



SYSTEMS THINKING PROCESS ANALYSIS

September 1999

MINNESOTA DEPARTMENT OF TRANSPORTATION
ACCESS MANAGEMENT INITIATIVE
TECHNICAL STUDY #1



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ACCESS MANAGEMENT INITIATIVE

TECHNICAL REPORTS

To provide a basic framework for evaluating the issues and opportunities surrounding access management in Minnesota, a series of technical studies was conducted by Mn/DOT:

1. An intensive *Systems Thinking* process took place with various jurisdictional stakeholders to determine the relationship of access management to external forces and how they drive or depend on each other.
2. Market research was conducted to determine the driving public's view of access management. A report, *Public Understanding of State Highway Access Management Issues*, was produced.
3. A study, *Statistical Relationship Between Vehicular Crashes and Highway Access*, was done to determine how the occurrence and frequency of access onto a roadway affect vehicular crash rates.
4. *Toward an Access Classification System and Spacing Guidelines* identifies how driveways, medians, and intersections should be managed on different types of roads in different urban/rural environments.
5. *A Permitting Practices Analysis* includes recommendations for improved roadway entrance permitting processes and techniques.
6. *Land Use Approaches* were developed that include strategies for strengthening the link between local land use decisions and state highway design and management.
7. *A Legal Analysis* was done that addresses the issues of the public's right to safe and efficient movement on the highway and an abutting property owner's right to reasonable access.
8. Workshops were held in all eight Mn/DOT districts in the fall of 1998 for state, county, city, and township transportation, planning, and elected officials. A report, *Access Management Local Government Workshops*, was created based on feedback received during workshop breakout sessions. Report findings indicate the most commonly perceived reasons, obstacles, and preferred approaches to improving access management in Minnesota. These report findings were used to develop the recommendations for an access management program outlined in the *Highway Access Management Policy Study*.

The culmination of Mn/DOT's 18-month Access Management Initiative was a report to the 1999 Minnesota Legislature, *Highway Access Management Policy Study*. This report includes recommendations for improving access management practices statewide.

I. INTRODUCTION TO ACCESS MANAGEMENT AND SYSTEMS THINKING

a. Access Management Initiative

Access Management is an effort to improve the traffic efficiency and safety of the roadway while still providing appropriate access to adjacent land development. The Minnesota Department of Transportation (Mn/DOT) established the Office of Access Management (OAM) in March 1997, to study the issues and to recommend a strategy for addressing those issues. A report was submitted to the Minnesota Legislature in January 1999, with recommendations for a comprehensive statewide access management policy. The report focuses on an incremental approach to ongoing access management efforts that includes partnerships with local governments to manage access more effectively.

During the 18-month initiative, the OAM gathered information and consulted with the counties, cities, and townships to develop a broad-based approach to improve access management statewide. Various studies were done to determine current and best practices in land use planning, engineering, and legal procedures.

b. System Thinking Workshop

As part of Mn/DOT's Access Management initiative, a two-day workshop was held in December 1997, to develop an understanding of the forces and players involved in the effort to manage the highway system and the access to that system from abutting land uses. The growth in the number of driveways and roads connecting to our major roads has accelerated congestion and compromised the safety of the roadways. This workshop included representatives from public and private sectors who have experience and insight into how these situations develop and an understanding of the forces that are at work to make access management a challenge.

c. Systems Thinking - A Definition

Systems Thinking is based on the premise that structure influences behavior. When different people, at different times, in different places experience the same results from a process or circumstance, it is likely because there is a system in place controlling the outcome. The Systems Thinking structure includes subtle factors such as how decisions get made and the operating policies of institutions that get translated into action. It also includes the motivations and perceptions of people involved. The power and leverage of Systems Thinking come from new ways of thinking about old problems. If we clearly understand the system, not just our part in it, we can choose to operate differently.

II. THE METHODOLOGY

a. The Question

The question for consideration by the workshop participants was:

What are the issues that affect how we provide or manage access to land development and simultaneously preserve the safe and efficient flow of traffic on the road system?

b. The Process

The workshop began with an introduction to Systems Thinking. Participants were asked to identify and capture all the issues they could think of based on the question stated above. The next step was to develop clusters which involved reviewing the list of issues and organizing them into groups of similar issues. Those clusters were given a title that captured the major common theme of the issues included in the cluster.

Participants then connected the clusters together and described the relationships between them. Loop diagrams were formed to describe the relationships between the clustered issues and the clusters were changed and modified as the relationships began to emerge.

