers nor business owners want to invest to heavily in something that may instantly become obsolete (Shankland 2005).

For these reasons, the transportation system of the future must decide how it wants to shape the battle for new energy sources. As with all transportation regulations, we first turn to the government and the International Standards Organization (ISO). Often, the government allows technologies to be decided by survival of the fittest in the marketplace (such as the VHS versus Beta debate of the 1980's) (Dilger 2007). But sometimes, especially when public well-being is at stake, standards are imposed upon markets (such as taking lead out of paint).

Initially, standardization seemed imperative so that supporting infrastructure would be prepared alongside the chosen technology. If the government could ensure fuel companies that "X" was the fuel of the next 100 years, they would be more willing to invest in fueling stations. Development could be focused in on the chosen source and efforts would no longer be "wasted" toward a multitude of divergent technologies. But what if short-

ly after a standard is established, a new system emerges that renders the new standard primitive?

Preemptive standardization can suffocate creativity and halt the development of new concepts. Because no technology or fuel source has proven itself a true frontrunner (Allen 2006), the market should remain open. This openness will allow further testing and development before a longterm standard is chosen. So until we arrive at a technology that will take us sustainably and cost-effectively into the next century, the government and standards organizations must allow the market to remain open.

# Defining Statement

Issue  
Automation

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Andy Conrad

## Contributors

Jennifer Lee  
William Huang  
Prashant Desai

## Sources

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## Question at Issue

To what extent should the system be automated?

## Position

- Constraint
- Objective
- Directive

The system should only automate tasks that require no human judgment.

## Alternative Position

- Constraint
- Objective
- Directive

The system should automate whenever possible.

## Background and Arguments

At first glance, automation may appear to be a universal solution for making tasks easier, faster, and more reliable. However, automation may be dangerous, misleading, and too simplistic. In other words, there are some situations better suited to automation, and others better suited to human judgment.

Automation can be dangerous when protocol meant for one situation are thrust into another. This is especially true in contexts where humans are unable to override an automated protocol. Paul Gruhn of the International Society of Automation, recounts the story of a 1993 Airbus crash due to automation (Gruhn 2003). The crew was unable to override and operate the ground spoilers, engine thrust reversers, and wheel brakes during an emergency landing due to a safety protocol that automatically disabled the use of these mechanisms above a certain speed (Gruhn 2003).

When something becomes automated, it's easy to assume "Computers don't make mistakes - it should be fine!" This false sense of security is not only misleading but dangerous when errors or exceptions arise. John D. Lee writes, "Overtrust is poor calibration in which trust exceeds system capabilities; with distrust, trust falls short of the automation's capabilities" (Lee 2004). This lack of synchronicity between human expectations with system capabilities can create disasters as small as "I thought the lights were automatic" and as large as "I thought the

flashing green light meant the system was taking care of it for me" (i.e. Chernobyl-esque interface problems). There is just so much that can go wrong when automating human-computer interactions that critical tasks, or those involving human safety, should not be automated.

Because of automation's inability to respond to novel situations and the risks created by overtrust, tasks that involve human safety should be left to human operators. This improves safety in exception handling and adds a critical level of human awareness about system performance.

### Project

Chicago Vision for the Future:  
Responsive Transport

### Originator

Prashant Desai

### Contributors

### Sources

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Nelson, Erik N. "Public Transit Use Recommended in Disaster." Oakland Tribune, October 18, 2006.

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### Question at Issue

To what extent should the system accommodate for disasters?

### Position

- Constraint
- Objective
- Directive

The system should be prepared to accommodate predicted disaster scenarios to the extent that said disasters have high probability of occurrence and high potential to adversely effect stability and longevity of system operations infrastructure and compromise the safety of stakeholders.

### Alternative Position

- Constraint
  - Objective
  - Directive
- 
- Constraint
  - Objective
  - Directive

The system must be prepared to accommodate the worst case disaster scenario. The system must preemptively plan and act to prepare itself for any and all possible disasters regardless of their probability of occurrence.

The system should only take into consideration the current disaster realities. Because Chicago is a fairly insulated city, it does not need to plan or prepare itself for disasters other than the kind that it already responds to.

## Background and Arguments

The Center for Research on the Epidemiology of Disaster defines a disaster as any incident that kills 10 or more people, affects 100 or more people, or necessitates a declaration of emergency or call for international assistance (Chafe 2007). A combination of poor urban government, and inadequate urban planning can make cities vulnerable to such incidents. Although disasters are often presented as rare and unexpected tragedies, the reality is that they now occur more frequently, affect more people, and cause higher economic damages (Chafe 2007).

"Urbanization affects disasters just as profoundly as disasters can affect urbanization" - Mark Pelling, King's College London.

When a disaster occur oftentimes people are not killed by the source of the disaster itself, but rather the effects these disasters have on infrastructure. (e.g., transportation system). Cities can become vulnerable to disasters due to high population, social and physical conditions, and an absence of an adequate risk management systems.

Disasters and hazards are and will always be part of human experience. That being said, disasters are often times predictable scenarios that can be planned and preemptively prepared for. The system will consider disasters to the extent that said disasters have a high probability of occurrence and high potential to adversely effect stability and longevity of system operations and infrastructure and compromise the safety of stakeholders. Among all US cities, the city of Chicago ranks #12 in terms of lowest natural disaster risk (Sustainlane.com). While disasters vary in scope and effects, no city is completely safe from them.

The presence of natural hazards, combined with high levels of vulnerability, routinely turn into major urban disasters (Chafe 2007). The concentration of heat and pollutants from power plants, industrial processes, and vehicles in cities contribute to the "heat-island effect" which exacerbates heat waves (Chafe 2007). Chicago's grid system with streets lined with tall buildings creates canyon like environments which contribute to strong turbulence and wind gusts. These effects can lead to hailstorms and heavily localized rainfall.

Public transportation can be an invaluable tool in dealing with the aftermath of terror attacks or disaster (Nelson 2006). Public transportation systems can be built strong enough to survive when other transportation related infrastructure such as bridges, streets, and tunnels, fail. Transportation also has the ability to evacuate, serve as transport, and even house displaced victims of disaster. The system can and should be pressed into serving the people in times of emergency and need. Without adequate understanding of disasters and a concerted effort to predict likely occurrences, the system will not be prepared to take on this role. Transportation agencies will need to coordinate plans with local rescue and police agencies and play a significant role in disaster planning (Nelson 2006).

That being said, the following are examples of disasters that the system should make accommodations for: Terrorism, Outbreak, Biowarfare, Storms, Earthquakes, Floods, Windstorms, Fires, Catastrophic Hail, Super-tornado Outbreaks.

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Originator**

Prashant Desai

**Question at Issue**

To what extent should the system consider alternative energy solutions?

**Contributors**

**Position**

- Constraint
- Objective
- Directive

Due to the inherent uncertainty in future energy standards and resource availability, the system should thoroughly explore environmentally friendly energy options and adequately consider the long-term environmental impact of incorporable solutions.

**Sources**

Steffen, Alex. World Changing: A User's Guide to the 21st Century. New York: Abrams, 2008.

**Alternative Position**

- Constraint
  - Objective
  - Directive
- 
- Constraint
  - Objective
  - Directive

Due to the inherent uncertainty in future energy and resource standards, the system should consider long-term environmental impacts and should invest in resources and environmentally friendly energy options better than what is currently available and widely used.

Due to the inherent uncertainty in future energy and resource standards, the system should not invest in any particular resource or environmentally friendly energy options without adequate consideration of long-term environmental impact and assessment of immediate benefit of already available solutions.

**Background and Arguments**

Oil is a limited resource. The scarcity of oil has made acquisition of the resource an expensive affair. Many researchers now acknowledge that the oil business will someday soon reach its production peak and the world will have to learn how to continue to function in the absence of the resource. Much like many other forms of infrastructure, today's transportation system relies heavily on oil. That being said, to what extent should the system consider alternative energy solutions when taking into account the long-term environmental impacts of incorporable solutions (Steffen 2008, 74-81)?

In today's increasingly green-friendly world, many companies and institutions have begun to plan for the "end of oil". Transportation systems around the world are doing major damage to the planet and the automobile is perhaps being the most guilty party. For the past decade or so, hybrid vehicles have been the highlight in the green movement. Because this option is still partially dependent on oil, a few questions arise. Is this good enough? What are the other options? Are those options good enough? With future energy standards still in limbo, it becomes all the more important to thoroughly explore the many options to determine what is actually realistic, and what might work for a major transportation system (Steffen 2008, 74-81).

Not all environmentally friendly energy options have long-term potential. Take for example ethanol fuel. Ethanol production from corn is highly dependent upon subsidies and it consumes a food crop to produce fuel. This is obviously not a sustainable solution.

That being said, there exist a variety of promising energy alternatives with

limited externalities. The US Department of Defence is very interested in US expansion of Fischer-Tropsch (F-T) synthetic fuels. These fuels are a product of thermochemical transformation of hydrocarbon gas. What this means is that gasified coal, natural gas, and methane from landfills can be made into diesel, gasoline, and aviation fuels – 3 huge energy resource needs for a transportation system) (Steffen 2008, 74-81).

Promising transitional alternative energy technologies that are particularly relevant to major transportation systems include: 1) grid-charged hybrids that use advanced and efficient combustion engines combined with robust electric motors and grid chargeable battery packs, and 2) diesel-electric hypercars. Promising long-term solutions (as technology continues to evolve) include: 1) electric: super-efficient battery, and 2) hydrogen fuel cell (Steffen 2008, 74-81).

The aforementioned promising long-term solutions are ways away from being incorporable. It will undoubtedly be many years before their environmental benefits will be seen. It is imperative that the system take alternative energy resources, technology, and research into deep consideration when planning the next iteration of transportation reality. Clear leaders are emerging in the alternative energy technology race. That being said, transportation planners have an unparalleled opportunity to set right the course of this planet's environmental history through the bold exploration of alternatives.

# Defining Statement

Issue  
Public-Private Partnership (PPP)

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Prashant Desai

## Contributors

## Question at Issue

To what extent should the system consider Public-Private Partnership (PPP)?

## Position

- Constraint
- Objective
- Directive

The system should actively consider Public-Private Partnership (PPP) as there exists a growing gap in the cost of providing and preserving transportation systems. PPP has the potential to expedite project delivery, operations, and maintenance in a more cost-effective manner.

## Sources

Dornan, Daniel L. *Case Studies of Transportation Public-Private Partnerships in the United States*. U.S Department of Transportation, Federal Highway Administration (2007): 1-215.

*Making the Case for Public-Private Partnerships in Illinois*. Business Leaders for Transportation (2006): 1-8.

## Alternative Position

- Constraint
- Objective
- Directive

The system should not consider Public-Private Partnership (PPP) as there exists a scarcity of promising research in the area of successful PPP in the urban planning of transportation systems.

## Background and Arguments

To keep the Chicago area competitive, our rails, roads and airways need regular investment in their maintenance and sensible expansion. But even with the new federal dollars, the state and northeastern Illinois still lack the money to complete critical transportation improvements. Creative use of private capital can minimize the need for governments to raise new revenue and take on new debt, thus freeing up limited resources for other priorities. To make the region work and maintain Chicago's position as a global commerce center and tourism destination, the system must be prepared to invest in the transportation systems. That being said, the combination of current funding methods is not sufficient to fully maintain the existing transportation system, let alone keep pace with increased demands. (*Making the Case for Public-Private Partnership in Illinois* 2006, 2).

Public-Private Partnerships (PPPs) represent a wide variety of project financing and delivery approaches which offer the potential to expedite project delivery, operations, and maintenance in a more cost-effective manner, enabling transportation agencies to effectively "do more with less" (Dornan 2007, 8).

The common element of a PPP is that the public sector sponsor of infrastructure projects engages the private sector to a greater degree in the performance of certain functions previously handled by the public sector. This can range from contracted maintenance services to full financing, development, operations, and preservation. (Dornan 2007, 8).

There is significant opportunity for state and local transportation agencies to

add PPP approaches to their means of accomplishing their missions. One way to present the implications and potential applicability of various types of PPP approaches is through the experience gained by early users of these alternative delivery approaches. (Doornan 2007, 8).

Areas of PPP that the system should explore:

- Why sponsoring agencies elect to pursue PPP projects
- PPP arrangement structure
- The nature of project financial and delivery responsibilities
- Issues and Impediments that confronted members of the PPP teams
- How said issues were addressed

PPPs provide an opportunity for governments to provide social capital infrastructure in the form of schools, hospitals and roads while benefiting from greater cost-efficiency that may be achieved from private sector involvement. Private sector participation in asset and service provision can maximize value for money for government by expediting financing, facilitating innovation, providing better risk management, and integrating life-cycle management (Dornan 2007, 8).

The rising cost of transportation infrastructure and elected official aversion to raising taxes to finance it creates a compelling argument for the exploration of PPP.

# Defining Statement

Issue  
Existing Infrastructure

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## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Prashant Desai

## Question at Issue

To what extent should the system accommodate existing infrastructure?

## Contributors

## Position

- Constraint
- Objective
- Directive

The system should do its best to working off of and building into existing transportation infrastructure. Building entirely new infrastructure could result in wasted resources, huge expense, and overwhelming technological and behavioral transition.

## Sources

Guy, Simon. **Infrastructure in Transition**. Sterling, VA: Earthscan Publications Ltd., 2001.

*Freight Systems: From System Construction to System Optimization*. U.S. Department of Transportation, Federal Highway Administration (2008): 1-24.

Team Deliberations

## Alternative Position

- Constraint
- Objective
- Directive

The system should not accomodate any existing infrastructure. The existing infrastructure will not be able to transition to a new and improved transportation system.

## Background and Arguments

While the number of vehicle lane miles traveled per year in the City of Chicago continues to increase dramatically, the number of vehicle lane miles constructed per year has not been keeping pace. In fact, between 1980 and 1998, vehicle travel grew by 78% while road miles only increased by 1% (U.S. Dept of Transportation 2008) The disparity between transportation infrastructure usage and availability is growing. That being said, is building more infrastructure the answer? Yes and no.

Chicago's responsive transportation system of the future should be restricted to working off of and building into existing transportation infrastructure. Building entirely new infrastructure could result in wasted resources, huge expense, and overwhelming technological and behavioral transition.

### *Demand Driven Infrastructure Growth:*

The parts and pieces of a transportation infrastructure exists only as part of larger network. For example, individual roads connect to other roads, and those roads connect to arterial throughways, and those throughways connect to highways (the same logic applies to rail infrastructure). That being said, how should this infrastructure be managed? A leading thought in infrastructure management has been to build supply capacity and extend the physical networks in order to meet rising demand, maximize connection levels, avoid supply bottlenecks, and satisfy higher performance standards (Guy 2001, 5).

### *Resources & Expense:*

The strategy of building addition infrastructure to meet rising demands need

should only be entertained after the transportation system has attempted to build smarter by: Exploring all opportunities to intelligently manage infrastructure use through optimization and is able to assure that all new construction is sustainable.

By building into existing infrastructure, the transportation system is not creating waste. Aged transportation infrastructure is likely to be difficult to recycle and repurpose, and extremely expense to dispose of.

### *Technological & Behavioral Transition:*

With new infrastructure comes new technology. With new technology comes the challenge of training an entire workforce about how to use it. By employing incremental changes to infrastructure, the transportation system workforce will grow and learn as the system evolves.

Because of the potential cost, waste, and behavioral transition involved in building completely new infrastructure, the system should prioritize building on and improving existing infrastructure before building new infrastructure.

# Defining Statement

Issue  
Burden of Cost

98

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

Prashant Desai

## Contributors

## Question at Issue

How should the system distribute the burden of transportation related cost?

## Position

- Constraint
- Objective
- Directive

The system should explore distributing the burden of transportation related costs through usage fees, public taxation, and public-private partnership support (Limited Zero-fare).

## Sources

Evensen, Jay. "Thumbs up to funding mass transit." Deseret News, July 1, 2007.

Bookrags Staff, "Zero-fare." [www.bookrags.com/wiki/Zero-fare\\_public\\_transport](http://www.bookrags.com/wiki/Zero-fare_public_transport) (accessed September 20, 2008)

Team Deliberations

## Alternative Position

- Constraint
  - Objective
  - Directive
- 
- Constraint
  - Objective
  - Directive

The public should carry the burden of transportation related costs through usage fees and government taxation.

Transportation related costs will be absorbed by private partners through public-private partnership.

## Background and Arguments

"Why is it that transit funding is a subsidy but highway funding isn't? Why do some people complain about seeing empty trains or buses in off-peak hours, but they won't complain about freeways that are empty or nearly empty during the same hours? Why do some people never consider that, by funding highways much more than transit through the years, we are forcing people, even ones of meager means, to buy expensive cars and to fill them with expensive gasoline? Why do we consider Americans to be car-crazy, when they really have few other options?" (Evenson 2007)

The rising price of gasoline has sparked an interesting debate: Should public funding go towards roads or mass transit? Furthermore, how exactly should a transportation system distribute the burden of transportation related costs?

Progressive cities like Chicago depend on progressive solutions. That being said, the system should explore distributing the burden of transportation related costs through usage fees, public taxation, and public-private partnership support. In other words, Chicago should explore a hybrid of a traditional distribution of costs with the idea of Limited Zero-fare.

Zero-fare public transport services are funded in full by means other than collecting a fare from passengers. They may be funded by national, regional or local government through taxation or by commercial sponsorship by businesses (Bookrags).

Many progressive cities have successfully incorporated, or are experimenting

with Zero-fare funding models. The zero-fare funding model has been praised for its operational benefits. Transport operators enjoy shorter dwell times and greater system efficiency. Businesses that privately fund a transportation system may experience a commercial benefit in that their sales revenue may increase from greater brand awareness. Zero-fare is also known for its community benefits as it makes transportation accessible to residents of all income levels. Generally speaking, because zero-fare promotes the use of public transportation, it decreases the effect of negative environmental externalities caused by automobiles.

We contend that Chicago's responsive transportation system of the future gradually incorporate a limited zero-fare method for distributing the burden of transportation related costs. By entering into public-private partnerships and accepting private funds from businesses, Chicago opens the doors to a wealth of resources and expertise it would not have otherwise been able to access or leverage. The transportation system could continue to collect fare from passengers, but would likely be able to charge a nominal amount due to user fares being subsidized by government taxation.

In the future, Chicago transportation system will be expected to be agile and innovative. The current method of distributing the burden of transportation related costs is dated. By embracing limited zero-fare, Chicago has the potential to rapidly improve the quality of its transportation system.



# Defining Statement

Issue  
Travel Experience

99

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

William Huang

## Question at Issue

To what extent should the system prioritize functionality over travel experience?

## Contributors

Andy Conrad	September 5, 2008
Prashant Desai	September 5, 2008
Jennifer Lee	September 5, 2008

## Position

<input type="checkbox"/> Constraint	In order to provide travelers with the best experience, the system should achieve a balance between travel efficiency and travel comfort.
<input checked="" type="checkbox"/> Objective	
<input type="checkbox"/> Directive	

## Sources

*Ball, Jim T. Our Future Travel.* Trafford Publishing, 2005.

## Alternative Position

<input type="checkbox"/> Constraint	The system should give priority to making traveling as efficient as possible, at the expense of some travel comfort.
<input checked="" type="checkbox"/> Objective	
<input type="checkbox"/> Directive	
<input type="checkbox"/> Constraint	The system should give priority to making traveling a delightful experience, at the expense of some travel efficiency.
<input checked="" type="checkbox"/> Objective	
<input type="checkbox"/> Directive	

## Background and Arguments

Public transits such as subways and buses are designed to efficiently move as much people and as quickly as possible. What they are lacking are the comfort and privacy of the space that smaller vehicles can provide, as well as the convenience and speed of getting from the departure point to final destination. Although there are many benefits of driving cars, they are expensive to own, prone to traffic congestion and cause air pollution.

Giving priority to either travel efficiency or travel comfort decreases the quality of transportation system. Packing as many people as possible in public transits allows maximum efficiency but may lead to lower ridership due to low quality of experience. Providing a luxurious environment in public transits allows an excellent travel experience but may also lead to lower ridership due to high ticket costs.

The system should be composed of large to small-scaled vehicles for both mass and personal transportation. Designs of large-scaled vehicles should incorporate elements of personal comfort and convenience found in smaller vehicles. Designs of small-scaled vehicles should incorporate elements of efficiency and safety found in mass transit. A good balance between efficiency and pleasant experience in transportation can be achieved by utilizing existing and emerging technologies.

# Defining Statement

Issue  
Who/ What's Moving?

100

## Project

Chicago Vision for the Future:  
Responsive Transport

## Originator

William Huang

## Question at Issue

To what extent should the plan assume that people will be the active element in transportation?