Issues, concerns, leverage points, and potential approaches were identified and a preliminary system diagram was created. (Figure 1)

The workshop was completed with a process check and final comments. A model diagram from the workshop was then referred to the access management staff for further refinement.

Access Management staff and the facilitator continued to refine the model to clarify the relationships and to make sure all issues were accounted for in the diagram. The resulting systems diagram was reviewed with selected workshop participants and several interest groups. Identified issues were addressed and are included in this report.

c. The Participants

David Ekern, Director, Engineering Services Division, Mn/DOT
Bill Schreiber, Director, Intergovernmental Policy, Mn/DOT
Pat Murphy, Director, State Aid Division, Mn/DOT
Karl Rasmussen, State Traffic Engineer, Mn/DOT
Dick Stehr, Division Engineer, Metro Mn/DOT
Connie Kozlak, Met Council Transportation Planning
Dennis Berg, Anoka County Commissioner
Troy Gilchrist, Attorney, Minnesota Association of Townships

Wayne Fingalson, Wright County Engineer
David Jessup, Woodbury City Engineer
Louis Robards, Assistant Attorney General, Transportation Division
Kerri Hermann, Assistant Attorney General, Transportation Division
Del Gerdes, Director, Project Development, Mn/DOT
Joanne Ploetz-President, Lofgren Trucking
Charles Cadenhead, Office of Advanced Transportation Systems, Mn/DOT
Neil Peterson, Commercial Developer, Metropolitan Council Member
Bob Engstrom, Commercial/Residential Developer
Jana King, Economic Development Services
Remi Stone, Attorney, League of Minnesota Cities
Jim Berg, Office of Strategic Initiatives, Mn/DOT
Office of Access Management-Staff
Cecil Selness, Director
John Anderson, Community Development
Tom Valley, Project Manager
Peggy Reichert, Land Use Planner
Donna Lindberg, Public Affairs
Mark Anderson, Project Documentation
Dave Engstrom, Principal Engineer

d. The Facilitator

Jim Berg of Mn/DOT's Office of Strategic Initiatives served as the facilitator for the workshop. Jim is a business systems consultant and is certified in Systems Thinking process facilitation. Berg has an MBA from the University of St. Thomas and has served in a variety of management, management analysis, and planning positions with the state of Minnesota since 1970.

III. ISSUES IDENTIFIED BY WORKSHOP PARTICIPANTS

a. Issues

During the brainstorming portion of the Systems Thinking workshop process, participants came up with approximately 120 issues. These issues were then organized into groups or “clusters” of like issues and were given these titles:

- ▶ Urban and rural differences
- ▶ Safety and mobility
- ▶ Statewide transportation planning
- ▶ Financial resource allocation
- ▶ Community involvement
- ▶ Coordination
- ▶ Political decision making
- ▶ Land use planning
- ▶ Engineering
- ▶ Peoples’ transportation needs and wants
- ▶ Value of access
- ▶ Money wants
- ▶ Societal trends
- ▶ Judicial decisions
- ▶ Money availability
- ▶ Community planning
- ▶ Dissatisfaction
- ▶ Environmental issues
- ▶ Jurisdictional authority
- ▶ Modal integration

These main issues were then placed on the wall and workshop attendees formed relationships between them. Figure 1 shows the result of that effort. This figure shows each of the issues and adds arrows which indicate relationships and intervening issues. The direction of the arrows indicates which issue has an impact on the other. Following the arrows from issue to issue often results in a full circle. When that occurs the result is a feedback loop that is important to understanding the system at work.

The primary relationships identified by the workshop participants were:

- The translation of the public’s transportation needs and wants through the legal structure
- The need for coordination of decision-making among the jurisdictions involved
- A political decision that results in financial resources dedicated to access management

Further analysis will refine and expand on this initial analysis.

b. Access Management Systems Thinking Exercise

Possible Interventions - places where the players can intervene in the process to change results.

Archetypes – common systems of behavior over time that can be identified and where long-term consequences can be predicted.

Leverage Points - places where the least amount of intervention will have the most likely chance of success.

Possible Interventions:

1. *Proposals for Profitable Developments* needs a link to *Highway Planning and Programming*. The current situation has this link occurring over time and based on changes in *Highway System Traffic Levels*.
2. *Proposals for Profitable Developments* needs a link to *Regional Land Use Policy*. The current situation does not have a direct link, nor is any connection clearly established.
3. The interrelationship between *Local Council/Board Support for Development*, *Expectations About Character of Community Development* (public attitudes) and *Demand for Development* (both Commercial and Residential) needs further exploration.
4. Dotted lines imply "weak" linkages. There is a need to study these linkages to determine if they are indeed "weak," exist at all or if other dynamics are at play.
5. There is no direct link from *Regional Land Use Policy* to *Economic and Demographic Changes*. There is a need to determine what information exists about whether or not *Regional Land Use Policies* directly affect *Economic and Demographic Changes*.

Archetype Discussion:

The diagram (Figure 12) that has a reinforcing loop and a balancing loop linking at *Highway Level of Service* is an example of the "limits to success" Systems Thinking archetype. The left-hand reinforcing loop creates a cycle that can appear to be quite successful. However, the linked balancing loop eventually limits the development that can occur. The natural tendency would be to push harder to make *Highway System Improvements*. In this case, the slow cycle for *Highway System Improvements* eventually limits the then opportunities for *Proposals for Profitable Development*.

Leverage Points

Leverage Points are actions or decisions, or a series of actions, that can have significant impact on what you are studying. Often it is a small, or overlooked, action or decision that can have the most impact. These are “leverage points.” The analogy of a “lever” to exert significant force with a minimum of effort is apt.

Systems Thinking helps identify complex interrelationships between variables. Often these relationships are not directly connected and actions taken can have unforeseen results. These relationships are frequently counterintuitive in that they work in unexpected ways.

Once the relationships have been identified, it is possible to use the Systems Thinking diagram to study the impact of proposed actions. By testing several options it is easier to identify possible errors, or to find leverage points before actual decisions are made.

Leverage points that were identified:

- ▶ Shorten the process time to allow for a timely response to changes
- ▶ Respond to unplanned development projects to provide more flexibility with right of way
- ▶ Identify key parts of the system and focus efforts on them
- ▶ Strengthen relationships with local units of government
- ▶ Understand and overcome the timing inconsistencies between jurisdictions
- ▶ Broaden the scope, rename the Access Management report to the 1999 Legislature
- ▶ Mn/DOT needs to get closer to local and private-sector decision-makers, those actually doing the project
- ▶ Encourage coordination between jurisdictions
 - ▶ In conjunction with planning
 - ▶ With those who can make decisions
- ▶ Select turn backs only if adequate funding is provided
- ▶ Look at funding options
- ▶ Define “rules”
- ▶ Access management is not a crisis, there is time to make better decisions
- ▶ Maybe preserving access is what we are about
- ▶ Community livability is an incentive for jurisdictions to work together
- ▶ Show and tell. Educate so decision makers understand the issue
- ▶ Get the right parties to the party
- ▶ Work where development is occurring
 - ▶ How to identify problems as projects
 - ▶ Include access management in corridor studies. It is an important state initiative with possible great impact
- ▶ Identify emerging issues and start talking sooner

- ▶ A few dollars to address access control now may be less expensive than paying later
- ▶ Get something on access management to those who have to do comprehensive plans in the metro area
- ▶ Define and defend a long-term plan in a short-term world

c. Systems Thinking Diagram

To build on the workshop results and to complete the integration of the issues identified by the participants, the staff of the Office of Access Management and the facilitator continued to refine the System Thinking diagram. This process included checking all the 120 issues to assure they were represented in the diagram and to complete the evaluation of how forces are directed, the timing in effect and the opposing or reinforcing nature of the relationship between the factors.

Figure 1 shows the final System Thinking diagram. This diagram was reviewed by workshop participants and others prior to its completion.

Figure Symbol Definitions:

S = same direction - a change in one variable causes a change in the affected variable in the same direction