## Contributors

Andy Conrad	September 5, 2008
Prashant Desai	September 5, 2008
Jennifer Lee	December 10, 2008

## Position

<input type="checkbox"/> Constraint	The plan should assume that people, as social & independent beings, prefer to move, so they should be the active element in transportation.
<input checked="" type="checkbox"/> Objective	
<input type="checkbox"/> Directive	

## Sources

Peapod. [http://www.peapod.com/corpinfo/GW\\_index.jhtml;jsessionid=LKDEKWEE1UE4UCQBD0WCIIQ](http://www.peapod.com/corpinfo/GW_index.jhtml;jsessionid=LKDEKWEE1UE4UCQBD0WCIIQ) (accessed December 10, 2008).

Tahmincioglu, Eve. 2007. *The Quiet Revolution: Telecommuting*. MSNBC.com (October 5), <http://www.msnbc.msn.com/id/20281475/> (accessed December 10, 2008).

## Alternative Position

<input type="checkbox"/> Constraint	The plan should assume that people will no longer need to travel if needs can be brought to them.
<input checked="" type="checkbox"/> Objective	
<input type="checkbox"/> Directive	

## Background and Arguments

Advanced telecommunications technologies are already changing the way people interact with each other. Video conferencing allows people to work or keep in touch without leaving the comfort of their homes. Traffic jams and waiting in lines at the supermarket can be things of the past if goods can be brought to them with online grocery; companies like Peapod, for example, currently service 1,500 zip codes and over 12,700,000 households across cities in the United States.

By 2009, the number of telecommuting workers, also known as teleworkers, will reach 14 million (Tahmincioglu 2007). The benefits are quite clear: teleworkers enjoy an amount of flexibility and freedom that office-based work simply does not afford, and company office space costs are reduced drastically. Furthermore, fewer commuters means fewer cars on the road and thus a decrease in the amount of pollutants that cars are putting into the atmosphere.

However, telecommuting cannot completely substitute for office time; face-to-face meetings with supervisors and colleagues are still necessary on occasion. Working from home also poses a challenge to balancing work and home life activities and responsibilities. Perhaps more importantly, though, is that no matter how much advanced technologies can alter the way people work and interact with each other, people, as social and independent beings, prefer to move about. People will continue to participate

in social activities such as meeting in coffee shops, window shopping, attending live baseball games, go swimming at the beach, and so on.

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Originator**

Andy Conrad

**Contributors**

Jennifer Lee  
William Huang  
Prashant Desai

**Sources**

Higgins, Michelle. "NY Times: Travel." August 15, 2006. <http://travel.nytimes.com/2006/08/15/travel/15prac.html> (accessed 09/30/08).  
David, Demerjian. "Wired Magazine: Autopia Blog." April 16, 2008. <http://blog.wired.com/cars/2008/04/bash-the-airlin.html> (accessed 09/30/08).  
Continental Airlines, 2008. <http://www.continental.com/web/en-US/content/Travel/airport/process/default.aspx> (accessed 09/29/2008).  
Richards, Brian. Future Transport in Cities. 1st ed. Taylor & Francis, 2002.

**Question at Issue**

To what extent should the system prioritize personal safety over convenience, privacy, or speed?

**Position**

- Constraint
  - Objective
  - Directive
- The system should provide some balance between convenience, privacy, and safety.

**Alternative Position**

- Constraint
  - Objective
  - Directive
- The system should provide safety at all costs.
- Constraint
  - Objective
  - Directive
- The system must provide convenience/privacy at all costs.

**Background and Arguments**

Since 9/11, changes in the TSA have earned airport security a reputation as an invasive and time-consuming procedure (Higgins, 2006). However, many value the speed of flight over driving and so endure the procedures (Demerjian 2008). While in-flight safety is priority, the TSA quotes Department of Homeland Security Secretary Michael Chertoff saying, "In a free and open society, we simply cannot protect every person against every risk at every moment in every place. There is no perfect security... in order to protect our country and defend our freedoms, we must continue to focus resources on the areas that pose the greatest risk..." (Travel Safety Administration 2008). While it is impossible to speculate the attitudes of future societies toward imagined modes of transportation, a metaphor can be drawn to the airline industry.

Perhaps the bottom line is safety; if the system isn't safe, it won't be used. Some might argue that violence, crime, and terrorism must be prevented at all costs. But are those individuals willing to endure the invasive, costly, and prolonged procedures the may be necessary to provide that level of security? It's highly unlikely that the public would be willing to add even a twenty minute check-in to their morning commute to ride a bus or train, even when compared to the average one to two hour airport check-in.

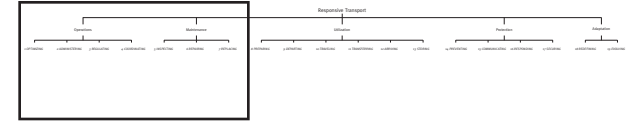
Does this mean the system should prioritize privacy and con-

venience in order to offer speedy travel? People generally dislike having their personal space invaded, even when it means a higher level of safety. After all, if the system isn't fast, it won't be an attractive mode of transport. Brian Richards argues that current mass transit options offer a level of service that is too slow to tempt ridership (Richards 2002).

For these reasons, the system should strike some balance that upholds a certain level of safety while maintaining speed. Any safety/security procedures must be optimized and weighed against their impact on speed of entry and overall travel time.

# Function Structure

Chicago: Vision for the Future



## Operations

## Maintenance

### 1 OPTIMIZING

- 1 monitor traffic
- 2 identify patterns
- 3 anticipate problems
- 4 prioritize needs
- 5 implement adjustments
- 6 gather feedback
- 7 revise approach

### 2 ADMINISTERING

- 8 establish goals
- 9 assess needs
- 10 delegate authority and responsibility
- 11 identify resources
- 12 gather resources
- 13 allocate resources
- 14 evaluate quality of system

### 3 REGULATING

- 15 set parameters
- 16 communicate expectations
- 17 identify violations
- 18 enforce protocol
- 19 educate violators
- 20 identify violation patterns
- 21 re-assess system

### 4 COORDINATING

- 22 specify organizational relationships
- 23 gather data
- 24 manage information
- 25 communicate between system components

### 5 INSPECTING

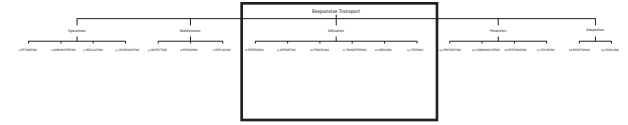
- 26 establish quality requirements
- 27 monitor system components
- 28 report observations
- 29 highlight anomalies
- 30 analyze cost benefit of repair or replacement
- 31 identify maintenance need

### 6 REPAIRING

- 32 gather repair resources
- 33 recycle or dispose of unneeded parts
- 34 make repairs
- 35 test repair
- 36 document repair
- 37 authorize repair for use

### 7 REPLACING

- 38 select substitute parts
- 39 recycle or dispose of old parts
- 40 make replacement
- 41 test replacement
- 42 document replacement
- 43 authorize replacement for use



# Responsive Transport

## Utilization

### 8 PREPARING

- 44 establish itinerary (destination/route)
- 45 check system activity
- 46 select optimal mode
- 47 package goods

### 9 DEPARTING

- 48 transaction for departure
- 49 load load
- 50 secure cargo
- 51 signal for departure

### 10 TRAVELING

- 52 monitor position
- 53 communicate between user and system
- 54 experience journey
- 55 make travel adjustments

### 11 TRANSFERRING

- 56 communicate transfer to users
- 57 retrieve cargo
- 58 orient to new departure point
- 59 move to new departure point
- 60 await next departure

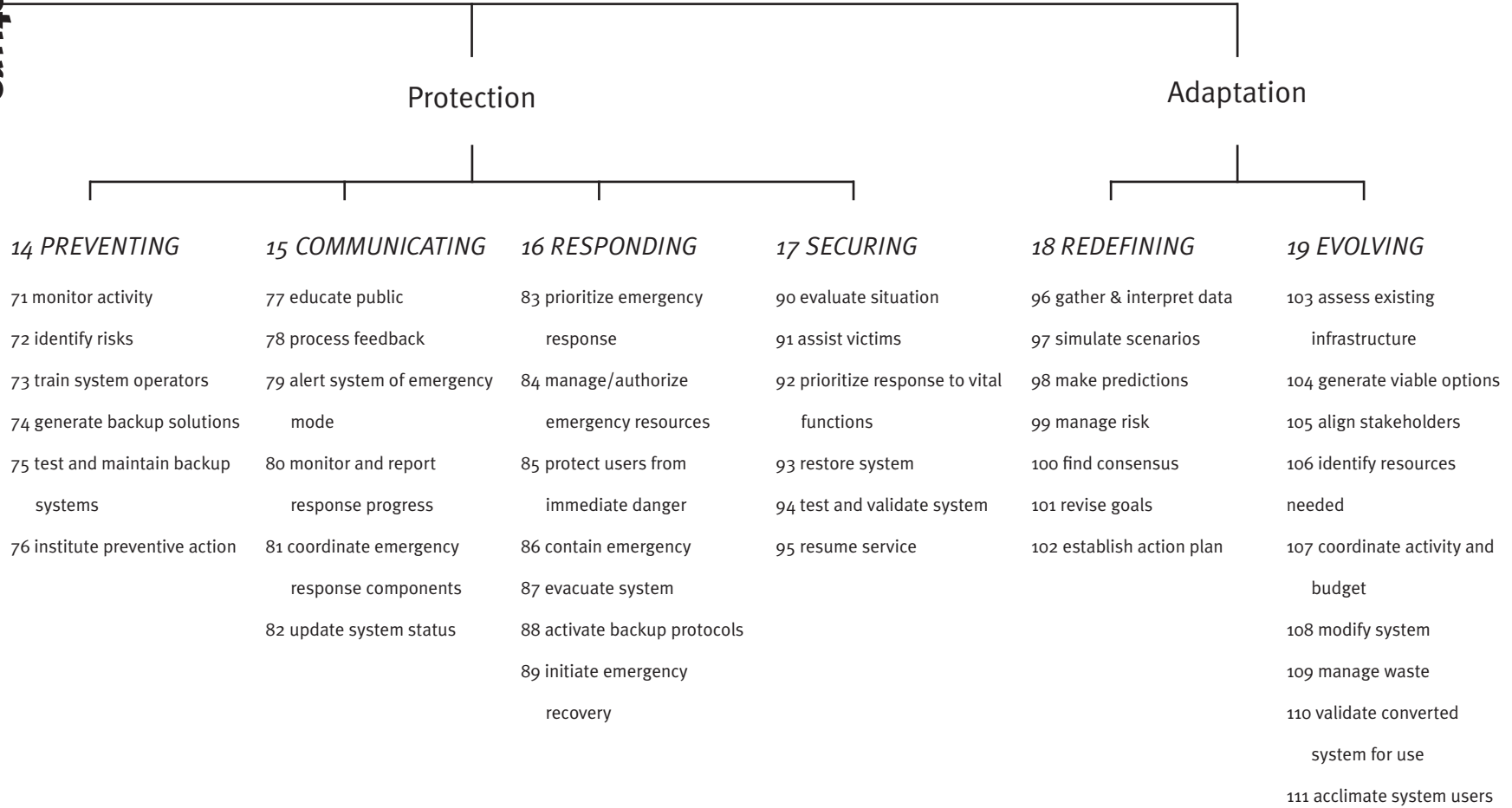
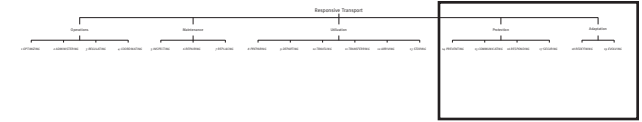
### 12 ARRIVING

- 61 signal for arrival
- 62 unsecure cargo
- 63 unload cargo
- 64 transaction for arrival

### 13 STORING

- 65 identify storage point
- 66 transaction for space
- 67 put vehicle/item in space
- 68 secure vehicle/item
- 69 record storage location
- 70 retrieve vehicle/item

Chicago: Vision for the Future  
**Function Structure**



# Design Factor

Budget issues may impede or interrupt progress

105

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation, Maintenance

## Activity

Evolving, Inspecting, Replacing, Repairing

## Originator

Prashant Desai

## Contributors

Andy Conrad	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

## Sources

Team deliberations

## Associated Functions

30. Analyze cost or benefit of repair or replacement.  
37. Authorize repair for use  
38. Select substitute  
39. Recycle or dispose of old parts  
40. Make replacement  
41. Test replacement  
43. Authorize replacement for use  
107. Coordinate activity and budget

## Observation

Evolution, particularly in the context of adapting, and maintaining a system, depends greatly on the coordination of activities and budgets. Often times, budgetary issues impede or interrupt progress because they raise the issue of resources and cost related to an increment of change.

## Extension

Examples of budget issues include, but are not limited to: (1) Budgetary constraints impeding general progress (2) Budgets not permitting repairs (3) Budget issues making it difficult to quantify and compare value of maintenance. (4) Replacement vs repair deadlines compromising quality (5) Budgetary, time, authorization, and deadline constraints or demands compromising quality. (6) Budgetary allotments can creating conflicts between quality and cost of parts.

While the number of vehicle lane miles traveled per year in the City of Chicago continues to increase dramatically, the number of vehicle lane miles constructed per year has not been keeping pace. This is only one of many examples where budgetary issues might be the impeding factor in the maintenance of an evolving, adaptable, transportation system.

## Design Strategies

Project long-term value of maintenance efforts

Find compromise in budgetary time, authorization, and deadline constraints.

## Solution Elements

- S** Maintenance Value Protocols
- E** Collaborative Decision Making

# Design Factor

Stakeholders may not agree with proposed solutions

106

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation

## Activity

Evolving, Redefining

## Originator

Prashant Desai

## Contributors

## Sources

"Stakeholder Alignment." <http://www.ebml.co.uk/> (accessed November 25, 2008).

Team deliberations

## Associated Functions

100. Find consensus  
105. Align stakeholders

## Observation

Finding alignment and agreement amongst all system stakeholders is challenging and may result in disagreement over proposed solutions.

## Extension

In order to implement changes in a system and move solutions past the point of consideration, stakeholders must be aligned.

Stakeholder alignment is based on common values and principles of system operation and on the alignment of objectives and processes amongst employees, customers, suppliers, the community, company management, and investors. Long-term stakeholder alignment should be managed continuously and is a core element of the whole business operating as a cohesive unit.

Because the changes made in the transportation system involve so many varied stakeholders, it becomes all the more important to involve stakeholders earlier in the solution generation and exploration process. Doing so will please all parties involved and save the system significant time and money.

## Design Strategies

Involve Stakeholders in solution generation and evaluation

Engage the community in the solution assessment process,

## Solution Elements

**S** Alignment Initiative

**S** Citizens for the Future of Chicago Transportation



# Design Factor

Adequate adaptation risk management systems do not exist

107

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation

## Activity

Redefining

## Originator

Prashant Desai

## Contributors

## Sources

Team deliberations

## Associated Functions

97. Simulate scenarios  
99. Manage risk

## Observation

Adequate adaptation risk management systems do not exist.

## Extension

Redefining a transportation system will require an adequate risk management resource that is capable of preparing for a variety of social, political, and environmental risks. Because risk management is a structured way to managing the uncertainty related to a threat, top of the line risk management systems will be necessary to mitigate the risk of the uncertain. An adequate risk management system must be capable of simulating a variety of scenarios that could potential damage system functioning. For example, the system could create a scenario that tests current transportation infrastructure against the growing usage demands. Another possible scenario be the simulation of a terrorist attack on system (perhaps virtual). Without adequate knowledge of how transportation facilities will react in the face of these likely dilemmas, the responsive transportation system of the future will not be able to preemptively redefine itself and adapt in time to be ready for such scenarios.

## Design Strategies

Recruit external risk management expertise

Create risk simulation capacity

Create risk management tool

Test the natural limit of a variety of social, political, and environmental scenarios.

## Solution Elements

- M** Transportation System Risk Management Tool
- E** TSA: Transportation Risk Assessment and Vulnerability Evaluation
- S** Pilot Neighborhoods

# Design Factor

Bureaucracy and internal politics impede action

108

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations  
Protection

## Activity

Administering, Optimizing, Coordinating,  
Responding

## Originator

Prashant Desai

## Contributors

Andy Conrad	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

## Sources

Team deliberations

## Associated Functions

04. Prioritize Needs  
08. Establish goals  
09. Assess needs  
10. Delegate authority and responsibility  
11. Identify resources  
12. Gather resources  
13. Allocate resources  
14. Evaluate quality of system  
22. Specify Organizational Relationships  
24. Manage Information  
84. Manage/Authorize Emergency Resources

## Observation

Paperwork and slow procedures are well-known hazards in the workplace. Employees often complain of having to jump through hoops to acquire resources and establish authority needed to effectively do their jobs.

Running into a wall of corporate bureaucracy is frustrating - it can stunt innovation, require mountains of paperwork and make employees feel like automatons. But a certain amount of procedure is necessary in any company.

## Extension

Corporate bureaucracy and internal politics are often the cause of employees feeling helpless, and losing a sense of purpose and motivation. When an employee decides to take an initiative, bureaucracy can destroy their momentum and enterprising nature. Bureaucracy has the potential to adversely effect factors beyond employee happiness.

For example, it can impede innovation efforts by overly complicating communication and progressive action. Internal politics can hinder the very mechanisms by which company goals and customer needs are explored. The pivotal functions upon which a company functions are the acquisition, management, and allocation of resources [financial, material, etc.] In an increasingly competitive and unpredictable world, organizations cannot control risk unless they are able to coordinate the efforts of all employees, set quality standards, streamline the flow of information.

## Design Strategies

Organize departments by project rather than function.

Hire external streamlining consultants

Make decision making fun and less contentious

Reduce hierarchical structure

Resolve conflicts between long and short term goals

## Solution Elements

**E** Water cooler exchange

**E** Streamlining Consultants

**M** Third Party

**E** Decentralized Administration

**E** Goal Tracker

# Design Factor

Communication is not always efficient or effective

109

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations, Protection

## Activity

Coordination, Communication, Regulation,  
Administration

## Originator

Prashant Desai

## Contributors

Andy Conrad	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

## Sources

Team deliberations

## Associated Functions

08. Establish goals  
10. Delegate authority and responsibility  
13. Allocate resources  
14. Evaluate quality of system  
16. Communicate expectations  
25. Communicate between system components  
78. Process feedback  
79. Alert system of emergency mode  
80. Monitor and report response progress  
81. Coordinate emergency response components.  
82. Update system status

## Observation

Communication is not always efficient or effective. It is often uncertain if a message was conveyed effectively and it is sometimes difficult to know if messages have been received accurately (or at all). Additionally, making all information available to everyone may overwhelm receiver of information

## Extension

Efficient internal system communication is an integral part of running an effective organization. Inefficient communication can result in lost time and money. In an increasingly collaborative workplace, it often becomes challenging to communicate with different departments with different communication styles.

Making all information available to everyone is not sufficient for coordinating between parts of the system. Information is only meaningful to those who are trained to understand it. Thus, when departments communicate, some filtering or translation must occur so that the receiver of the information understands what the sender is trying to convey.

## Design Strategies

Filter/translate communications

All departments should use common communication medium

All departments should use common information technology.

## Solution Elements

- E** InfoFilter
- E** System Wide Sync
- M** Information Translation Hub
- E** Jargonology Training

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Mode**

Maintenance, Adaptation

**Activity**

Repairing, Replacing, Evolving

**Originator**

Prashant Desai

**Contributors**

Andy Conrad	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

**Sources**

Team deliberations

**Associated Functions**

- 34. Make repairs
- 35. Test repair
- 40. Test replacement
- 108. Modify System

**Observation**

Systems often experience service disruptions when maintaining and modifying infrastructure and operations.

**Extension**

System maintenance (repairs/replacements/modifications) can significantly disrupt transportation services. Implementing both small and large scale changes to existing infrastructure can be time consuming and costly in terms of lost business. Because a system is so difficult to modify while in use, it is imperative that system administrators exercise creativity and tact when carrying out system maintenance efforts. The challenge: How can a system make aggressive changes without sacrificing both performance and service expectations?

**Design Strategies**

- Minimize disruptions
- Expedite Maintenance
- Do not modify system while in use
- Compensate for disruption inconvenience

**Solution Elements**

- S** Consecutive Renovations
- E** Considerate Disruptions
- S** Service Disruption Credits
- S** Extra Lane
- M** Concurrent Engineering

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Maintenance

### Activity

Repairing, Replacing

### Originator

Prashant Desai

### Contributors

Andy Conrad	December 8, 2008
William Huang	December 8, 2008
Jennifer Lee	December 8, 2008

### Sources

Team deliberations

### Associated Functions

36. Document repair  
42. Document replacement

### Observation

Maintenance documentation can be a frustrating and cumbersome task for system staff when dealing with the demands of the actual maintenance work. This problem is further exacerbated by confusing and inefficient documentation methods.