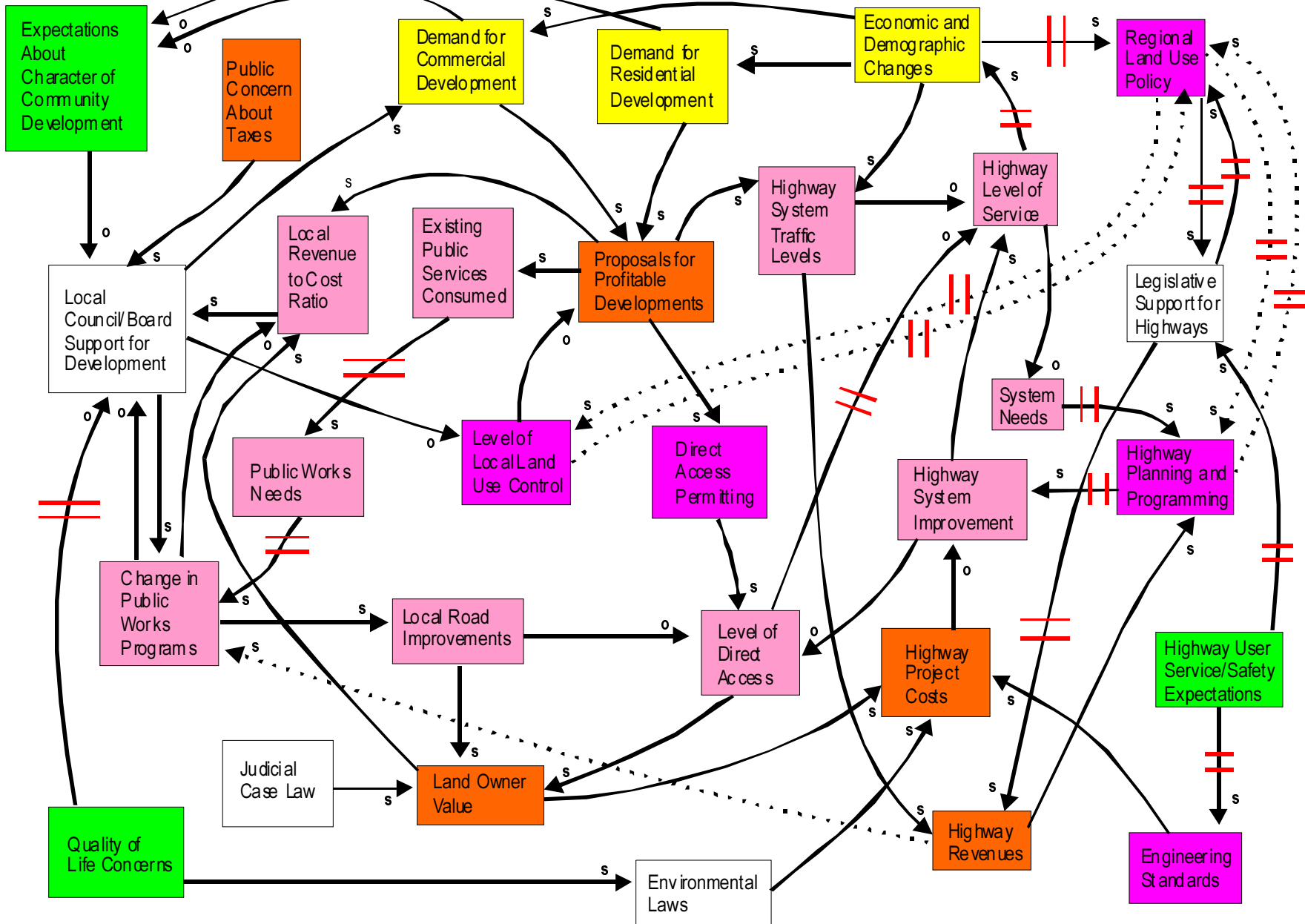
O = opposite direction - a change in one variable causes a change in the affected variable in the opposite direction (as "A" goes up or down, "B" goes down or up).

NOTE: In a series of activities/events, the same/opposite relationships can get quite complex and the reader has to carefully study the "story" of the series of events

Arrow direction = indicates which factor has an impact on other factors

≠ = represents delay - if process is long term and impact will not be felt for a period of time

... = indicates weak links - a relationship exists, but it is not always noticeable



IV. MAJOR THEMES

a. Analysis of the Access Management Systems Thinking Diagram

The purpose of Systems Thinking is to provide insight into and direction in dealing with problems and challenges of complex systems such as Access Management in Minnesota. While there are many insights to be gained from an analysis of this diagram there are three main subsystems at work. If these subsystems are understood, they can provide a basis for improving the way Minnesota handles access management problems.

Three Main Loops:

There are Three Main Loops or subsystems represent this system thinking diagram One is the subsystem the developer and local government official sees. This is called the Developer/Local Government Drivers loop (Figure 2). A second subsystem represents the perspective of the community and owners in the community. This loop is called the Land Values and Development loop (Figure 3). The third subsystem is the one which describes what the highway provider sees and is called the Highway System loop (Figure 4.)