### Extension

Maintenance documentation is often a requirement for all repair, replacement, and modification activities. Documentation is typically required for the legal purposes, and quality control issues. Because maintenance tasks have the potential of interrupting or otherwise adversely effecting system performance and efficiency, its very important that the maintenance activity be completed in as little time as possible while retaining quality standards. Documentation is even more cumbersome for system workers when repair records are not dynamically linked to new repair documents. Much like a physician has patient records at hand on a wireless tablet, maintenance should also have mobile information access and documentation resources at hand when diagnosing and addressing a maintenance issue.

### Design Strategies

Create real-time mobile documentation resource

Create smart tools with information management capability

### Solution Elements

**M** Handheld Documentation

**S** Tool Tracker

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Maintenance, Adaptation

### Activity

Replacing, Repairing, Evolving

### Originator

Prashant Desai

### Contributors

Andy Conrad	November 5, 2008
William Huang	November 5, 2008
Jennifer Lee,	November 5, 2008

### Sources

"Chicago Recycling." <http://www.chicagorecycling.org/index.php> (accessed November 25, 2008).

"Glossary." <http://www.suffolk.gov.uk/> (accessed November 25, 2008).

### Associated Functions

33. Recycle or dispose of unneeded parts  
39. Recycle or dispose of old parts  
109. Manage waste

### Observation

Recycling or disposing of old parts can potentially be environmentally harmful. Generating non-recyclable or repurposeable waste in construction counteracts efforts to be "green"

### Extension

Old parts or scrap materials are often times not recyclable, reusable, and are hard to repurpose. To be truly sustainable, a system, regardless of industry context, must only use the earth's resources at a rate at which they can be replenished. Scientific evidence exists that proves that humanity is living unsustainably. An effort is needed to keep human use of natural resources within sustainable limits.

Recycling: To reprocess waste materials in a production process for the original purpose or for other purposes, including composting but excluding energy recovery.

A system that is truly sustainable might add process of energy recovery to it's definition of recycling. In the future, the transportation system will need to find ways to repurpose and reuse it's waste as it expands to meet the demands of a growing population.

### Design Strategies

- Use sustainable materials
- Repurpose old materials
- Reuse/Donate old materials

### Solution Elements

- S** Sustainable Construction
- E** Envirostructures
- S** "Sister Cities"

# Design Factor

Patterns are limited by inherent unpredictably

113

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations, Protection

## Activity

Optimizing, Responding, Preventing

## Originator

Prashant Desai

## Contributors

## Sources

Personal observation

## Associated Functions

02. Identify patterns
03. Anticipate problems
71. Monitor activity
72. Identify risks
73. Train system operators
74. Generate backup solutions
75. Test and maintain backup systems
76. Institute preventative action
87. Evacuate system

## Observation

Risk identification, in the context of optimizing system operations through anticipating potential challenges (congestion, emergencies, disasters), will rely on pattern databases that are inherently unpredictable.

## Extension

A pattern database cannot be confidently utilized until the accuracy in its application is known and proven. Complex pattern algorithms can be leveraged to avoid problems like traffic congestion, and prepare for likely emergency situations and disasters. While patterns are an excellent indicator of what has come before, they are plagued by an inherent and intrinsic inability to predict future challenges with 100% accuracy. Many situations for which anticipation is desired, are unpredictable and can be erratic. Often times, systems are not prepared to deal with the unpredictable nature of these situations.

## Design Strategies

- Maintain pattern database
- Constantly update pattern database
- Establish parameters around unforeseen events

## Solution Elements

- S** Pattern Thinktank
- E** Variable Database
- E** Continually Increase Awareness
- S** Emergency Patterns Database

# Design Factor

Optimal mode selection for mass transit can vary

114

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Preparing

## Originator

Prashant Desai

## Contributors

## Sources

Team deliberations

## Associated Functions

46. Select optimal mode

## Observation

Transport mode selection creates limitations, because optimal mode selection varies depending on transport purpose. (mass transit)

## Extension

When selecting a mode of travel, a traveller's choice of transportation is limited by the purpose of their travel. For example, should a traveller require extra storage space, they are unlikely to take any light mode of travel. Should a few travellers be in a large group, they are likely to require travel accommodations that can transport everyone together. Current transportation systems are not currently equipped to accommodate the individual needs for all travel scenarios. Because the transportation system cannot sense traveller needs or demand in real-time, they are unable to optimize mode availability in time to encourage use of public transportation.

## Design Strategies

Create real-time itinerary planning resource that links with CTA information database.

Create on-demand facilities that are capable of gathering, and processing travel mode needs of an individual.

Create variety of transport mode options to meet a variety of needs.

## Solution Elements

**M** Real-time Itinerary Planning Resource (Transcom)

**S** Info Kiosks

**E** Privic Transportation



# Design Factor

Difficulty in finding, locating, remembering storage points

115

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Storing

## Originator

Prashant Desai

## Contributors

Andy Conrad    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee    December 10, 2008

## Sources

Team deliberations

## Associated Functions

65. Identify storage point  
67. Put vehicle/item in space  
70. Retrieve vehicle/item

## Observation

As urban populations continue to increase, the task of finding, locating, and remembering storage locations for both vehicles and personal belongings has become increasingly difficult.

## Extension

The difficulty involved in finding, locating, and then remembering a storage point is rooted in a common challenge: The scarcity of storage locations. This challenge applies to both the storage of vehicles as well as the storage of belongings. There simply aren't enough storage points for all storage needs at any given time. This is partly due to the inefficient nature of the storing task. Significant amounts of time are wasted in the search for storage. For example, searching for an available public parking space might require up to 30 minutes of time. The very nature of storage utilization is rooted in sharing. That being said, both the person looking for storage, and the storage management entity should provide each other with information about needs and availability, respectively.

## Design Strategies

Make it easier to find vehicle location.

Make it easier to find and reserve available parking and other storage locations

## Solution Elements

**M** GPS vehicle locator.

**S** CTA Storage Application (mobile)

**E** Smart Meters

# Design Factor

Urban storage of vehicle is costly and insecure

116

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Storing

## Originator

Prashant Desai

## Contributors

Andy Conrad	December 8, 2008
William Huang	December 8, 2008
Jennifer Lee	December 8, 2008

## Sources

Wisniewski, Mary. "Cost of Downtown Parking Skyrocketing." November 17, 2008.<http://www.suntimes.com/news/transportation/1283082,CST-NWS-parking17.article> (accessed November 25, 2008).

Team deliberations

## Associated Functions

66. Conduct transaction for space  
67. Put vehicle/item in space  
68. Secure vehicle/item

## Observation

Urban vehicle storage is often expensive, scarce, and insecure.

## Extension

The cost of urban parking in Chicago is skyrocketing. The median daily price for parking is \$30 while the median monthly parking fee is \$310. Parking fees can differ from block to block depending on proximity of local attractions. Additionally, these parking lots are often full and difficult to find in many areas. Chicago ranks 4th amongst American cities for daily parking rates. Parking facilities vary a great deal from lot to lot. Security comes at a price and the customer is usually responsible for any damage or theft.

## Design Strategies

Create smarter & safer parking facilities.  
Reduce dependency on urban parking

## Solution Elements

- M** Robotic Parking
- E** Car Free Housing
- E** Park & Ride
- S** Car Free Chicago

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Operations

### Activity

Administering

### Originator

Jennifer Lee

### Contributors

### Sources

Kling, Arnold. *Stanford Marshmallow Experiment*.  
**Library of Economics and Liberty** (October 5, 2007),  
[http://econlog.econlib.org/archives/2007/10/stanford\\_marshm.html](http://econlog.econlib.org/archives/2007/10/stanford_marshm.html).

Personal observation

### Associated Functions

8. Establish goals

### Observation

When establishing goals, it is essential to establish both long- and short-term objectives. However, there can be conflict between what people hope to accomplish in the long run, and what they are able to achieve in the short term.

### Extension

Short-term goals and needs, by definition, demand more immediate attention. They often lead to tangible results to which users can easily make the connection between cost and benefit. It is frequently much more challenging for a system to gain support for the worth or benefit of long-term goals, especially when the immediate burden of a large investment up front can overshadow the benefits over time.

Consider a family that needs to replace a boiler in their home. A replacement for a standard 80-85% efficient boiler will cost the family approximately \$5000 while a more eco-friendly 90-93% high-efficiency boiler costs over \$10,000. Even though a high-efficiency boiler will reduce gas bills and usage, the recovery of the up front cost difference is too slow for the family to afford at the moment of replacement. In this case, the family must weigh availability of limited resources against long-term financial and environmental payoff.

This conflict also recalls the dilemma presented to four-year-olds by the Stanford Marshmallow experiment in 1990, in which researchers left each child alone in a room with a marshmallow. They were allowed to eat it; however if they could wait 20 minutes for the return of the researcher, they would be rewarded with two marshmallows.

### Design Strategies

Remove differences between long- and short-term goals

Reduce differences between long- and short-term goals

Create resource pool large enough to accommodate both long- and short-term goals at the same time

Demonstrate value of long-term goals

Clarify similarities and differences between long-and short-term goals and needs

### Solution Elements

**E** Goal Tracker

**S** Balance

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Operations

### Activity

Administering

### Originator

Jennifer Lee

### Contributors

### Sources

Grava, Sigurd. **Urban Transportation Systems.**  
Chicago: McGraw-Hill, 2003.  
Lueck, Thomas J. *Experts Debate Proposed Fare Increases.* New York Times, August 6, 1995, New York and Region section, online edition. <http://query.nytimes.com/gst/fullpage.html?res=990CE2DF1530F935A3575BC0A963958260&sec=&spoon=&pagewanted=all> (accessed October 6, 2008).

### Associated Functions

- 08. Establish goals
- 09. Assess needs
- 11. Identify resources
- 12. Gather resources
- 13. Allocate resources

### Observation

With user fares and charges as a major source of revenue for transportation systems, there is often a conflict between providing accessible, low cost services and covering the cost of operating such a complex system.

### Extension

In order to maintain operations of extensive transportation systems, many urban areas charge fares to users. As operations costs rise with growing cost of materials, inflation, and expansion projects, fare increases often appear to be the most straightforward solution to prevent deterioration of the system (Grava 2003, 446-8).

However, fare increases can have a negative impact on the system as well. According to a study released in New York City in 1995, "for every 10 cents that bus and subway fares have been increased over the last 25 years, the transit agency has suffered a setback, sometimes only temporary, of 60 million passengers a year" (Lueck 1995). Decreased ridership leads to decreased revenue. Increased use of automobiles is another effect if the cost difference between fare and gasoline decreases, leading to rises in pollution and traffic congestion.

### Design Strategies

Utilize alternate sources of funding - employers, other taxes, reduce fare in some places, increase in others

Eliminate conflict

Reduce conflict

Incentives & credits for ridership

Make benefit immediate

### Solution Elements

**E** Pay as You Drive insurance

**S** Zero Fare

**S** Trash Fare

**E** Distance-based fare

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Operations, Maintenance, Adaptation

### Activity

Administering, Inspecting, Redefining

### Originator

Jennifer Lee

### Contributors

### Sources

Regents of the University of California. *Personal Environmental Impact Report*. University of California Los Angeles. <http://peir.cens.ucla.edu> (accessed October 6, 2008).

Personal observation

### Associated Functions

- 08. Establish goals
- 09. Assess needs
- 14. Evaluate quality of system
- 26. Establish quality requirements
- 27. Monitor system components
- 96. Gather & interpret data

### Observation

In a large system, gathering and managing information for evaluation is difficult, and many systems rely heavily on quantitative data.

### Extension

Quantitative research can be a relatively efficient method of gathering large amounts of data from the system. However, utilizing qualitative research may help build a more robust understanding of the system from multiple user perspectives, and understand the "why" behind the numbers. However, qualitative data can be time consuming to gather and challenging to use for setting objective standards.

It is also important to find ways to gather information about what part of the system may not be effectively utilized — understanding users who opt out of the system, or recognizing which options are considered before an ultimate choice is made and why.

When it comes to system components specifically, some weaknesses are not easily observable or measured without more holistic information gathering. For example, it can sometimes be difficult to measure things like the level of stress on an old part or the level of decay of a wooden beam on a station platform.

### Design Strategies

Find and encourage new sources for qualitative data

Don't wait on symptoms to act

Test working samples

Develop new ways to evaluate decay

Build flexibility into current evaluation practices

### Solution Elements

**M** Participatory Feedback

**M** Response Incentive

**M** Open Inspection Rubrics

**M** Rubric Revisions

**M** Automatic Replacement

**S** Malfunction Cues

**S** System Biopsy

# Design Factor

Sometimes responsibilities/capabilities unclear

120

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations

## Activity

Coordinating

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

## Sources

Darley, J.M , Teger, A.L. & Lewis, L.D. "Do Groups Always Inhibit Individuals Responses to Potential Emergencies.." Journal of Personality and Social Psychology 26, no. (1973): 395-399.

## Associated Functions

22. Specify organizational relationships  
23. Gather data  
25. Communicate between system components

## Observation

When capabilities overlap or new situations arise, responsibilities can become unclear.

## Extension

When more than one division is capable of performing the same task, many times both parties assume the other will take care of it. This confusion can cause tension between departments or result in task neglect. John Darley's seminal 1973 article in the Journal of Personality and Social Psychology first identified this trend. When roles are unclear, responsibilities are diffused among bystanders. In other words, the more people are ambiguously involved in a task, the less likely is one person to step up and take action. This is why one is more likely to get help with a flat tire on a lone country road than on a busy highway - we all assume that someone else will help unless we perceive ourselves to be the victim's "only hope." This phenomenon is why things often "fall through the cracks" in an organization. What steps can Responsive Transport take to deal with ambiguous or overlapping responsibilities?

## Design Strategies

Make capabilities explicit  
Foster helpfulness  
Decide overlaps based on availability

## Solution Elements

- S** Explicit Capabilities:  
Reduce confusion by making the functions of every unit visible
- S** Interdepartmental Job-sharing:  
Reward working together and sharing responsibilities
- S** Demand-based Coordination:  
In cases of overlap, assign tasks based on workload

# Design Factor

Departments use different communication and info technologies

121

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations

## Activity

Coordinating

## Originator

Andy Conrad

## Contributors

Prashant Desai    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee      December 10, 2008

## Sources

Price, Amy. "Florida Department of Transportation: Citrix Implementation." [www.dot.state.fl.us](http://www.dot.state.fl.us) (accessed December 10, 2008).

## Associated Functions

24. Manage information  
25. Communicate between system components

## Observation

Parts of the system may use different technologies to perform their tasks, making coordination difficult.

## Extension

Police carry their own devices, Surveyors carry their own devices, and Maintainers carry their own devices. When everyone needs to communicate or share information, how do these technologies interact?

New system-wide software, hardware, and training pose quite a challenge. The Florida Department of Transportation recently unified the way it manages its 7 Districts and 2,939 distinct userIDs with a program called Citrix (Price, 2008). Although syncing technologies requires a significant initial investment in hardware, software, and training, the errors reduced and time saved easily outweigh the expense. Rather than continuing to fumble translations from one system to another, how can the system create a unified network of centrally-managed hardware, software, and communication devices?

## Design Strategies

Change the hardware  
Change the software  
Change the interaction

## Solution Elements

- S** System-wide Hardware Sync:  
Everyone carries the same hardware with customized software
- S** System-wide Software Sync:  
Everyone uses the same software
- S** Information Translation Hub:  
Everyone keeps current hardware and central hub translates info between devices

# Design Factor

Cannot establish parameters/requirements around unforeseen events

122

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Maintenance

## Activity

Inspecting, Monitoring

## Originator

Andy Conrad

## Contributors

Prashant Desai    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee       December 10, 2008

## Sources

Team deliberation

## Associated Functions

26. Establish quality requirements  
27. Monitor system components

## Observation

The system can only inspect or monitor for things that it knows can go wrong.; unforeseen problems cannot be inspected or monitored for.

## Extension

Consider recent bridge collapses, the Leaning Tower of Pisa, and increased natural disasters. Additionally, some system failures show no warning signs to monitor. These incidents become disasters because of a lack of knowledge about what might go wrong. So long as we know what kinds of things to expect, we can certainly prepare protocol. However, the system cannot inspect or monitor for potential problems that have yet not been conceived of or experienced. Rather than being limited to addressing things that have happened in the past or are already beginning to malfunction, the Responsive Transport system must create protocols that mitigate the occurrence of novel situations.

## Design Strategies

Increase awareness  
Test harder  
Identify risk  
Respond faster  
Expect the unexpected

## Solution Elements

**M** Continually Increase Awareness:  
Investigate disasters/problems in other contexts/countries in order to increase perspective

**M** Extreme Testing:  
Test systems at a level of extreme use or user error in order to reveal system vulnerabilities

**S** Failure Risk Levels:  
Monitor other concurrent factors to prepare for possible failures

**M** On-call Maintenance:  
Have a maintenance response prepared to immediately respond to novel or unforeseen failures



# Design Factor

Human attention extremely limited for routine "monitoring" tasks

123

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Maintenance

## Activity

Inspecting

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jenny Lee	December 10, 2008

## Sources

Huang, L. Q.. "Attention capacity and task difficulty in visual search." *Cognition* 94, no. 3 (2005): B101-B111.

Johnson-Laird, Philip. "Peter Wason" Psychological pioneer of human reasoning who rescued his subject from the dark days of behaviourism . " April 25, 2003. [www.guardian.co.uk/news/2003/apr/25/guardiano-bituaries.highereducation](http://www.guardian.co.uk/news/2003/apr/25/guardiano-bituaries.highereducation) (accessed December 10, 2008).

## Associated Functions

27. Monitor system components

## Observation

Humans become disinterested and easily distracted when a task is too simple or repetitive.

## Extension

If the system relies on humans to perform lengthy, repetitive inspections, information will be unreliable due to the limits of attention for visual search tasks (Huang, 2005). This is especially true in tasks like inspections where the difference between "ok" and "not ok" can be very subtle. Peter Wason, a cognitive psychologist also wrote of "Confirmation Bias" or "Expectancy Bias" (Johnson-Laird, 2003). This psychological effect occurs when researchers seem to only notice what confirms their assumptions or hypothesis. Things that are dissonant are more easily ignored. Because inspectors find 99% of equipment in good working condition, it becomes increasingly difficult to notice the 1% in need of repair. For example, if during an inspection, 12,457 bolts on a track meet requirements, will the inspector notice the 12,458th bolt which happens to be loose? How should the Responsive Transport system address the limitations of human cognition in the context of inspections?

## Design Strategies

Combat boredom with routine of inspections

Make search more "obvious" or easy

Shift responsibility from humans

## Solution Elements

**S** Shared Monitoring:  
Monitoring tasks should be divided and shared between participants to decrease length of inspections and boredom

**S** Malfunction Cues:  
Build signals into system or materials (e.g. bolts turn green when fully tight)

**S** Automated Inspections:  
Where possible, rely on system features to reveal anomalies

# Design Factor

Some anomalies may not fit rubrics and go unreported

124

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Maintenance

## Activity

Inspecting

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jenny Lee	December 10, 2008

## Sources

Team deliberation

## Associated Functions

26. Establish quality requirements
27. Monitor system components
28. Report observations
29. Highlight anomalies

## Observation

When an inspection reveals something that protocol hasn't addressed, the system or inspector may ignore it.

## Extension

Inspections compare current observations to some established criteria. Inspectors (both human or automatic) will likely ignore anything not accounted for in the comparison protocol. For example, if I have only been instructed to check for twisted sprockets on Widget A, and my reporting tools and communication structure are only designed to let me report about Widget A, I have no established way to report things that I noticed during my inspection about Widget B. Currently, this information is passed on informally, if at all, meaning that this additional information may be lost or ignored. Narrow rubrics lead to narrow inspections and thus, shortsighted diagnoses and repairs.

## Design Strategies

- Make rubrics more open-ended
- Keep rubric fresh
- Make a better rubric
- Encourage new observations

## Solution Elements

<b>M</b> Open Inspection Rubrics: Include open-ended questions or ways to document additional findings	<b>S</b> Inspector Exchange: Continually swap domains of human inspectors and reward new observations
<b>S</b> Rubric Revisions: Continually revise rubric so that criteria doesn't become outdated	
<b>S</b> Rubric Consultants: Bring in third parties to offer new perspectives	

# Design Factor

System may deteriorate further between inspection and repair or replacement

125

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Maintenance

## Activity

Inspecting

## Originator

Andy Conrad

## Contributors

Prashant Desai December 10, 2008  
William Huang December 10, 2008  
Jenny Lee December 10, 2008

## Sources

Team deliberation

## Associated Functions

31. Identify maintenance need

## Observation

The delay between inspecting and repairing/replacing may render the recommendation obsolete.

## Extension

Ideally, repairs would be conducted immediately after being diagnosed. However, in the real world, there is often a delay between the time of inspection and the time of corrective action. After an inspection is conducted, a higher committee may have to decide if a repair versus replacement is justified. Next, a budget must be established. Depending on the scale of budget required, this one step can delay repairs for years until funding is acquired. Then, replacement parts may need to be ordered and crews must be hired. Only after all this can repairs begin. Meanwhile, the system may have deteriorated further, which leads to a change in diagnosis, regressing the project back to where it began. How can the system minimize the effects of delay between inspections and repairs?

## Design Strategies

Minimize the gap  
Check for changes  
Triage needs

## Solution Elements

- S** Inspection Expirations:  
Use timestamp to mark for how long an inspection is valid
- S** Pre-work Inspections:  
Inspect system again just before maintenance to ensure situation has not changed
- S** On-call Maintenance:  
Keep supplies and crews on-hand so that maintenance can be performed immediately
- S** Inspection Triage:  
Identify time-critical maintenance needs and conduct these repairs/replacements first

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Operations, Maintenance

### Activity

Administering, Repairing, Replacing

### Originator

Jennifer Lee

### Contributors

### Sources

Cooper, Michael. *The Mayor's Budget Proposal: Overview; Bloomberg Seeks Cuts in Spending at Most Agencies*. New York Times, February 14, 2002, Education section, online edition. <http://query.nytimes.com/gst/fullpage.html?res=9901E0DD143FF937A25751C0A9649C8B63&sec=&spoon=&pagewanted=all> (accessed December 9, 2008).

Personal observation

### Associated Functions

- 09. Assess needs
- 10. Delegate authority and responsibility
- 11. Identify resources
- 12. Gather resources
- 13. Allocate resources
- 32. Gather repair resources
- 34. Make repairs
- 38. Select substitute

### Observation

Resources are not always available when you need them.

### Extension

A fundamental problem shared by a majority of systems and institutions is the lack of resources. Money, materials, and personnel are just a few examples of the basic resources that commonly fall short of ideal needs. Moreover, the more complicated a system is, the more challenging it maybe to accurately anticipate what resources will be needed in the short- and long-term future.

Several different problems can arise from a lack of resources such as internal and external conflict over what resources may exist, or disruptions to activity or service before a new stream of resources can be found. For example, after the tragedy of September 11, 2001, New York City faced a \$4.76 billion deficit which it responded to with cuts and reductions in services in nearly every agency across the city including schools, libraries, recycling, and firehouses - a less than ideal set of decisions that had to be made as a result of limited resources.

### Design Strategies

Find appropriate substitutes for limited resources

Manage existing resources more effectively

Generate resources

### Solution Elements

**E** Spare Tire

**M** Resource Generator

**M** Dynamic Inventory Management

# Design Factor

Risk of harm to people performing maintenance

127

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Maintenance

## Activity

Repairing, Replacing

## Originator

Jennifer Lee

## Contributors

## Sources

Bureau of Labor Statistics.  
*Census of Fatal Occupational Injuries Summary, 2007*. U.S. Department of Labor. <http://www.bls.gov/news.release/cfoi.nr0.htm> (accessed December 9, 2008).

Personal observation

## Associated Functions

33. Recycle or dispose of unneeded parts
34. Make repairs
35. Test repair
39. Recycle or dispose of old parts
40. Make replacement
41. Test replacement

## Observation

Some aspects of system maintenance are hazardous and can result in harm to the person performing repairs or replacements.

## Extension

In 2007, a total of 5,488 fatal work injuries were reported in United States. Of those fatalities, approximately 25% involved workers in transportation and material moving occupations. In a transport maintenance setting, working with heavy machinery and infrastructure components or on highly repetitive tasks are just a few examples of exposing workers to potential harm.

While workplaces are required to do as much as possible to reduce the risk of harm to employees and some forms of compensation for work-related injury exist, risk of injury is an inevitable possibility that humans must accept in today's current maintenance practices.

## Design Strategies

- Reduce or remove risk
- Remove person from risky situation

## Solution Elements

- E** Automated On-Call Mechanics

# Design Factor

Uncomfortable journey

128

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Traveling

## Originator

Jennifer Lee

## Contributors

## Sources

Personal observation

## Associated Functions

54. Experience journey

## Observation

During travel, the journey can be uncomfortable. Depending on the transport mode, discomfort can be attributed to a variety of different sources.

## Extension

When it comes to travel, complaints are unfortunately abundant; many of these concerns are comfort-related. For example, in a city like Chicago the winter months can often make biking and walking cold, wet, and generally miserable experiences. Even waiting for buses or trains can become a cold and wet experience when stations and stops expose passengers to the elements. In the summer, extreme temperatures and humidity likewise cause much discomfort.

Other sources of travel discomfort are low light levels that make activities such as reading difficult. Noise from vehicles or other passengers can reduce one's ability to concentrate or even relax. Moreover, seats can be limited on mass transit vehicles while positioning of bars for crowded standing passengers are not optimally placed for comfortable rides.

## Design Strategies

Reduce discomfort

Protect passengers from the elements (of weather)

Compensate for discomfort with other more attractive aspects of transportation

## Solution Elements

**E** Separated & Protected Lanes & Walks

**M** Delightful Distractions

**E** Sun Roofs

**E** Amenities

**S** Trans Music

**E** Noise Cancellation

# Design Factor

Other users affect journey

129

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Traveling

## Originator

Jennifer Lee

## Contributors

## Sources

Personal observation

## Associated Functions

54. Experience journey

## Observation

On mass transit modes of transportation, other users can affect the journey both positively and negatively.

## Extension

The urban environment is often characterized by its high population density, which forces citizens to interact with one another in a variety of settings including on public transportation. While these interactions can often be described as negative in nature, there are also possibilities for positive interactions.

Train rides are sometimes avoided specifically because of the lack of privacy afforded in crowded cars; cell phone conversations are overheard, noise from nearby passengers can make a ride less relaxing or prevent riders from concentrating on tasks such as reading. Rush hour crowds contribute to an uncomfortable journey, and some fear that late night rides can be disturbed by general security issues. Moreover, careless drivers, bikers, and walkers can sometimes increase risk of accidents on the road.

However, it should also be noted that this same community of riders and passengers can offer positive experiences during travel. Interacting with other people offers the opportunity to get help with directions, to receive assistance when problems arise, and to meet new people and neighbors.

## Design Strategies

Promote more positive interactions

Reduce discomfort caused by other users

Reduce the number of riders on a given mass transit vehicle

Provide for more space or privacy options

Reduce careless riding/driving of others

## Solution Elements

**S** FrTs

**S** Privic Transportation

**M** Auto Pilot

**E** Mini Train Cars

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Operations, Protection

### Activity

Regulating. Preventing

### Originator

Jennifer Lee

### Contributors

Andy Conrad	September 29, 2008
Prashant Desai	September 29, 2008
William Huang	September 29, 2008

### Sources

Williams, Timothy and Sewell Chan. *In New Security Move, New York Police to Check Commuters' Bags.* **New York Times**, July 21, 2005, New York/Region section, online edition. <http://www.nytimes.com/2005/07/21/nyregion/21cnd-security.html?scp=8&sq=search%20subway&st=cse> (accessed September 29, 2008).

Marta, Suzanne. *New Security Scan at DFW Airport has Privacy Advocates Worried.* **QuickDFW.com**, June 13, 2008. <http://www.quickdfw.com/sharedcontent/dws/bus/stories/061308dnbustascans.fcd920.html> (accessed September 29, 2008).

### Associated Functions

17. Identify violations  
71. Monitor activity

### Observation

The process of monitoring user activity within the system can sometimes violate one's right to privacy.

### Extension

There are various methods to monitor the activity of a transport system and its users, some more invasive than others. This is necessary to a certain degree; in order to act swiftly to prevent a problem from occurring or reducing its harmful impact, the system must be highly aware of activity. For example, cameras to monitor train platforms can be used to identify problems and alert the need for police or fire intervention.

However, it is difficult to draw the line between monitoring for the sake of system security and monitoring that begins to infringe on users' civil liberties. For example, in New York City, police began to randomly check bags of subway riders at various stations in an effort to deter bombing attempts after the events of September 11. However, if bags were checked and showed evidence of other types of illegal activity such as illegal drug use for example, citizens could be arrested for those crimes as well. Citizens could refuse bag checks, but would not be allowed to enter the station. Questions were also raised around how the random search process would work to avoid racial profiling. Since the checks began in 2005, lawsuits have been filed arguing the Fourth Amendment's protection against unreasonable search and seizure.

### Design Strategies

- Minimize invasive of monitoring
- Offer non-monitored transport alternatives
- Monitor only for specific objectives (e.g., security but not drug use)
- Make monitoring more transparent & objective
- Eliminate human bias in monitoring
- Monitor all or none, not just some

### Solution Elements

- M** Targeted Scanners
- M** OptOut
- E** Selective Monitoring



**Project**

Chicago Vision for the Future:  
Responsive Transport

**Mode**

Protection

**Activity**

Preventing

**Originator**

Jennifer Lee

**Contributors**

**Sources**

Macdonald, R. Spencer. *Rational Profiling in America's Airports*. **BYU Journal of Public Law** XVII (2003), <http://www.law2.byu.edu/jpl/Vol%2017.1/Macdonald%20pdf.pdf> (accessed December 8, 2008).

**Associated Functions**

72. Identify risks

**Observation**

Risk identification can sometimes be a subjective process.

**Extension**

Predicting and identifying risks is not a perfectly objective science. Those who monitor the system are sometimes subject to their own personal biases and intangible "gut feelings" to help them in the process of identifying potential risks. Unfortunately, while there may be some times when such instinct maybe helpful to averting risk, incorrectly identifying a potential problem can prove to be a waste of resources, energy, and efficiency. Furthermore, it may unfairly subject some people to unnecessary harassment.

One salient example in today's world is the controversy surrounding racial profiling in America's airports where terrorism is a theme of wide concern. Debates swirl around appropriateness and legality of basing security profiles on characteristics such as race, gender, and age. On one side is the concern that constitutional rights are violated if such profiling is allowed, while the other side argues that such information helps contribute to building patterns of information that could potentially reduce risk of harm in the future. Unfortunately this is a controversy that has not yet been resolved, nor will it be in the near future.

**Design Strategies**

Target all or target none for monitoring

Use objective and/or quantifiable information points for risk identification

**Solution Elements**

**M** Leveled Risk Identifier

**M** Targeted Scanners

# Design Factor

Effective operator safety training can be inconsistent

132

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Preventing

## Originator

Jennifer Lee

## Contributors

## Sources

Personal observation

## Associated Functions

73. Train system operators

## Observation

Effective emergency training of system operators can be inconsistent.

## Extension

System operators are expected to work reliably and consistently in order to effectively protect passengers. However, training and action can be inconsistent for a variety of reasons.

It can be difficult to sustain interest and attention to detail if tasks are repetitive. If operators are asked to work on several tasks simultaneously, they may not have the capacity to respond in an effective or timely manner. Additionally, differences in judgment are another cause for inconsistency in emergency action and response. What makes this issue even more challenging is that one can never fully anticipate how a person will behave in the case of an actual emergency; simulations and practice are limited in predicting how consistent or effective emergency training programs are.

## Design Strategies

Automate emergency responses

Partner automated response with human judgment

Provide supports, guides, or prompts to operators in the moment of emergency

## Solution Elements

**E** Semi-Automated Operators

# Design Factor

Backup solutions can burden regular system operations

133

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Preventing

## Originator

Jennifer Lee

## Contributors

## Sources

Personal observation

## Associated Functions

74. Generate backup solutions  
75. Test and maintain backup systems

## Observation

Backups are necessary and helpful to damaged systems, but can be a burden to regular system operations.

## Extension

Backup systems seem to be a logical solution to dealing with and anticipating problems. For example, most personal computers in today's world have built in capabilities to recover damaged systems and to scan machines periodically in order to prevent potential harm.

However, backup systems can be costly; in other cases backup systems can interfere with the efficiency of regular operations. To continue the example introduced above, one major complaint about anti-virus software and other backup and recovery processes is that they interfere with daily use by slowing down machines and also do not seem worth the cost as compared to the odds of a problem occurring. Unfortunately, lessons learned about the value of backup capabilities can sometimes come at an even higher cost.

## Design Strategies

Make backup capabilities available only as needed

Make backup capabilities nearly invisible when not in use

Make back up capabilities unnecessary

## Solution Elements

**S** Graduated BackUp

**S** Self-healing Systems

# Design Factor

Public education of emergency protocol not effective

134

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Communicating

## Originator

Jennifer Lee

## Contributors

## Sources

Chang, Yu-Hern, and Meng-Yuan Liao. 2008. *Air passenger perceptions on exit row seating and flight safety education*. *Safety Science* 46, no. 10 (December), [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6VF9-4RDBYX5-2&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=93cbf3b5a6a048ff0c41c18464ce2efc](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VF9-4RDBYX5-2&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=93cbf3b5a6a048ff0c41c18464ce2efc) (accessed December 10, 2008).

Personal observation

## Associated Functions

77. Educate public

## Observation

Oftentimes, emergency protocol is not effectively communicated to the general public.

## Extension

Sometimes it can be difficult for a system to effectively communicate general safety information to passengers. Since major emergencies are not a regular occurrence, knowledge of emergency protocol is not a priority for most regular commuters. Convincing riders to carefully review complicated safety procedures can sometimes be a challenge, and public education often becomes a passive set of signs posted inside a vehicle or in the corner of a bulletin board.

Safety regulations abound, but regulations cannot force effective education and learning. For example, airlines are required to review safety information at the beginning of every flight, but one look around shows that the majority of passengers choose not to pay close attention to the information because of the belief that the information will most likely not be useful or relevant to their short flight. Moreover, passengers regularly request to be seated in emergency rows, but those requests are usually motivated by the desire for more legroom rather than an active hope to assist with evacuation should a problem occur. Studies show that there still remains misunderstanding about exit row requirements and obligations.

## Design Strategies

Make emergency response intuitive

Provide emergency instructions as necessary or relevant to the situation

Periodically assess passenger knowledge of emergency protocol

Increase presence of trained people to help in moments of emergency

## Solution Elements

 Bird in Hand

 Passenger Education Requirements

# Design Factor

Delay between detection, processing, & reaction amplifies problem

135

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations, Protection

## Activity

Optimizing, Communicating

## Originator

Jennifer Lee

## Contributors

Prashant Desai                      December 8, 2008

## Sources

Dwyer, Jim et al. *Why police made it out of the World Trade Center when firefighters didn't*. New York Times, online. <http://www.scanboston.com/fdny911problems2.htm> (accessed December 9, 2008)

## Associated Functions

01. Monitor traffic
05. Implement adjustments
06. Gather feedback
78. Process feedback
79. Alert system of emergency mode
80. Monitor and report response progress
81. Coordinate emergency response components
82. Update system status

## Observation

Poor communication that results in a delay between detection, processing, and reaction can amplify a problem. Harm to communication systems during an emergency situation in particular often only exacerbates emergency problems.

## Extension

Effective communication is backbone to any system. In order for communication to be effective, it needs to be swift, accurate, and easy to access. Unfortunately, this is not often the case with complex communication systems, especially when they need to work with and for a variety of users in a range of situations. When it comes to situations such as traffic optimization, a situation can emerge and continually shift quite rapidly. If a system cannot detect, process, and react to problematic situations with minimal delay, then responses can become ineffective, or even worse, contribute to more problems.

Especially in a case of emergency, damage to a communication system can lead to grave repercussions. One striking and tragic example of this is when, as described by the New York Times, firefighters did not receive early warnings to leave the World Trade Center on September 11, 2001 due to a failed radio network, resulting in the death of at least 121 firefighters.

## Design Strategies

Make delay of communication inconsequential

Reduce or eliminate delay

Establish back up solutions for failed or ineffective communication

Provide alternate options to ineffective communication

## Solution Elements

**E** Pre-packaged Response

**M** Polycentric Optimization Control

**S** Early Adjustment

**M** Remote Artificial Intelligence

**S** Self-healing Communications

**M** Graduated Backup

**S** Info/Action Coordination

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Protection

### Activity

Communicating, Responding, Securing

### Originator

Jennifer Lee

### Contributors

### Sources

Dwyer, Jim et al. *Why police made it out of the World Trade Center when firefighters didn't*. New York Times, online. <http://www.scanboston.com/fdny911problems2.htm> (accessed December 9, 2008)

### Associated Functions

- 78. Process feedback
- 80. Monitor and report response progress
- 81. Coordinate emergency response components
- 82. Update system status
- 84. Manage/Authorize Emergency Resources
- 85. Protect users from immediate harm/danger
- 86. Contain Emergency
- 91. Assist victims

### Observation

Coordination and information sharing between many agencies is difficult. If this cannot be managed effectively, the efforts of any and/or all involved agencies can be undermined.

### Extension

In a majority of circumstances, various agencies are established as independent entities to help organize and separate functions within a larger city system. This separation of agencies may be a difference in services (e.g., police, fire, medical response) or a difference in jurisdiction or scope (e.g., local, regional, national). However, in a case of emergency, it may become necessary that these distinct agencies coordinate to contribute to a unified effort.

This is most evident when large scale disasters occur. If information and communication is not well coordinated, one encounters a situation in which the right hand knows not what the left hand is doing; efforts can be duplicated, or holes in action are created. Responses can become ineffective, or even worse, contribute to more problems.

One striking and tragic example of this is when, as described by the New York Times, police radios received earlier warnings to leave the World Trade Center on September 11, 2001, but firefighters did not receive those warnings, resulting in the death of at least 121 firefighters. This was due in part to the lack of a pre-planned incident command system and also unlinked communication systems between police and fire officials.

### Design Strategies

- Link communication across agencies
- Consolidate agencies

### Solution Elements

- S** Info/Action Coordinator
- M** Distributed Service Centers

# Design Factor

System may be incapacitated or inoperable

137

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Securing

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jennifer Lee	December 10, 2008

## Sources

Team deliberation

## Associated Functions

90. Evaluate situation  
91. Assist victims  
93. Restore system

## Observation

Depending on the extent of damage/emergency, the system may be unable to evaluate itself or assist victims.

## Extension

If certain parts of the system are incapacitated, attempts at restoring normalcy cannot begin. Communication hubs or centers of control will be crucial for coordinating an Emergency Response. If these become inoperable, Chicago cannot manage it's own recovery. If communication hubs are intact yet infrastructure is severely damaged, responders may not have access to make repairs or assist victims. Collapsed tunnels, fallen bridges, or lack of power may prevent responders from reaching their targets. The basic problem in both scenarios is that emergency situations have the potential to reduce or completely erase planned emergency response methods.

## Design Strategies

- Distribute dependencies
- Monitor via many channels
- Equip passengers to help themselves
- Make system more accessible
- Facilitate on-board response

## Solution Elements

<p><b>S</b> Emergency Response Network: Train neighboring cities on how to restore service to local systems</p>	<p><b>M</b> Multiple Access Points: Provide periodic access to system infrastructure</p>
<p><b>S</b> Multi-channel Emergency Status: Provide multiple ways to evaluate status of system in crisis states</p>	<p><b>S</b> Multi-mode Response: Prepare both on-road, off-road, water, and air-support methods</p>
<p><b>S</b> Passenger Education Requirements: Like driver licensing, require passengers to understand certain emergency contingencies before boarding mass transit</p>	<p><b>S</b> On-board Disaster Supplies: Equip remote aspects of system with safety equipment and disaster supplies</p>

# Design Factor

System may not have access to information required to respond

138

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Securing

## Originator

Andy Conrad

## Contributors

Prashant Desai    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee      December 10, 2008

## Sources

Team deliberation

## Associated Functions

92. Prioritize response to vital functions

## Observation

The system cannot prioritize a response if it lacks necessary information.

## Extension

In order to prioritize a plan of action to restore vital functions, the system must have access to status information. If the system is unaware of what vital functions have been damaged, it cannot make decisions about what to restore first. This lack of information could even result in further catastrophe. For example, if the system tries to route emergency services through a subway but is unaware that subway trains are without power and on fire, they could be sending the response team to a fiery entrapment. For these reasons, Responsive Transport must find alternate ways to gather information when primary methods of gathering data are unavailable.