Figure 2

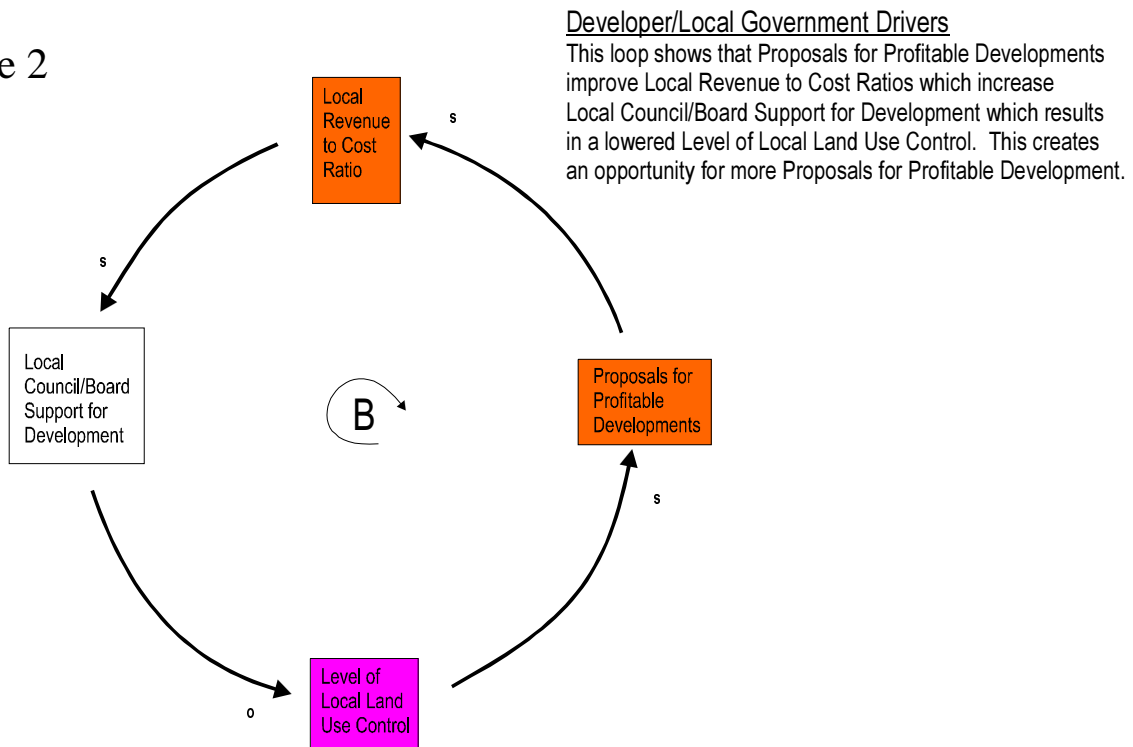


Figure 3

Land Values and Development

This relationship is a reinforcing loop that is modified by the slower rate for developing Highway System improvements and growing quality of life issues. As development occurs, it encourages more development because land values rise and public tax revenues increase.

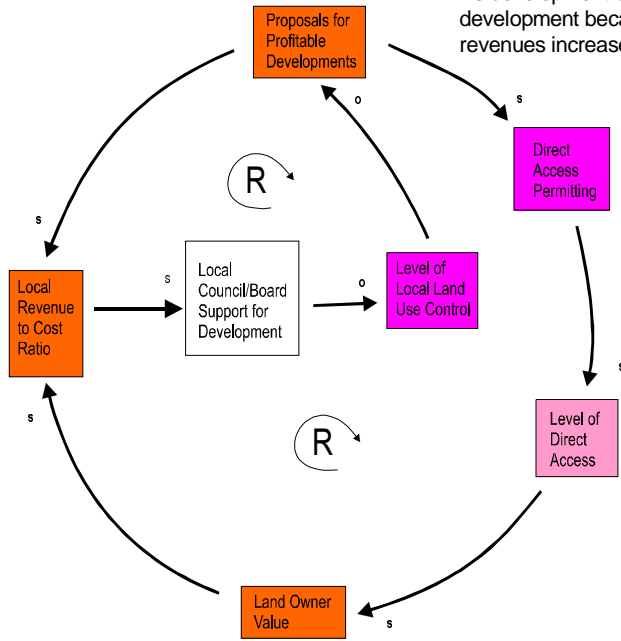
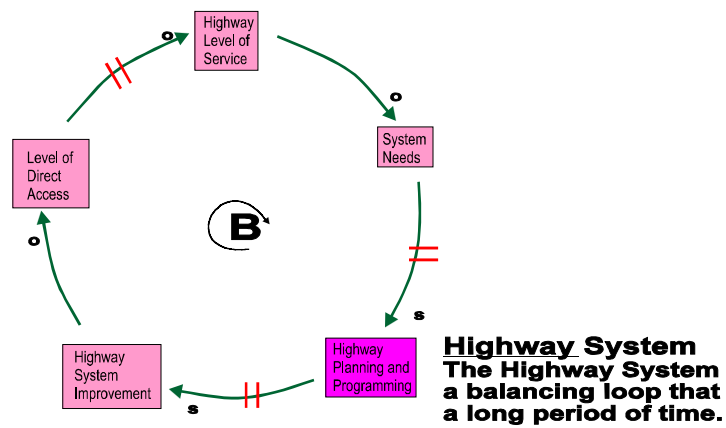