## Design Strategies

Execute blanket checklists

Monitor via many channels

Make it easy to gather information

## Solution Elements

- M** Emergency Checklists:  
When damage reports are unavailable, execute a checklist for all vital functions
- S** Multi-channel Emergency Status:  
Provide multiple ways to evaluate status of system in crisis states
- S** Easy-Access Damage Reports:  
Provide non-electric, easy-access gauges to quickly gather info



# Design Factor

Restoring and testing system may take too long

139

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Securing

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jenny Lee	December 10, 2008

## Sources

Davis, Robert. "The price of just a few seconds lost: People die." May 20, 2005. [www.usatoday.com/news/nation/ems-day2-cover.htm](http://www.usatoday.com/news/nation/ems-day2-cover.htm) (accessed December 10, 2008).

## Associated Functions

93. Restore system  
94. Test and validate system

## Observation

Delayed response times put lives at risk.

## Extension

According to a study by USA Today, more than 1,000 "saveable" lives are lost needlessly each year in the nation's biggest cities because of inefficiencies in the cities' emergency medical transport systems (Davis, 2005). When this study aired, it was titled "Six Minutes to Live or Die" and tracked response times for EMS runs across the country. When the human body is in such a critical state, it seems that every second matters. It is imperative that the Responsive Transport has the ability to respond quickly to emergencies large and small.

## Design Strategies

Reduce response time  
Bring responders closer  
Lengthen timeline

## Solution Elements

- S** Contractor Network:  
Create network of "on-call" contractors ready to assist in crisis
- S** On-board Responders:  
Staff mass transit with emergency responders
- S** First-aid Stations:  
Equip system infrastructure with medical kits to increase survival rate of victims

# Design Factor

Difficult to determine what infrastructure is worth saving

140

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation

## Activity

Evolving

## Originator

Andy Conrad

## Contributors

Prashant Desai	December 10, 2008
William Huang	December 10, 2008
Jenny Lee	December 10, 2008

## Sources

Team deliberation

## Associated Functions

103. Assess existing infrastructure  
104. Generate viable options  
106. Identify resources needed

## Observation

At what point does the system determine that the existing infrastructure is no longer viable?

## Extension

To keep costs low, the system should try to use or adapt existing infrastructure when expanding. However, at some point, population demand, advances in technology, or environmental concerns may demand dramatic transformations. With disparate values around how money should be spent on the system, the decision to upgrade or downgrade service certainly poses a difficult question. Additionally, where is the line between "We can build onto what already exists" versus "We must tear this down and start anew." When dramatic changes occur (such as the introduction of electricity), it may be obvious or even required to make significant change. But when there exists no such impetus, what should be the system's attitude toward evolution and development?

## Design Strategies

Set thresholds for destructive renovations

Allow public to decide

## Solution Elements

**S** Renovation Threshold:  
Any destructive renovations must improve overall system performance by at least X %

**S** Scaled Renovations:  
Approve any construction that causes more good than harm

**M** Democratic Renovations:  
Public is formally polled when a proposal affects the entire system

# Design Factor

Expanding means destruction of nature or current developments

141

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation

## Activity

Evolving

## Originator

Andy Conrad

## Contributors

Prashant Desai    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee      December 10, 2008

## Sources

Team deliberation

## Associated Functions

104. Generate viable options

## Observation

Expanding service/coverage means breaking new ground and demolishing existing homes and businesses in the path of the project.

## Extension

A Responsive Transport should support, not destroy, the livelihood of its users. Unfortunately, adding transportation to the city sometimes means first creating a new path. Even when modes are suspended, support infrastructure must touch the earth at some point. This intersection between new and old creates conflict when expanding. While the increased transportation coverage is good for residents, no one wants to have their home or green spaces bulldozed. Afterall, routes may change but the damage remains. How should the transportation system expand with minimal impact on both man-made and natural environments?

## Design Strategies

Compensate for relocations  
Incent cooperation  
Make positive contributions to nature  
Build intelligently and considerately

## Solution Elements

- S** Relocation Compensation:  
The system will cover the cost of any required relocations
- S** Financial Incentives:  
Offer tax credits to any residents whose property values drop due to renovations
- S** Environmental Contributions:  
New construction will feature the natural environment or include green/sustainable features
- S** Intelligent Impacts:  
The system should conclusively optimize any expansion for minimal environmental impact and longevity of service

# Design Factor

Opinions may change later and stop a project in progress

142

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Adaptation

## Activity

Evolving

## Originator

Andy Conrad

## Contributors

Prashant Desai    December 10, 2008  
William Huang    December 10, 2008  
Jennifer Lee       December 10, 2008

## Sources

Richards, Brian. Future Transport in Cities. 1 ed. Taylor & Francis, 2002.

## Associated Functions

105. Align stakeholders  
107. Coordinate activity and budget

## Observation

Finding and keeping consensus among parties with varied interests can prove difficult.

## Extension

It is very likely that Corporation X has very different goals for the system than Resident Y. Bringing the public, the government, system administration, and third parties into alignment can prove challenging, if not impossible. Furthermore, once alignment is achieved, parties can change their positions. An example of this is the Embarcadero freeway in San Francisco, CA. The freeway was voted down after construction had began (Richards, 2002). The incomplete structure was later repurposed as Herb Caen Way, a 3.2 mile pedestrian promenade along the beach. However, wasting money and time on projects that may later be defeated is an atrocious growth strategy. How should the Responsive Transport system find and keep consensus among stakeholders?

## Design Strategies

Offer better solutions to preclude debate  
Test/prototype solutions to foresee problems  
Wait longer to build

## Solution Elements

**S** Pre-compromised Proposals:  
Try to minimize conflicts before making proposals by researching the values of all stakeholders

**M** Test Zones:  
Conduct public tests of proposals so that adverse reactions cause less damage

**M** Project Incubation Periods:  
Allow time for parties to change their minds or conduct multiple polls before building

# Design Factor

May be difficult to pass laws and regulations

143

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations

## Activity

Regulating

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

15. Set parameters

## Observation

Regulating the city involves setting parameters and laws/regulations may take a long time to pass or may never pass.

## Extension

Passing laws and regulations is a time consuming process that involves consensus of multiple parties in bureaucracy. Policy makers often have external pressures from corporations who have interests and agendas of their own.

## Design Strategies

Decentralizing will make protocols more efficient.

## Solution Elements

**E** Decentralized Bureaucracy

# Design Factor

System efficiency can be affected while enforcing protocol

144

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Operations

## Activity

Regulating

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

18. Enforce protocol

## Observation

While law enforcement is dealing with the offender, traffic may be slowed or halted by passing system users.

## Extension

When a car is pulled over by the police, other vehicles often slows down to watch the action as they pass by. This not only causes traffic congestion but can also be dangerous.

## Design Strategies

Deal with the offender as discretely as possible

Make a record and deal with the offender later

## Solution Elements

**M** Enforce Discretely

**S** Enforce Later

# Design Factor

Payment methods can be unclear and inconvenient to users

145

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Departing

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

48. Transaction for departure

64. Transaction for arrival

## Observation

Payment methods are different between transportation system, causing confusion and inconvenience for users.

## Extension

In the current Chicago public transportation system, there are several different types of transaction methods such as the Chicago Card, magnetic swipe card and cash. This system is confusing and slows people down when they purchase cards, going pass gates and boarding public transits.

## Design Strategies

Unify payment methods between all systems

Pay with cell phone

Pay biometric scanning

## Solution Elements

 IntelliCard

 PhonePay

 BioPay

# Design Factor

Far distance to new departure point

146

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Transferring

## Originator

William Huang

## Contributors

Andy Conrad    September 26, 2008  
Prashant Desai    September 26, 2008  
Jennifer Lee    September 26, 2008

## Sources

Team deliberations

## Associated Functions

59. Move to new departure point

## Observation

After arriving at the transfer point, going to the next departure point can be far away.

## Extension

Getting around by public transportation has its advantages. It is inexpensive and eliminates the need to personally operate the vehicle. One disadvantage is that sometimes transfers are needed in order to get people to their destinations. In the case of airplane, subway and bus transfers, going to the next departure point can be a long walk. This causes wasted time and energy, as well as unnecessary stress especially for people carrying things. A higher level of efficiency and customer satisfaction can be achieved if the system is designed to consider the needs of users at transfer points.

## Design Strategies

Reduce distance between transfer points  
Provide free rides between transfer points  
Eliminate transfers

## Solution Elements

**S** Reduce Distance  
**S** Free Rides  
**S** No Transfers



# Design Factor

Long waits before departure

147

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Transferring

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

60. Await next departure

## Observation

After arriving at the next departure point, waiting for the transport can take a long time.

## Extension

During a transfer a person would have to wait for the arrival of the next transit. This is can be inconvenient, uncomfortable and unsafe. If at arrival to the transport point a vehical is standing by and ready to go, no time will be wasted.

## Design Strategies

Increase frequency of departures

On-demand transports await users

## Solution Elements

**E** Depart Frequently

**S** On-Demand Transports

# Design Factor

## Poorly designed waiting areas

148

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Utilization

### Activity

Transferring

### Originator

William Huang

### Contributors

### Sources

Team deliberations

### Associated Functions

60. Await next departure

### Observation

Waiting for departure in a poorly designed spaces can be unpleasant and even unsafe.

### Extension

The wait time at off-peak hours can be as long as 20-30 minutes. Waiting at a poorly designed area with insufficient seats, dim lighting and unprotected from harsh weather can cause great frustrations for people.

### Design Strategies

- Provide sufficient lighting
- Provide comfortable seating
- Provide emergency phones
- Provide departure information
- Communicate regulations and system updates
- Set up vendors
- Monitor waiting area

### Solution Elements

- E** Well-Lit Space
- E** Comfortable Seats
- E** Emergency Phones
- M** Departure Info
- E** Info Display
- M** Buy Stuff
- E** Security Cams

# Design Factor

Prioritization can be subjective

149

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Responding

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

83. Prioritize Emergency Response

## Observation

In case of a large-scale emergency, prioritizing resource allocation can be subjective.

## Extension

Dispatching emergency response to multiple locations requiring limited resources can be a challenge. Prioritizing the immediacy of response can make a difference in number of lives saved. Implementing emergency protocols will allow emergency response teams to make accurate judgements and decisions.

## Design Strategies

Set up protocols to deal with prioritization

## Solution Elements

**M** Priority Protocols

# Design Factor

System may have trouble locating victims

150

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Responding

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

85. Protect users from immediate harm/  
danger

## Observation

During emergencies, especially in the case of natural disasters, finding victims quickly and efficiently can be a problem.

## Extension

Finding victims in large catastrophies require a vast resource of people and equipment. In many cases lives were lost due to the lack of resources and slow process in rescuing. Having more resources of people or having more high-tech equipment can help to save lives.

## Design Strategies

- Many spread-out emergency service centers
- Acquire high-tech search equipment
- Recruit more emergency response volunteers

## Solution Elements

- E** Emergency Centers
- E** Emergency Equipment
- E** Emergency Volunteers

# Design Factor

Containing emergency may involve risking lives

151

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Responding

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

86. Contain Emergency

## Observation

The decision to respond to an emergency may risk the lives of crews.

## Extension

Rescuing people is an extremely dangerous task. Not having enough training or sufficient equipment can risk the lives of rescue personnel. Decisions of management to contain emergencies is especially important and it is crucial they have the best tools and data to make these decisions.

## Design Strategies

Increase training of emergency crews

Invest in high-tech rescue equipment

## Solution Elements

**M** Increase Training

**M** High-tech Rescue

# Design Factor

System may be incapacitated by large-scale evacuations

152

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Protection

## Activity

Responding

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

87. Evacuate System

## Observation

In case of large-scale evacuations, city infrastructure (transportation and communication systems) may be incapacitated.

## Extension

Roads can be jammed and transportations cannot effectively get people away from danger in case of a large-scale emergency. Better planning of evacuations and providing people with real-time instructions may help save lives and prevent injuries.

## Design Strategies

Invest in more infrastructure

Prepare existing transportation for evacuation

Effectively communicate evacuation info

## Solution Elements

**M** Increase Infrastructure

**S** Transport for Evac

**M** Evac Info

# Design Factor

## Backups can fail

153

### Project

Chicago Vision for the Future:  
Responsive Transport

### Mode

Protection

### Activity

Responding

### Originator

William Huang

### Contributors

### Sources

Team deliberations

### Associated Functions

89. Initiate Emergency Recovery

### Observation

In responding to an emergency even backups can fail.

### Extension

In a major emergency situation, backup communication systems and resources can fail and become unavailable. Design of the emergency response system must include worst case scenarios in order to be fully prepared.

### Design Strategies

Plan for worst case scenarios

Prepare secondary backup

### Solution Elements

**M** Worst scenarios

**M** Secondary Backup

# Design Factor

Unclear or lack of info & communication hinders travel

154

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Preparing, Departing, Traveling, Transferring,  
Arriving

## Originator

William Huang

## Contributors

Andy Conrad	September 26, 2008
Prashant Desai	September 26, 2008
Jennifer Lee	September 26, 2008

## Sources

Team deliberations

## Associated Functions

44. Establish itinerary
45. Check system activity
46. Select optimal mode
48. Transaction for departure
51. Signal for departure
52. Monitor position
53. Communicate between user and system
55. Make travel adjustments
56. Communicate transfer to users
58. Orient to new departure point
59. Move to new departure point
61. Signal for arrival

## Observation

Departure, transfer, and arrival information are not always apparent or available. Payment methods are different between transportation system, causing confusion and inconvenience for users. There is an absence of real-time dynamic itinerary planning resource. Insufficient tools to help with navigation or making travel adjustments.

## Extension

Unnecessary confusion can be avoided if details of transportation system is better thought-out. Information that allows people to plan their time more effectively can be incorporated inside public transits or stations. Payment methods can be consolidated into a single method for convenience. Real-time itinerary planning and navigation tools can help guide people to their destinations.

## Design Strategies

- Unify payment methods between all systems
- Pay with cell phone
- Pay biometric scanning

## Solution Elements

- S** IntelliCard
- S** PhonePay
- S** BioPay
- E** You're Here Map
- M** Interactive Kiosk
- M** Follow Signs
- S** Guide Ink



# Design Factor

Inconvenience with cargo degrades travel experience

155

## Project

Chicago Vision for the Future:  
Responsive Transport

## Mode

Utilization

## Activity

Preparing, Departing, Transferring, Arriving

## Originator

William Huang

## Contributors

## Sources

Team deliberations

## Associated Functions

49. Load cargo  
50. Secure cargo  
57. Retrieve cargo  
59. Move to new departure point

## Observation

Loading cargo onto a public transit can be inconvenient, time consuming and can even cause injuries.

## Extension

Most people would not take the public transit if they are carrying large bags due to the lack of storage space. Designing a better storage and securing system in all public transits will encourage higher number of people to take trains and buses.

## Design Strategies

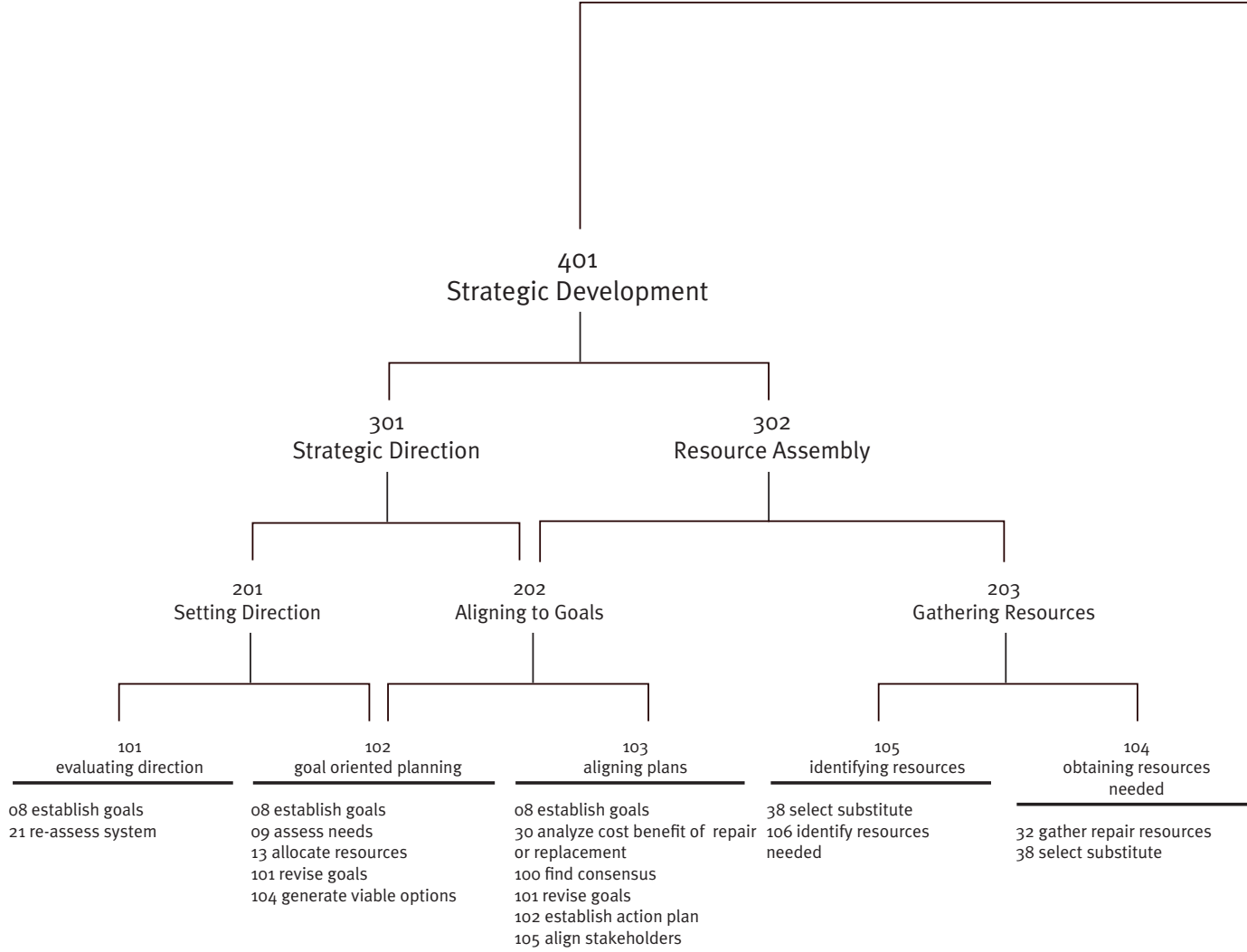
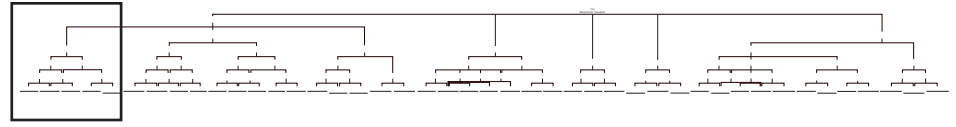
Have large space to accommodate oversized cargo  
Provide simple way to secure cargo  
Load cargo with minimum effort  
Provide automated loading

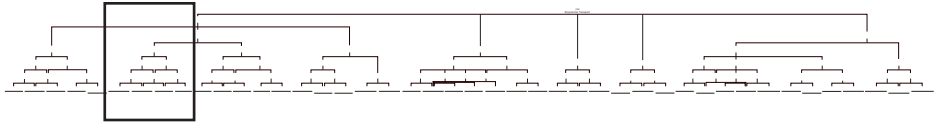
## Solution Elements

**S** LG Cargo Space  
**S** EZ Cargo Secure  
**S** Assisted Loading  
**E** Auto Loading

# Information Structure

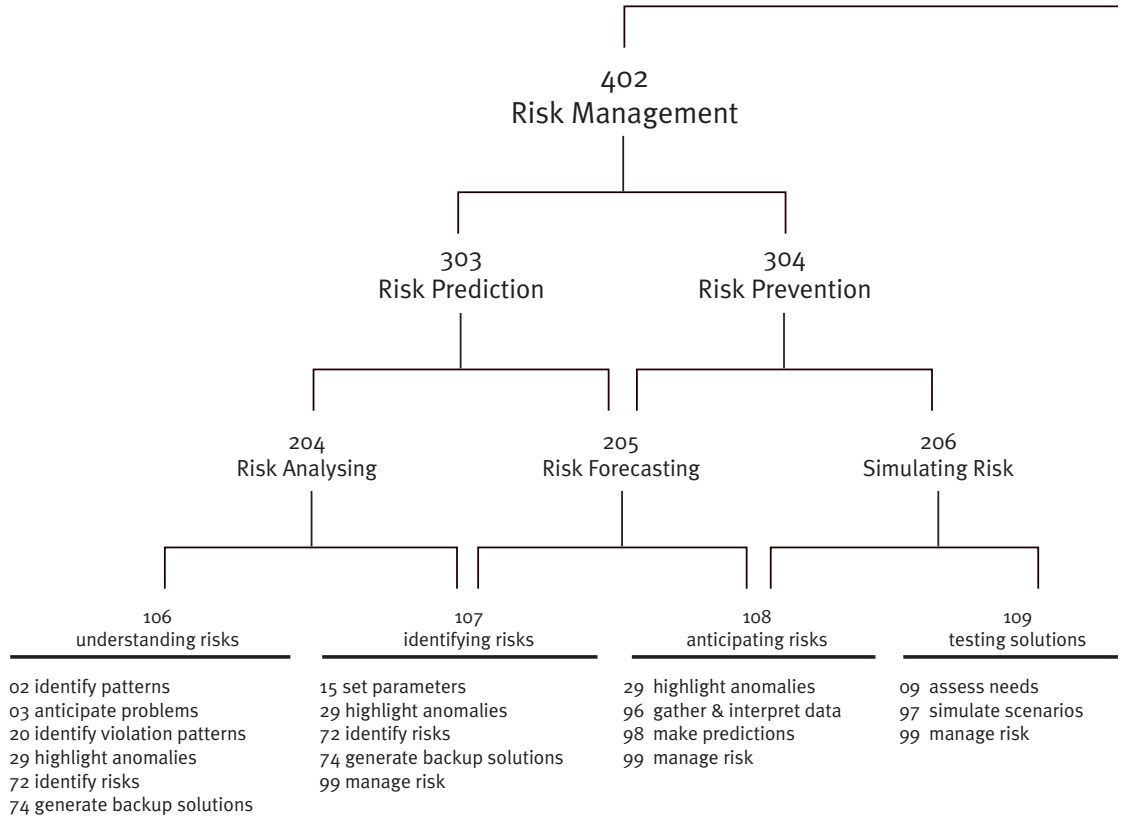
Chicago: Vision for the Future





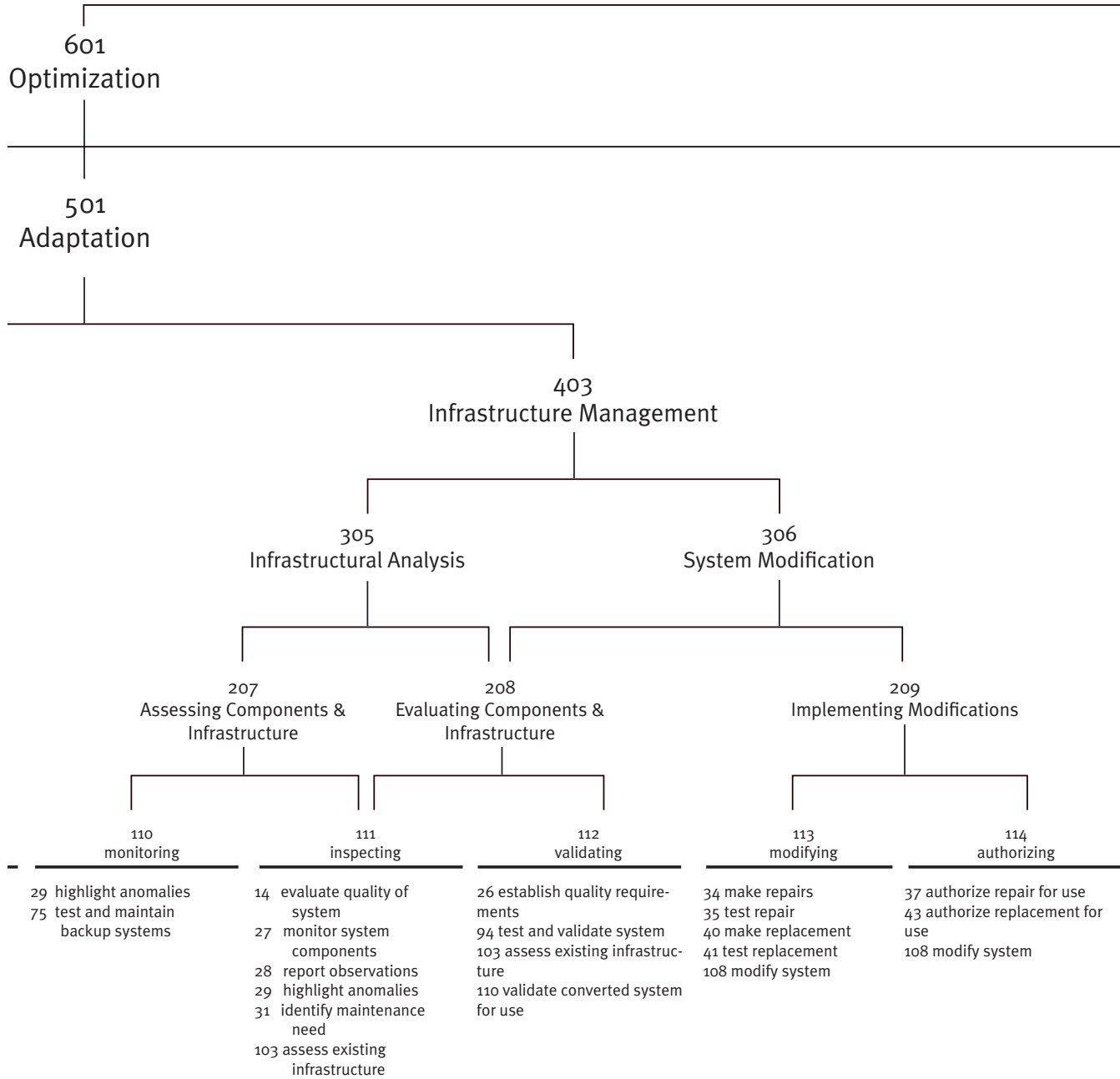
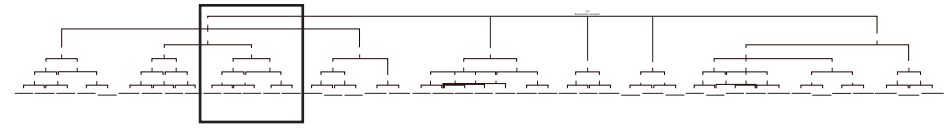
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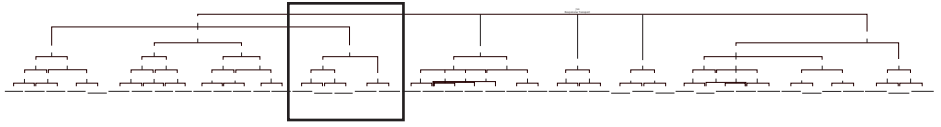
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# Information Structure

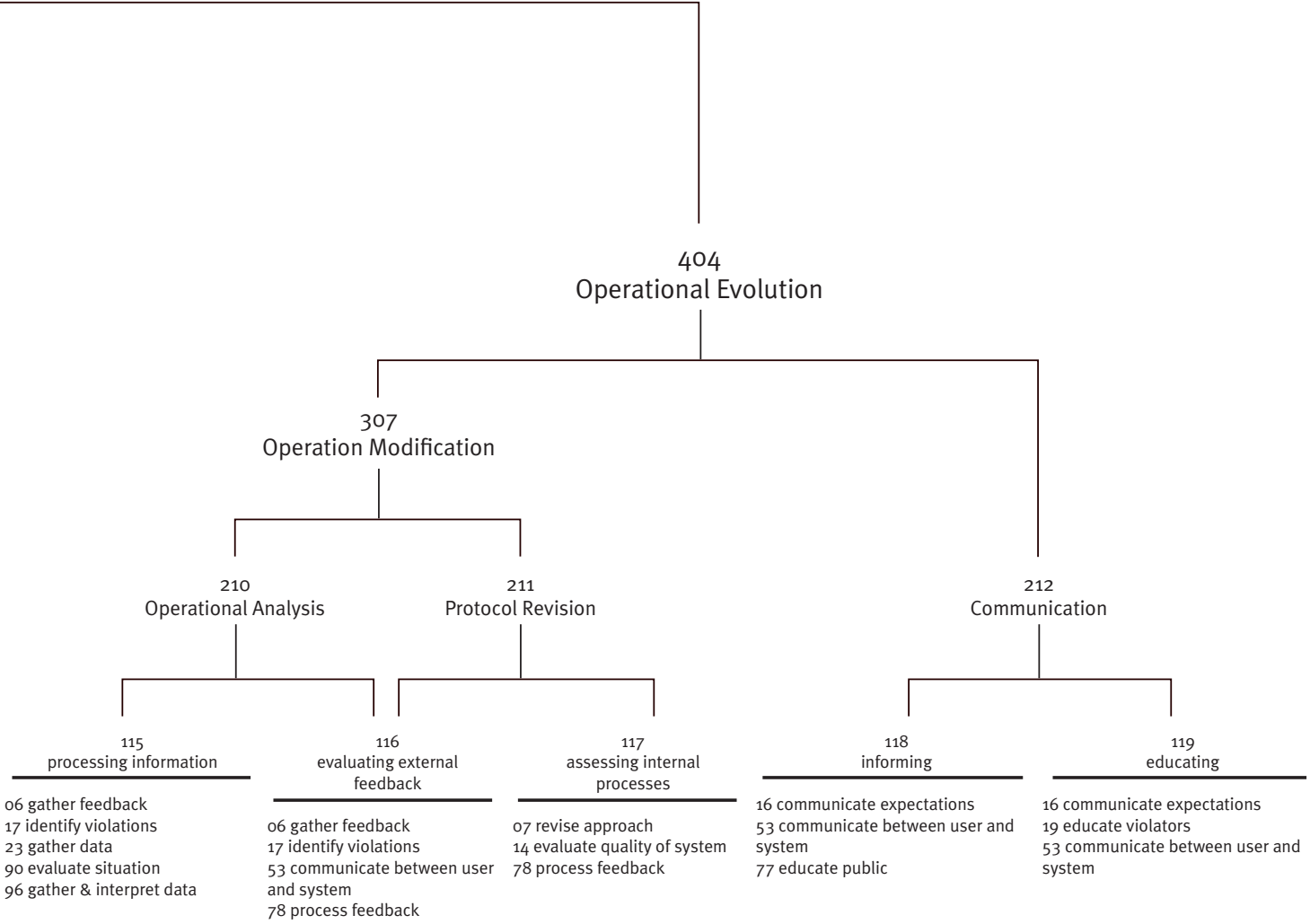
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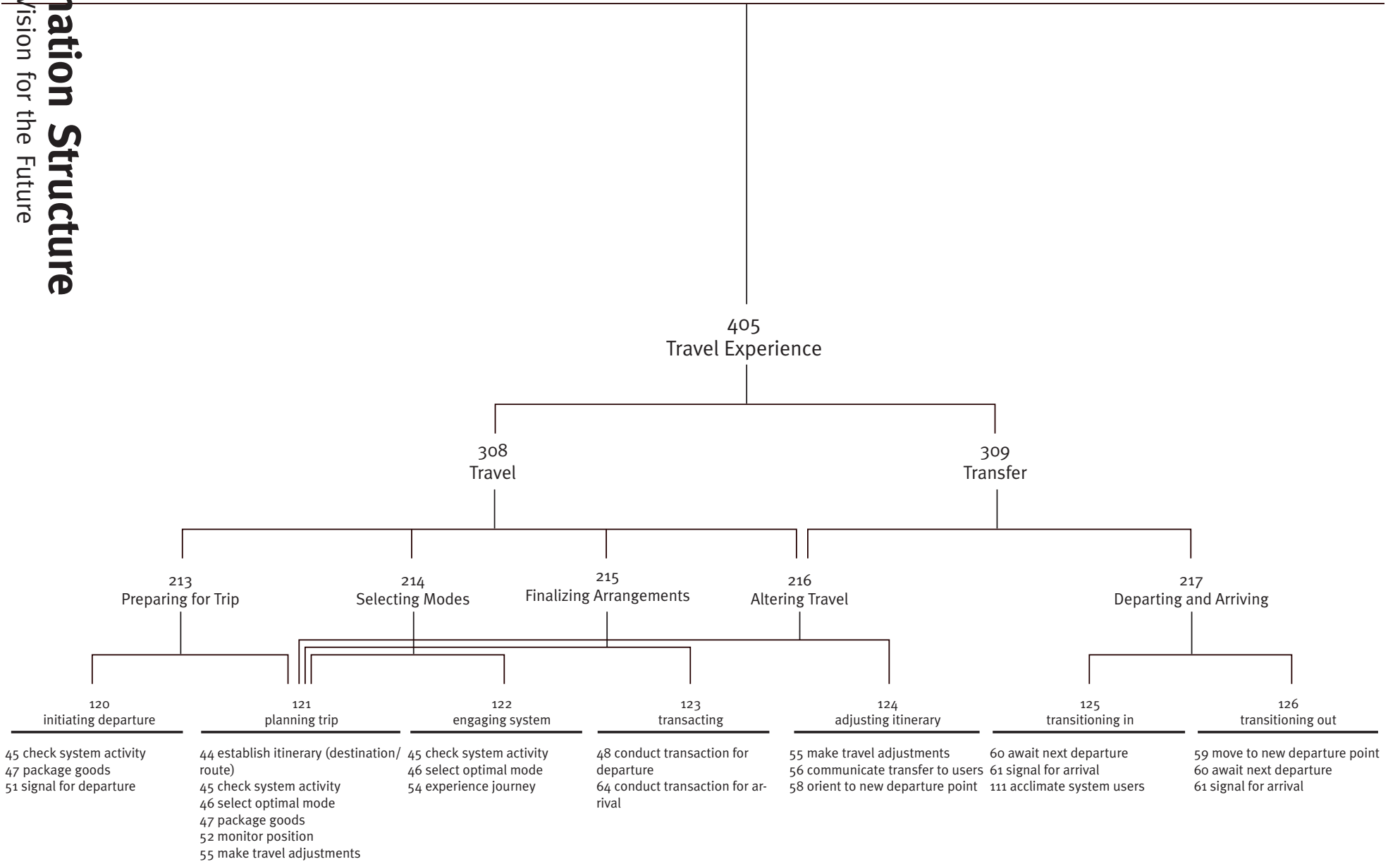
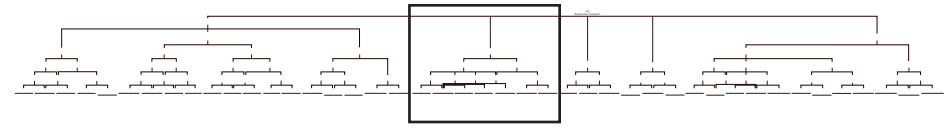
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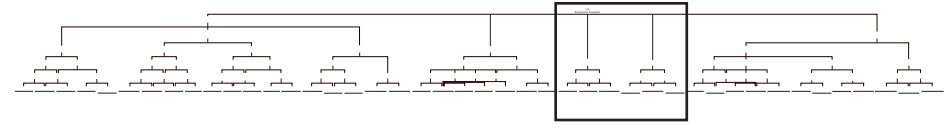
Chicago: Vision for the Future



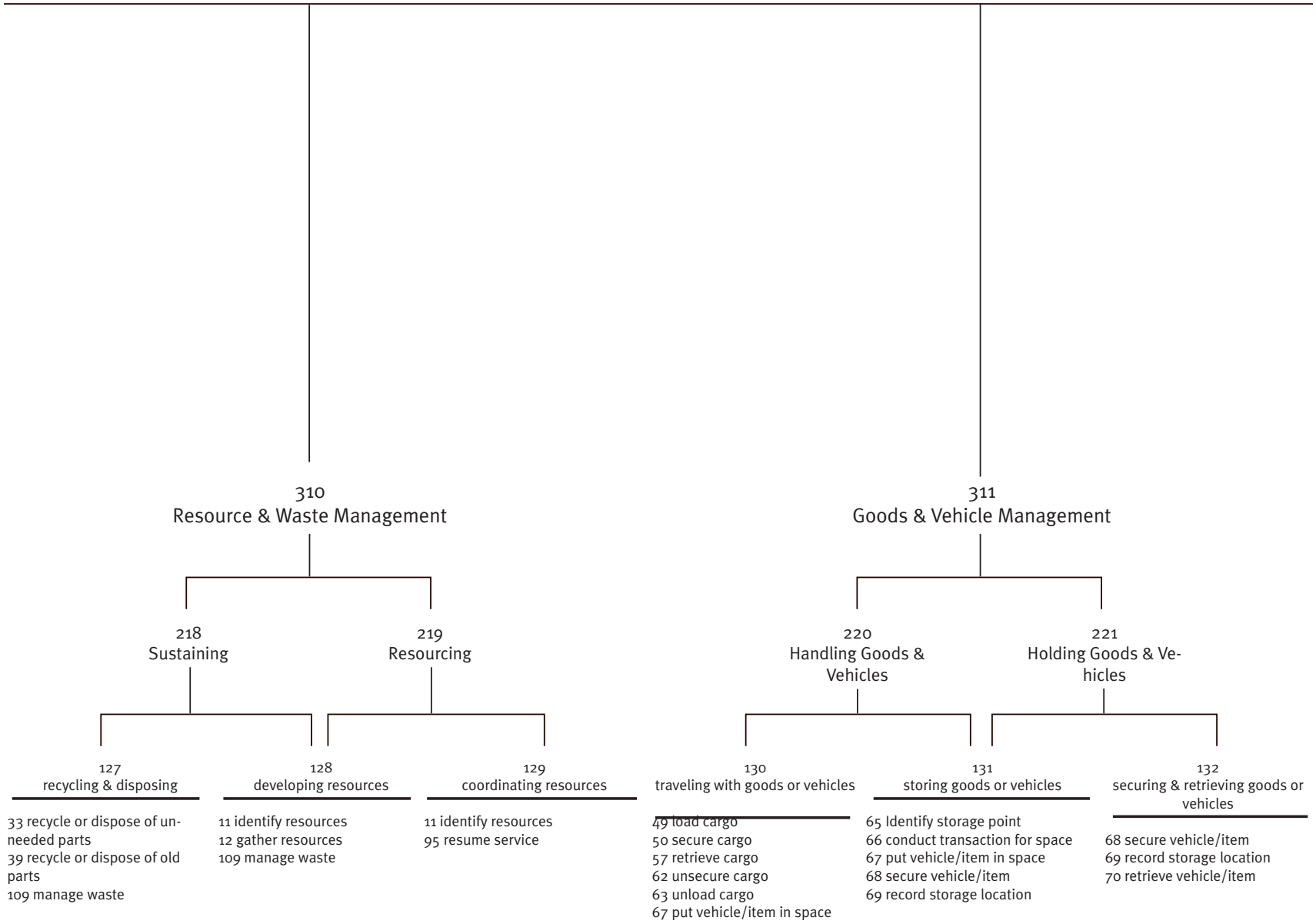
# Information Structure

Chicago: Vision for the Future



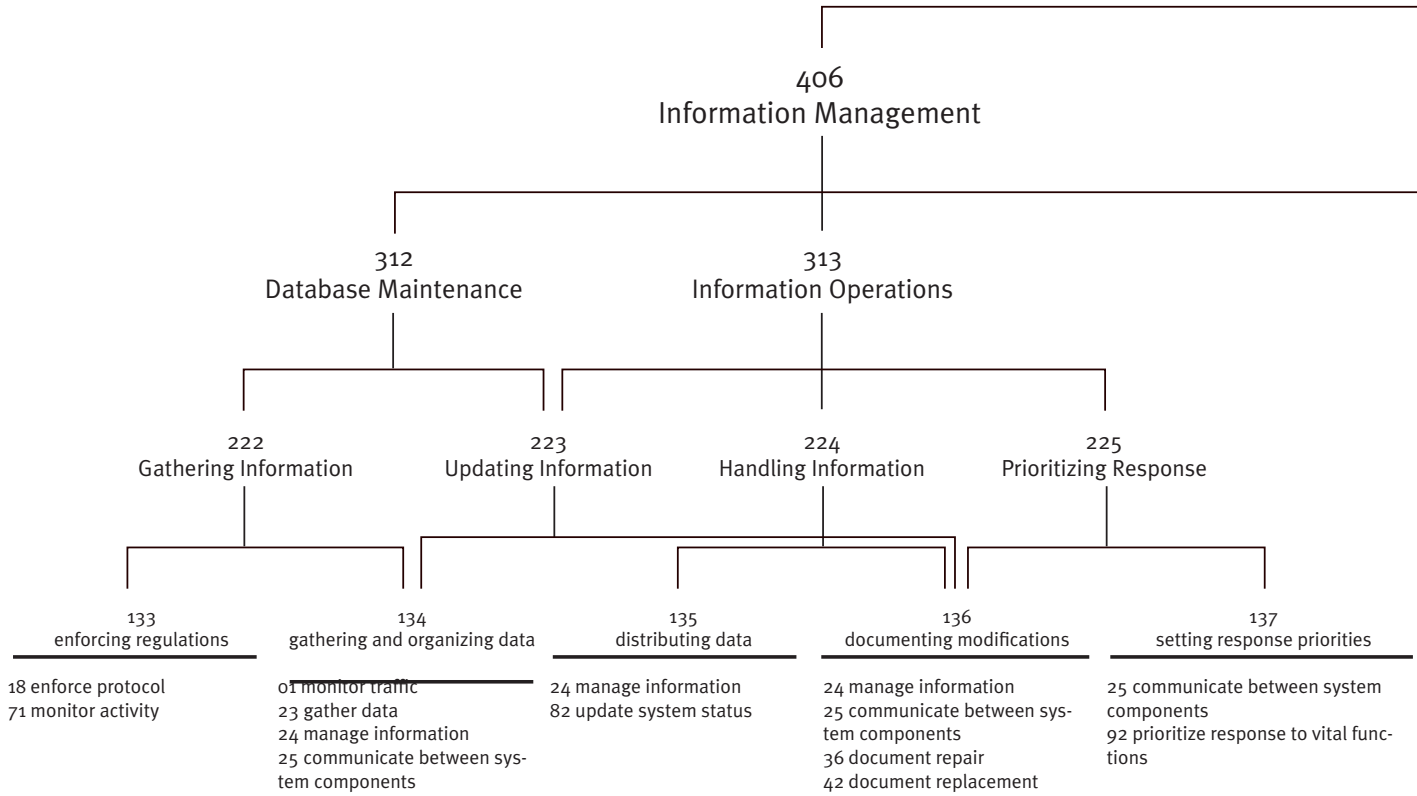
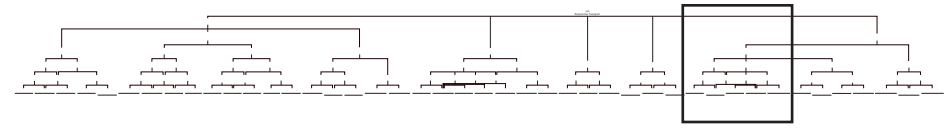


701  
 Responsive Transport



# Information Structure

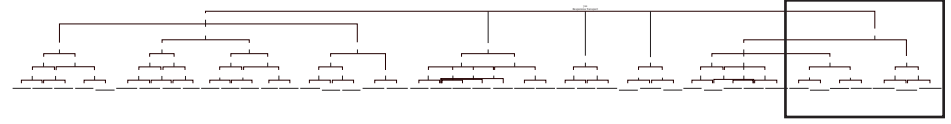
Chicago: Vision for the Future





# Information Structure

Chicago: Vision for the Future



502  
Coordination

314  
Network Communications

315  
Emergency Management

226  
Organizing Communication Channels

227  
Optimizing Communication Protocols

228  
Responding to Problem

229  
Restoring to Baseline

138  
coordinating parties

139  
readying emergency response

140  
adjusting response needs

141  
prioritizing emergency needs

142  
taking emergency action

143  
coordinating emergency response

144  
maintaining functionality

- 10 delegate authority and responsibility
- 22 specify organizational relationships
- 25 communicate between system components
- 81 coordinate emergency response components
- 84 Manage/Authorize Emergency Resources
- 107 coordinate activity and budget

- 73 train system operators
- 81 coordinate emergency response components

- 05 implement adjustments
- 80 monitor and report response progress

- 04 prioritize needs
- 83 Prioritize Emergency Response

- 85 Protect users from immediate harm/danger
- 86 Contain Emergency
- 87 Evacuate System
- 89 Initiate Emergency Recovery
- 91 assist victims

- 79 alert system of emergency mode
- 84 Manage/Authorize Emergency Resources
- 86 Contain Emergency
- 88 Activate backup protocols
- 89 Initiate Emergency Recovery
- 93 restore system

- 76 institute preventive action
- 93 restore system

# Activity Analysis

Activity  
Inspecting

164

## Project

Vision for the Future: Responsive Transport

## Mode

Maintenance

## Originator

Andy Conrad

## Contributors

Jenny Lee  
William Huang  
Prashant Desai

## Scenario

In order to keep the system running safely and effectively, inspections must be carried out to identify maintenance needs.

## Users

- system managers
- system operators
- system maintenance staff
- system users
- construction crews

## System Components

- safety/government regulations
- evaluation heuristics
- active system components
- infrastructure
- safety equipment
- tools

## Environmental Components

- weather/climate/seasons
- subcontracted/temporary help
- budget constraints
- time to repair/system availability

## System Functions

26. establish quality requirements
27. monitor system components
28. report observations
29. highlight anomalies
30. analyze cost/benefit of repair or replacement
31. identify maintenance need

## Associated Design Factors

- (26, 27) cannot establish parameters/requirements around unforeseen events
- (26, 27) measuring system quality is difficult
- (27) human attention extremely limited for routine "monitoring" tasks
- (26, 27, 28, 29) some anomalies may not fit rubrics and go unreported
- (30) Budget issues may impede or interrupt progress
- (31) system may deteriorate further between the inspection and the repair or replacement

# Activity Analysis

## Activity Preventing

165

### Project

Adapting to Climate Change: Rising Seas

### Mode

Protection

### Originator

Jennifer Lee

### Contributors

Andy Conrad	October 3, 2008
Prashant Desai	October 3, 2008
William Huang	October 3, 2008

### Scenario

The system takes measures to mitigate or preclude harm to users or the system itself in the event of unusual occurrences.

### Users

- system operators & managers
- public safety and security personnel
- emergency planning teams
- police & fire departments
- hospitals
- Chicago Office of Emergency Management
- US Department of Homeland Security & Illinois Office of Homeland Security, other relevant federal & state agencies
- researchers
- policy makers

### System Components

- monitoring & communication equipment (cameras, satellites, radios, phones, sensors, etc.)
- vehicles
- data, charts & maps
- computers & software
- signs & signals
- communications systems (inter-agency, intra-agency, user-to-system, system-to-user)

### Environmental Components

- configuration & conditions of roads, rails, & other infrastructure
- weather
- transfer, entry & exit points
- storage locations
- special events
- command center
- computer network
- emergency relief centers
- police stations, fire stations, and hospitals

### System Functions

71. monitor activity
72. identify risks
73. train system operators
74. generate backup solutions
75. test and maintain backup systems
76. institute preventive action

### Associated Design Factors

- (71) protecting civil liberties vs. monitoring the system
- (71, 72, 73, 74, 75, 76) patterns are limited by inherent unpredictability
- (72) subjectivity of risk identification
- (73) effective operator safety training can be inconsistent
- (74, 75) backup solutions can burden regular system operations

# Solution Element

**E M S**

Malfunction Cues

166

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Mode**

Maintenance

**Activity**

Inspecting

**Originator**

Andy Conrad

**Contributors****Description**

Parts that provide visual cues when quality is degraded

**Source**

personal observation

**Properties**

- system infrastructure components such as bolts, fasteners, ties, etc.

**Features**

- builds signals into system or materials (e.g. bolts turn green when loose or rusted)

**Associated Function/s**

27. monitor system components

**Source Design Factor/s**

Human attention extremely limited for routine "monitoring" tasks

# Solution Element

**E M S**

Targeted Scanners

167

**Project**

Chicago Vision for the Future:  
Responsive Transport

**Mode**

Operations, Protection

**Activity**

Regulating, Preventing

**Originator**

Jennifer Lee

**Contributors****Description**

Scanning machines that search for targeted materials or items

**Source**

personal observation

**Properties**

- an arch over key transport points (e.g., entry points, point of transaction) that scans all users unobtrusively upon system entry
- a lot like metal detectors, but Targeted Scanners search for other and/or all security-threatening materials
- a regularly updated database of material types, combinations, and proportions and other key patterns that match the makeup of potentially threatening items

**Features**

- scans for potentially harmful materials and substances
- unobtrusively identifies potential threats by comparing to the database of potentially threatening materials or items
- separates potential threats for further examination while allowing others to move through without delay
- system will not search for or identify non-relevant materials or items

**Associated Function/s**

17. identify violations  
71. monitor activity

**Source Design Factor/s**

Protecting civil liberties vs. monitoring the system

Functions Means	
29	Highlight anomalies
75	Test and maintain backup systems
14	Evaluate quality of system
27	Monitor system components
28	Report observations
29	Highlight anomalies
31	Identify maintenance need
103	Assess existing infrastructure
26	Establish quality requirements
94	Test and validate system
103	Assess existing infrastructure
110	Validate converted system for use
34	Make repairs
35	Test repair
40	Make replacement
41	Test replacement
108	Modify system
37	Authorize repair for use
43	Authorize replacement for use
108	Modify system

Ends	Means
110	Monitoring (29, 75)
111	Inspecting (14, 27, 28, 29, 31, 103)
112	Validating (26, 94, 103, 110)
113	Modifying (34, 35, 40, 41, 108)
114	Authorizing (37, 43, 108)

Ends	Means
207	Assessing components & infrastructure (110, 111)
208	Evaluating components & infrastructure (111, 112)
209	Implementing modifications (113, 114)

End
305 infrastructural analysis (207, 208)
306 system modification (208, 209)

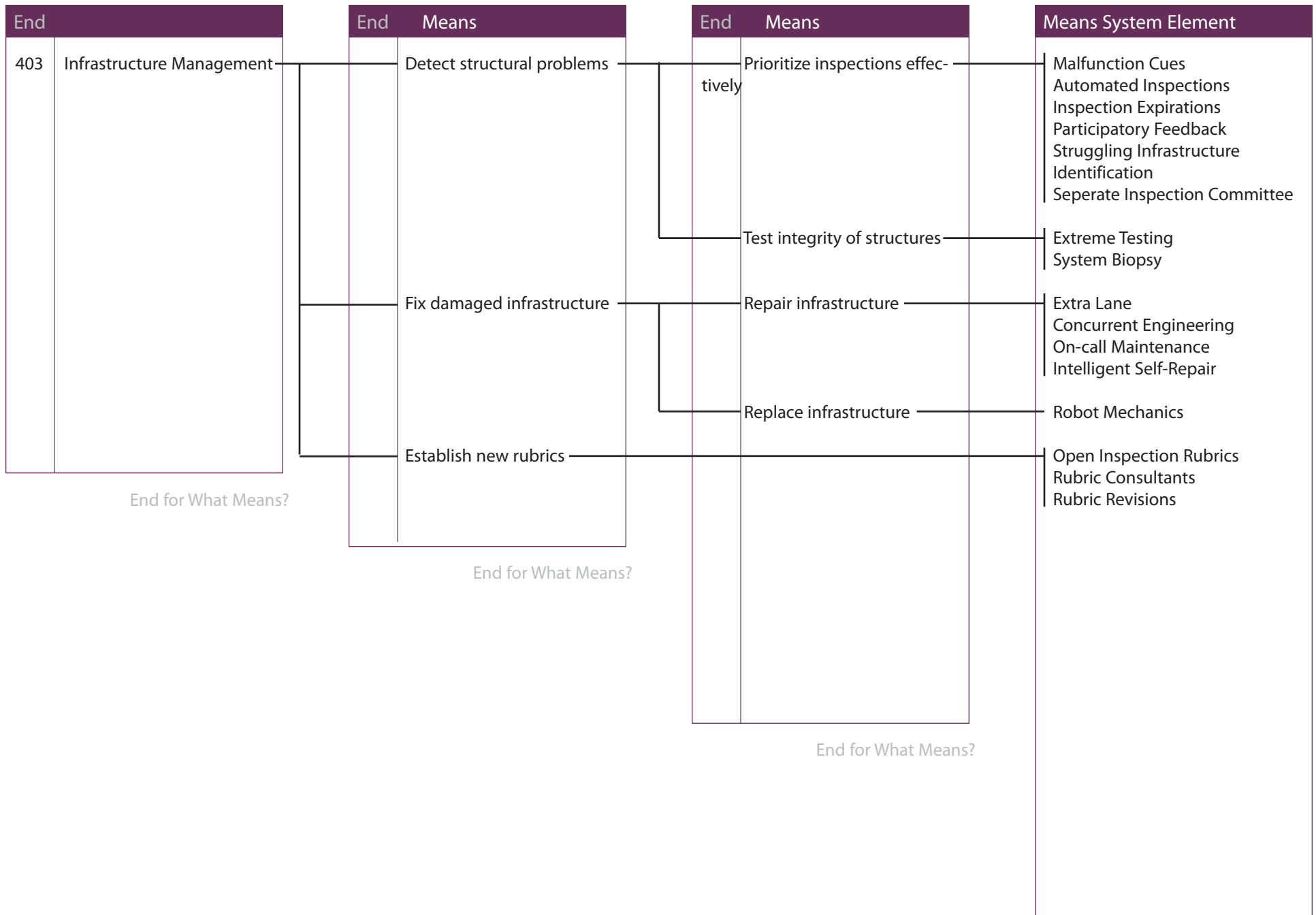
403 Infrastructure Management  
(305, 306)

Functions Means	
85	Protect users from immediate harm/danger
86	Contain emergency
87	Evacuate system
89	Initiate emergency recovery
91	Assist victims
79	alert system of emergency mode
84	Manage/Authorize emergency resources
86	Contain emergency
88	Activate backup protocols
89	Initiate emergency recovery
93	Restore system
76	Institute preventive action
93	Restore system

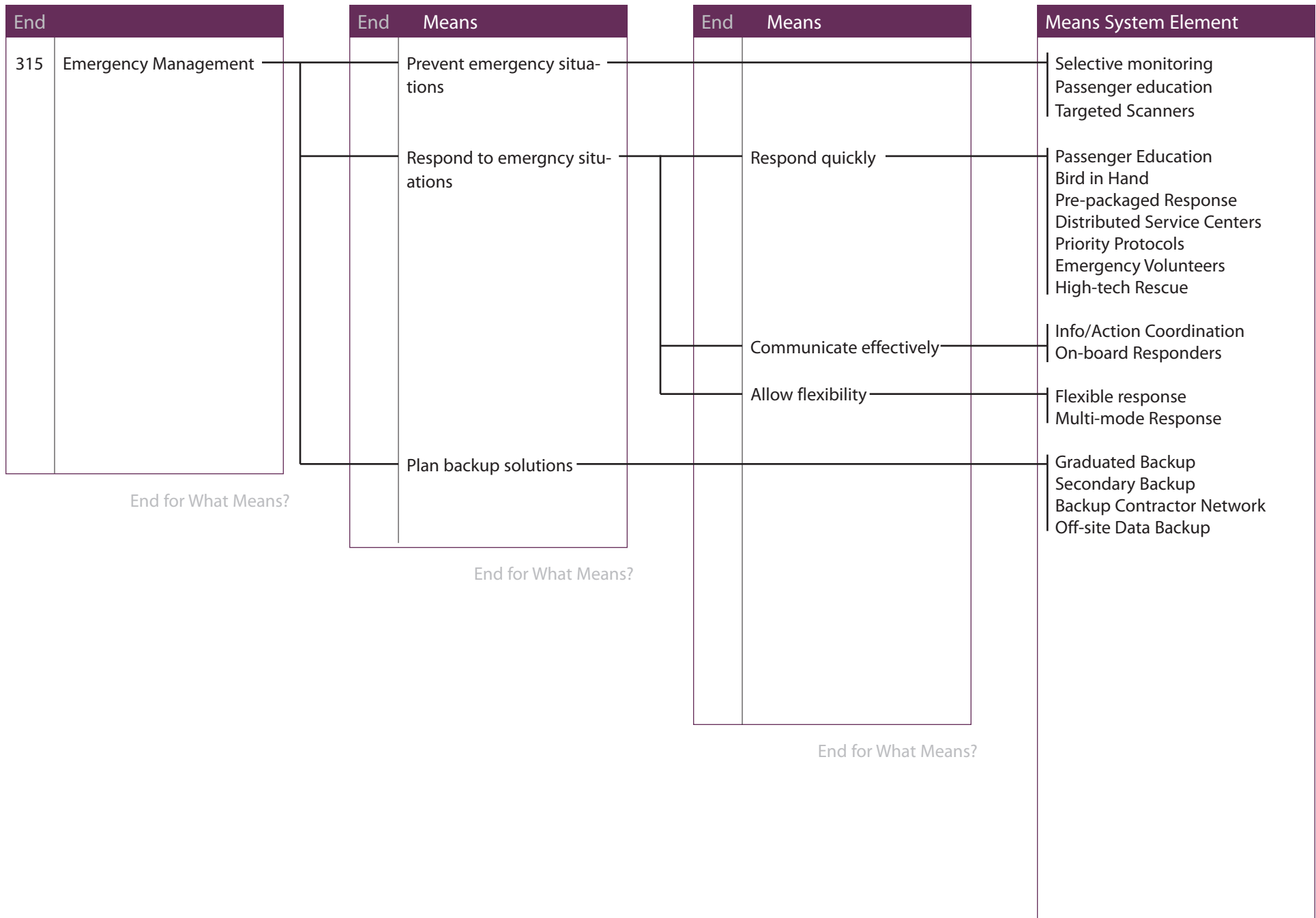
Ends	Means
142	Taking emergency action (85, 86, 87, 89, 91)
143	Coordinating emergency response (79, 84, 86, 88, 89, 93)
144	Maintaining functionality (76, 93)

Ends	Means
228	Responding to problem (142, 143)
229	Restoring to baseline (143, 144)

End	
315	Emergency Management











# System Element Relationships

07 Privic Transport	0			
08 Transcom Network	Transcom facilitates & supports maintenance duties; Transcom relies on maintenance for effectiveness 1	0		
09 Delightful Travel	1	0	0	
10 Inhale/Exhale Initiative	Inhale/Exhale provides guidelines [energy & material use] for Evolutionary Maintenance 1	Working well with others laterally across company and in the context of partnership 1	0	Inhale/Exhale decides where to build and what to use and how to operate 3

Scoring  
 3 Critical Relationship  
 2 Strong Relationship  
 1 Slight Relationship  
 0 No Relationship

03 Evolutionary Maintenance	04 Operational Excellence	05 Optimized Infrastructure	06 New Connected Infrastructure
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# System Element Relationships

<p><b>11 Cargo Concierge</b></p>	<p>successful use of Cargo Assist relies heavily on network maintenance <span style="float: right;">1</span></p>			
<p><b>12 Vehicle Storage</b></p>	<p><span style="float: right;">0</span></p>	<p><span style="float: right;">0</span></p>		
<p><b>13 Distributed Information Management</b></p>	<p>Maintenance resources can be pooled from distributed networks to solve problems. Wireless handheld uses DIM for record keeping. <span style="float: right;">1</span></p>	<p>Operational Excellence enables skilled and efficient usage of the Distributed Information Network <span style="float: right;">3</span></p>	<p>Optimized Infrastructure is efficiently distributed through the DIM and relies on DIM network for implementation <span style="float: right;">3</span></p>	
<p><b>14 Nimble Response</b></p>	<p>Maintenance equipment can be used in Nimble Reponse (e.g., Automated Mechanics become rescue assistants). Maintenance efforts can be leveraged to reinstate system functioning post emergency. <span style="float: right;">1</span></p>	<p>Operational Excellence builds an intimate understanding of system that can aid in more effective Nimble Response <span style="float: right;">2</span></p>	<p>Nimble Response relies on capabilities of Optimized Infrastructure to contain and respond to emergencies <span style="float: right;">2</span></p>	<p>Nimble Response depends on availability and accessibility of infrastructure <span style="float: right;">2</span></p>

Scoring  
 3 Critical Relationship  
 2 Strong Relationship  
 1 Slight Relationship  
 0 No Relationship

<p><b>03 Evolutionary Maintenance</b></p>	<p><b>04 Operational Excellence</b></p>	<p><b>05 Optimized Infrastructure</b></p>	<p><b>06 New Connected Infrastructure</b></p>
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<b>Originator</b> Jennifer Lee	<b>SuperSet Element(s)</b>	<b>Related Elements</b> <ul style="list-style-type: none"> <li>• Chicagotopia</li> <li>• New Connected Infrastructure</li> </ul>
<b>Contributors</b> Andy Conrad                      November 18, 2008 Prashant Desai                      November 18, 2008 William Huang                      November 18, 2008		
<b>Sources</b>	<b>SubSet Element(s)</b>	

## Description

**Evolutionary Maintenance** is a set of system components, devices, guidelines, and protocols that work together to simplify, automate, streamline, standardize, and sustain the existing infrastructure while supporting plans for future infrastructure development.

## Properties

### *Infrastructure Assessment*

- system components with built in cues to indicate malfunction
- combination of human inspectors and automated infrastructure inspection
- adaptation benchmarks (coordinated with Chicagotopia)
- open inspection rubrics
- sensors throughout system
- periodic intensive testing of healthy infrastructure
- expiration dates for all inspection reports
- leveled reporting and identification

### *Infrastructure Maintenance*

- automated robot maintenance mechanics
- on-call maintenance crews
- self-healing infrastructure materials
- modular parts
- handheld devices connected to Distributed Information Management System
- maintenance tools with built-in sensors
- real-time inventory displays

## Features

1. provides quick & easy identification of potential problems
2. reduces human workload stressors and error without compromising accuracy of inspections or maintenance
3. aligns short-term decisions with long-term goals
4. allows flexibility for inspection processes to evolve
5. maintains ubiquitous system awareness
6. prevents reliance on outdated inspection information
7. rates infrastructure status along a continuum to identify and monitor potential problems early on
8. minimizes extended maintenance-related service disruptions
9. simplifies and reduces maintenance needs and record keeping

**Fulfilled Functions**

- 09 assess needs
- 14 evaluate quality of system
- 26 establish quality requirements
- 27 monitor system components
- 28 report observations
- 29 highlight anomalies
- 30 analyze cost benefit of repair or replacement
- 31 identify maintenance need
- 34 make repairs
- 36 document repair
- 38 select substitute
- 40 make replacement
- 42 document replacement
- 72 identify risks

**Related Design Factors**

- Risk of harm to people performing maintenance
- Resources not readily available
- Measuring system quality is difficult
- Conflict between long and short term goals
- Difficult to determine what infrastructure is worth saving
- Restoring and testing system may take too long
- System may deteriorate further between inspection and repair or replacement
- Some anomalies may not fit rubrics and go unreported
- Human attention extremely limited for routine “monitoring” tasks
- Maintenance documentation can be cumbersome
- System maintenance can disrupt service

**Discussion**

Infrastructure maintenance is fundamental in influencing the ongoing effectiveness and future direction of a cohesive transport system. **Evolutionary Maintenance** is a set of system components, devices, guidelines, and protocols that work together to simplify, automate, streamline, standardize, and sustain the existing infrastructure while supporting plans for future infrastructure development.

As technology continues to develop and automation plays an increasingly role in daily life, **Evolutionary Maintenance** combines the strengths of human and automated maintenance. The goal of **Evolutionary Maintenance** is not to replace human activity with automation completely, but rather leverage technology to play a supportive role in reducing the burden of repetitive or dangerous tasks. This allows humans to focus more time on tasks requiring higher-order thinking and judgment so that they can make the crucial maintenance decisions that contribute to moving the transport system toward its long-term plans and objectives.

*Infrastructure Assessment*

For successful **Evolutionary Maintenance**, it is key to consider not only if services are not only meeting current demands but also whether each modification, repair, and replacement to the system moves infrastructure forward to serve future demands.

To begin, **Evolutionary Maintenance** efforts are closely tied to the **Adaptation Benchmarks** developed through **Chicagotopia**. Relying on solutions such as **Goal Tracker** (described in **Chicagotopia**), the system ensures that short-term maintenance decisions are aligned with long-term system goals.

When setting standards for inspections, **Open Inspection Rubrics** are used to capture observations and relevant information. In an effort to allow for maximum flexibility in inspections

and thereby support infrastructure evolution, such **OI Rubrics** include open-ended components and are periodically reviewed for revision.

During inspections, **Evolutionary Maintenance** provides solutions to provide quick, easy, and accurate identification of potential problems. **Malfunction Cues** are built into components to assist inspectors in more easily identifying problems that often require meticulous observation; for example, parts such as bolts, lights, or flooring materials change color to indicate cracks or other problems that degrade system quality. **Shared Monitoring** and **Automated Inspections** work together to further reduce human workload stressor and error without compromising the accuracy of inspections or maintenance. **Automated Inspections** utilize ubiquitous sensing technology to work systematically through system components for regular inspections. In order to catch potential problems that may be missed by **Automated Inspections**, **Shared Monitoring** partners human inspectors to share and trade off in inspection duties in order to maintain attention through long detailed inspections. Moreover, **Inspection Expiration** dates are attached to all reports in order to prevent reliance on outdated inspection information.

To ensure that infrastructure is capable of meeting both immediate and long-term quality standards, periodic **System Biopsies** deeply analyze healthy infrastructure components and take anticipate potential problems as changes in system demand and technology are shift in the future.

To support the results of **System Biopsies** and other system inspection reports, a system of **Leveled Reporting and Identification** rates the status of infrastructure health along a continuum to identify, address, and monitor potential problems as necessary. **Leveled Reporting** enables system redefinition

**Discussion cont'd**

by working to identify struggling infrastructure and prioritize maintenance and adaptation needs according to long- and short-term objectives outlined by the **Goal Tracker**.

*Infrastructure Maintenance*

Once ongoing assessments identify maintenance needs, **Evolutionary Maintenance** implements repairs, replacements, and modifications expeditiously, efficiently, and with minimal damage to environment and surrounding infrastructure.

Similar to the inspection process, modification duties are shared between human workers and automated system components. **On-Call Automated Maintenance Mechanics** are used in situations where risk of injury may be high, and also work on basic repairs during off-peak system hours. **Automatic Replacement** is another feature that regularly removes and replaces components subject to heavy system use. When removed these components can be inspected more thoroughly with minimal disruption to system services; if components are still fit for use, they can be returned to service.

Additionally, the introduction of **modular parts** can simplify maintenance and inventory management. For example, standardizing parts ranging from bolts to doorways to flooring materials will support unified maintenance efforts across the city and allow for the potential of cohesive intra-system compatibility of modes and components over time.

In order further reduce the burden of system maintenance – especially in heavy-use areas of the system – **self-healing infrastructure materials** based on nanotechnology are introduced to the system in the future. Components such as road beds, rails, and sidewalks that are subject to wear from frequent use can incorporate nanotechnology-based materials to slow deterioration.

Through **ToolTracker**, maintenance tools are embedded with sensors that track use of such tools to automatically document maintenance activities and send this information to **Distributed Information Management** in order to simplify record-keeping processes.

As replacements are carried out and monitored, system programs establish **Dynamically Adjusted Timelines** in which maintenance activity collected through **ToolTracker** and other maintenance communication systems such as handheld devices and real-time inventory displays is compared to projected completion dates. Timelines are adjusted to achieve optimal balance of quality and timeliness.

**Scenario:**

Amber is a maintenance inspector whose job today is to inspect a recently renovated thruway station at Irving Park. She spends her morning looking at the station structure at point of

passenger entry into the station. Utilizing the **Open Inspection Rubrics**, Amber systematically works through the different components of the entry way, making note of changes visually indicated by **Malfunction Cues**. While looking at one of the Targeted Scanners, she notes that a few supporting bolts have turned green, indicating that it is time for replacement.

Amber also notices that there is some water from the waterfall wall that has been regularly splashing onto the edge of the walkway, and makes note of this in the **Open Inspection Rubrics** as a pattern she has noticed at a few other stations she's inspected in previous days and suggests that perhaps it is a low-to medium-level problem that might need to be addressed in the near future.

Meanwhile, John, a system maintenance mechanic is supervising a **Personal Mass Transit** vehicle **biopsy**. Vehicles are regularly removed with **Automatic Replacement** from service for inspection and maintenance so that problems can be avoided before they surface during use.

**Automated Maintenance Mechanics** complete regular maintenance work under the carriage of the vehicle while John detects some evidence of a recently self-repaired crack that had developed on the exterior shell of this vehicle since its last periodic check-up, although there is nearly no trace of it left thanks to **self-healing nanomaterials**. He uses his handheld device to confirm that sensors in the vehicle have already automatically submitted this information to the **Distributed Information Management** system.

While looking at the displayed maintenance information on his handheld, John sees that a low-level report has been submitted that requests inspection of some loose wiring of the interior personal console. John responds and discovers a loose wire. He uses some pliers to secure the connection. Since these pliers are embedded with **ToolTracker** technology, a record of his activities are automatically submitted to the **Distributed Information Management** system with a simple "confirm" action on John's part. There is only one more vehicle on John's list that will need regular maintenance before he goes to his afternoon meeting to discuss possible solutions for the Waterfall Wall splash patterns that inspectors have recently brought up for department discussion.



<b>Originator</b> Jennifer Lee	<b>SuperSet Element(s)</b>	<b>Related Elements</b> <ul style="list-style-type: none"> <li>• Risk Identification &amp; Treatment</li> <li>• Operational Excellence</li> <li>• Optimized Infrastructure</li> <li>• New Connected Infrastructure</li> <li>• Transcom Network</li> <li>• Cargo Concierge</li> <li>• Distributed Information Management</li> </ul>				
<b>Contributors</b> <table border="0"> <tr> <td>Andy Conrad</td> <td>November 18, 2008</td> </tr> <tr> <td>Prashant Desai</td> <td>November 18, 2008</td> </tr> <tr> <td>William Huang</td> <td>November 18, 2008</td> </tr> </table>			Andy Conrad	November 18, 2008	Prashant Desai	November 18, 2008
Andy Conrad	November 18, 2008					
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<b>Sources</b>	<b>SubSet Element(s)</b>					

### Description

**Nimble Response** is a collection of action plans, preparation, partnerships, and technologies that come together to provide a fluid and unified system response to emergency situations.

### Properties

#### *Emergency Planning*

- distributed/decentralized response and service centers (see Distributed Info)
- prepackaged response plans
- backup response partnerships (contractors & cities)
- emergency patterns database
- targeted scanners
- ubiquitous sensors
- software that uses collected data to identify risks and rate according to risk level (e.g., needs immediate response, warning to monitor, etc.)

- backup data, communications, and coordination systems with multiple communication routes, off-site data backup systems, and capability to be activated gradually

#### *Emergency Action*

- handheld devices & other communication interfaces with GPS capabilities to link system and users
- info-action coordination dashboard
- semi-automated operators
- communication protocol requiring varied levels of communication responses depending on importance of message
- multiple transport modes used to respond to emergencies (e.g., air, water, surface, rail, etc.)

### Features

1. minimizes emergency response time
2. stores and protects critical information in alternate locations
3. expands emergency response network and capabilities by building supportive relationships outside of Chicago
4. anticipates potential problems and solutions for more effective response by learning from the past and from other cities
5. identifies potential risk by monitoring activity patterns
6. activates comprehensive back up systems as necessary without overburdening the regular system
7. provides personalized real-time emergency information and instructions to system users through Transcom Network interfaces, including handheld devices
8. GPS linked interfaces allow system to locate potential victims
9. coordinates and optimizes inter-agency response
10. supports effective human judgment in emergency situations

**Fulfilled Functions**

22 specify organizational relationships	Response
25 communicate between system components	84 Manage/Authorize Emergency Resources
71 monitor activity	85 Protect users from immediate harm/danger
72 identify risks	86 Contain Emergency
73 train system operators	87 Evacuate System
74 generate backup solutions	88 Activate backup protocols
76 institute preventive action	89 Initiate Emergency Recovery
77 educate public	90 evaluate situation
78 process feedback	91 assist victims
79 alert system of emergency mode	92 prioritize response to vital functions
80 monitor and report response progress	93 restore system
81 coordinate emergency response components	95 resume service
82 update system status	96 gather & interpret data
83 Prioritize Emergency	99 manage risk

**Associated Design Factors**

- Coordination between many agencies is difficult
- Delay between detection, processing, & reaction amplifies problem
- Public education of emergency protocol not effective
- Backup solutions can burden regular system operations
- Effective operator safety training can be inconsistent
- Protecting civil liberties vs. monitoring the system
- Restoring and testing system may take too long
- System may not have access to information required to respond
- System may be incapacitated or inoperable
- Communication is not always efficient or effective
- System may have trouble locating victims
- Containing emergency may involve risking lives
- Backups can fail

**Discussion**

**Nimble Response** is a collection of action plans, preparation, partnerships, and technologies that come together to provide a fluid and unified system response to emergency situations. While it is of utmost importance to build an efficient and responsive system for everyday use, it is also crucial that the transportation system be capable of equally efficient and responsive services in case of emergency. To this end, **Nimble Response** provides solutions for both emergency planning and action.

*Emergency Preparation & Planning*

**Nimble Response** builds on **Distributed Information Management (DIM)** and the current model of fire and police service stations by distributing services across the city. Moreover, all of these distributed transportation and emergency services within each localized zone are housed together in comprehensive polycentric **Distributed Service Centers** to facilitate inter-agency communication. With emergency planning and response distributed across the city and housed together with related transportation and city services, response time to any specific location is minimized without diminishing response capabilities. Moreover, if any particular **Distributed Service Center** is incapacitated, neighboring **Distributed Service Centers** are available nearby to coordinate and take over responsibilities as needed.

Whenever possible, **Nimble Response** preparation teams assemble comprehensive **Prepackaged Response plans (PpRp)**. **PpRps** serve as a quick and robust starting point for easily anticipated emergencies in the city such as weather emergencies

(e.g., blizzards, tornados, heat waves), small-to-medium system fires, system evacuations, etc. Multidimensional **PpRps** include components such as initial drafts of public announcements, actions to be taken by transportation, police, fire, and other service personnel, and communication plans for affected municipal services and utilities. Having **PpRps** on hand aids in rapid response for predictable emergencies to reduce delays in response time.

Since many emergencies are not easily anticipated, **Nimble Response** makes use of the **Multi-Mode Response Council** and solutions such as an **EmPatt**, **Leveled Risk ID**, **Targeted Scanners**, ubiquitous sensing technology, **Graduated Backup**, and **Response Networks** for further planning. Together these preparations anticipate and identify potential problems or risks; collect, archive, and package possible response solutions; and establish backup supports.

**EmPatt**, the **Emergency Patterns Database**, is a security tool used to help collect, organize, and analyze information from past emergency cases and security threats in Chicago and other cities around the world. As part of Chicago's preparation and planning for future emergencies, **EmPatt** helps **Nimble Response** planners identify possible preventative action for various situations based on patterns and multiple factors along with the source of both successes and failures of various cases in order to continually improve emergency planning and action.

**Leveled Risk ID**, in conjunction with the information generated by **EmPatt**, is a supporting tool that incorporates and matches

**Discussion cont'd**

real-time transportation activity patterns to identify potential risks through the use of **Targeted Scanners** and ubiquitous sensing technology monitoring activity patterns within the system. **Leveled Risk ID** helps **Nimble Response** prioritize action by rating potential risks according to different levels of attention needed (e.g., needs immediate response, warning to monitor, currently non-threatening but with potential depending on specific factors, etc.)

**Targeted Scanners** arch over key transportation points (e.g., station entry points, points of transaction) and scan all system users unobtrusively upon system entry. They are similar to present-day metal detectors, but **Targeted Scanners** are capable of scanning for all security-threatening materials and substances through **EmPatt**'s regularly updated database of material types, combinations, proportions and other key patterns that match the makeup of potentially threatening items. Instead of focusing security scans and searches on specific users, **Targeted Scanners** and ubiquitous sensors shift the focus of security to potentially harmful materials moving through the system (see scenario for further explanation). Together, **EmPatt**, **Leveled Risk ID**, **Targeted Scanners**, and ubiquitous sensing technology provide **Nimble Response** with a system-wide awareness that aids in emergency preparation.

**Nimble Response** includes an inter-agency **Multi-Mode Response Council (MMRC)** to maximize rescue access in any given emergency situation. Examples of **MMRC** plans include identifying and organizing the use of air, water, surface, rail, and underground freight as available modes for emergency system access. The **MMRC** also finds opportunities for multi-purpose preparation and use of system components such as **Automated Maintenance Mechanics** (see **Evolutionary Maintenance**) for emergency rescue efforts.

For the backup components of **Nimble Response**, **Graduated BackUp** and **Re-Routing Communications** are used to protect critical information and communication and provide backup support to the system without overburdening the regularly run system. **Graduated BackUp** exists in discrete modules of support separated into categories (e.g., geographic location, transportation mode, maintenance-related systems, etc.) that provide a continuous range of backup services rather than a simple "all systems on/off" for appropriate support as alerted without overburdening the entire system.

For communication backup specifically, **Nimble Response** plans for multiple communication routes through the use of **Re-Routing Communications**. **Re-Routing Communications** begins with the use of self-healing materials for the core network of vital communications. In cases where extensive damage makes this impossible, then communication is automatically re-routed through alternate routes and channels to maintain vital communications and access necessary data that has been regularly copied and stored off-site.

The final component of **Nimble Response**'s planning and preparation includes building Chicago's **Backup Response Networks (BRN)**. **BRNs** are partnerships between the city and various contractors or neighboring cities such as Gary, Indiana or Milwaukee, Wisconsin. These mutual **BRN** partnerships are regularly negotiated so that in large-scale emergency cases that may overwhelm the capacity of **Nimble Response**, relationships and responsibilities are already in place for **BRN** partners to come in for immediate support if necessary and thereby expand the capabilities of coordinated response and backup.

*Emergency Response*

When emergencies cannot be prevented, **Nimble Response** takes action with coordinated efforts through **Bird in Hand**, **the Info/Action Coordination Dashboard**, **Call & Response** protocols, and **Semi-Automated Operators** to protect users and secure the system.

**Bird in Hand** works with the **TransCom Network** and **Distributed Information Management** as a multi-channel platform that utilizes handheld devices with GPS capabilities, other **TransCom** interfaces, & multiple communication channels (e.g., TV, radio, etc.) to link the system and users with personalized real-time emergency information, depending on the scope of the emergency. **Bird in Hand** distributes specific and relevant emergency information and instructions to individuals; communications are adjusted in real-time in response to what the user does, where the user is located, and how the situation changes. The GPS technologies embedded in the **TransCom Network** also aids **Nimble Response** teams in locating potential victims in the case of disaster emergencies.

During an emergency, the **Distributed Service Centers** utilize the **Info/Action Coordination Dashboard** program within each center and across centers to automatically collect and organize coordinated activity. **Info/Action** provides emergency responders with ongoing access to activity of other relevant parties across the city and across agencies. Additionally, **Info/Action** is used to organize and implement **MMRC** solutions and plans when appropriate. If there is overlap or holes in emergency action, **Info/Action** immediately identifies and flags these cases to help response teams make better informed decisions of how to prioritize and distribute response resources effectively.

To further maximize the impact of emergency action, communication protocols known as **Call & Response** are built into the **Nimble Response** communication system. These response actions are more or less complicated depending on the priority and importance of the communication; for example, message received e-signatures may be required for higher security communications while simple "button press" responses may be used for low priority communications. Where there is no response to a communication, **Call and Response** will

**Discussion cont'd**

follow-up more or less aggressively depending on the urgency of the message.

Finally, in order to support effective human judgment in emergency situations, **Nimble Response** includes the use of **Semi-Automated Operators** in the transport system. **Semi-Automated Operators** consist of a partnership between human system operators (e.g., station employees, vehicle operators) and automated response technologies. If a problem in the system is identified, options for appropriate action are suggested by the system to operators to support decision-making in the moment of emergency, but ultimately the decision is left to human operators, and actions reported through **Nimble Response** communications.

**Scenario I:**

Like any other regular work day, William is at the North Center **Distributed Service Center (DSC)** seated in front of his **Distributed Information Management (DIM)** console monitoring transportation system activity. He notices that a **Targeted Scanner** at the Montrose thruway station has identified the entry of a potentially harmful substance into the system. Ubiquitous sensors track the movement of this substance; by itself, the substance is harmless, but when combined with a specific catalytic chemical it can be used as an explosive, which is why **EmPatt** has it tagged as a low-level risk. However, **Targeted Scanners** and ubiquitous sensors have detected the movement of that very second catalytic chemical in another part of the system on the west side of the city. It is also flagged, and William sends a message to the Humbolt Park **DSC** and all **DSCs** between them are cc'd on the message as well. William almost instantaneously received a "message read and noted" response through **Call & Response** protocols. As sensors monitor the movement of both of these substances, it becomes noted that they are moving toward the same station. **Leveled Risk ID** automatically raises the risk to medium and all nearby **DSCs** are alerted. William continues to watch the exchange of messages and movement of flagged risks, but within a few minutes it is noted that the primary substance has left system, eliminating the potential risk of harm to the system. The activity is automatically logged into the **DIM** system and William returns to his regular work.

**Scenario II:**

One week later, William sees that there is a small fire that has broken out at the Addison thruway station. He has been alerted to the event and sees on the **DIM** console that there are 3 passengers still in the station who have been sent **Bird In Hand** emergency instructions via **Transcom Network** interfaces to their handheld devices. William can see through the **Info/Action Coordination Dashboard** that the firefighters downstairs have already been alerted and moments later he hears the fire trucks leaving the **DSC** with sirens blaring. Since traffic has already been cleared by **Optimized Infrastructure**

for a direct fire truck route, William knows that the firefighters will arrive at the Addison station in a matter of minutes.

William turns back to the **DIM** console to note that through **Call & Response** protocols that all 3 passengers had received the **Bird In Hand** instructions, left the station, and were already on their way headed east on a **secondary express route**.

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