Figure 4



V. MAJOR PARTICIPANTS AND THEIR PERSPECTIVES

a. Community Perspective

- ▶ Development is good for the local economy and produces tax revenue.
- ▶ Best developments require little city infrastructure.
- ▶ Communities support business access requests, particularly when there is competition between communities for the development.

Communities love the prosperity and tax base that comes with economic development.

Proposals for residential and commercial development are supported by the local communities because they fuel the growth and prosperity of the community/county and increase the tax base. Expecting the communities to oppose requests for access to the highway is counter intuitive.

b. County Perspective

- ▶ A strong tax base is important to counties.
- ▶ They desire higher land values generated by economic growth.
- ▶ County roads are also affected by indiscriminate access.
- ▶ The result can be additional roadway costs.

Figure 5

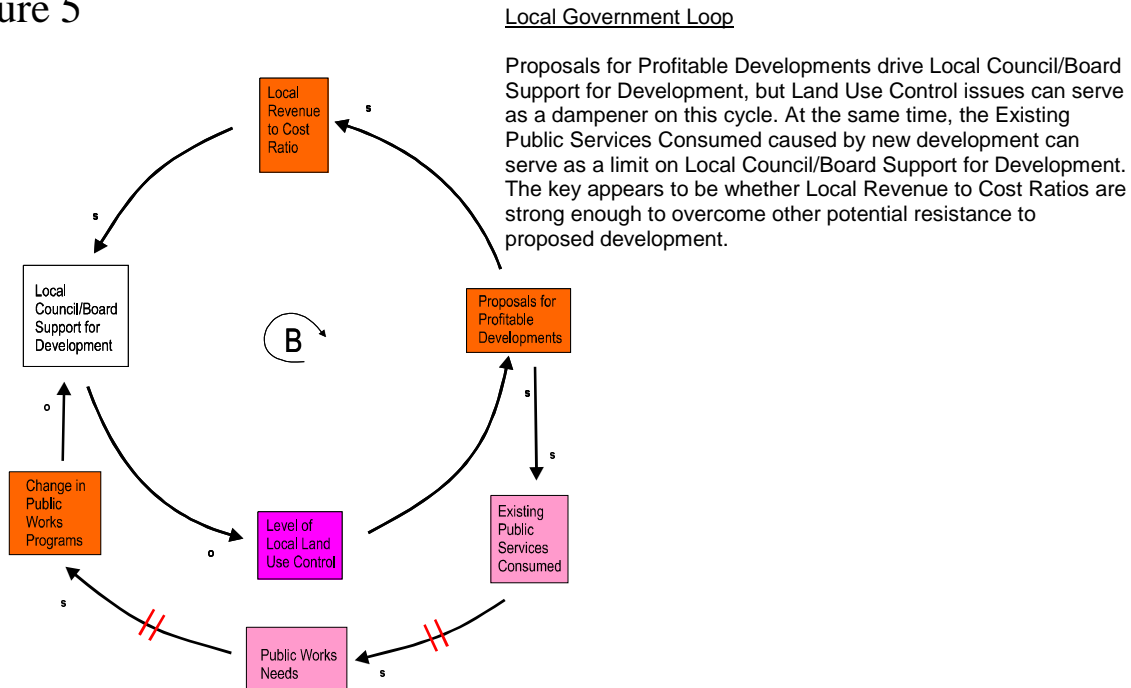


Figure 6

Commercial Development Loop

Proposals for development are supported by elected officials while those developments result in growth and improved revenue. Once capacity in the infrastructure is consumed, investments need to be made, and the public starts to express concerns. As a result, support for investment slows.

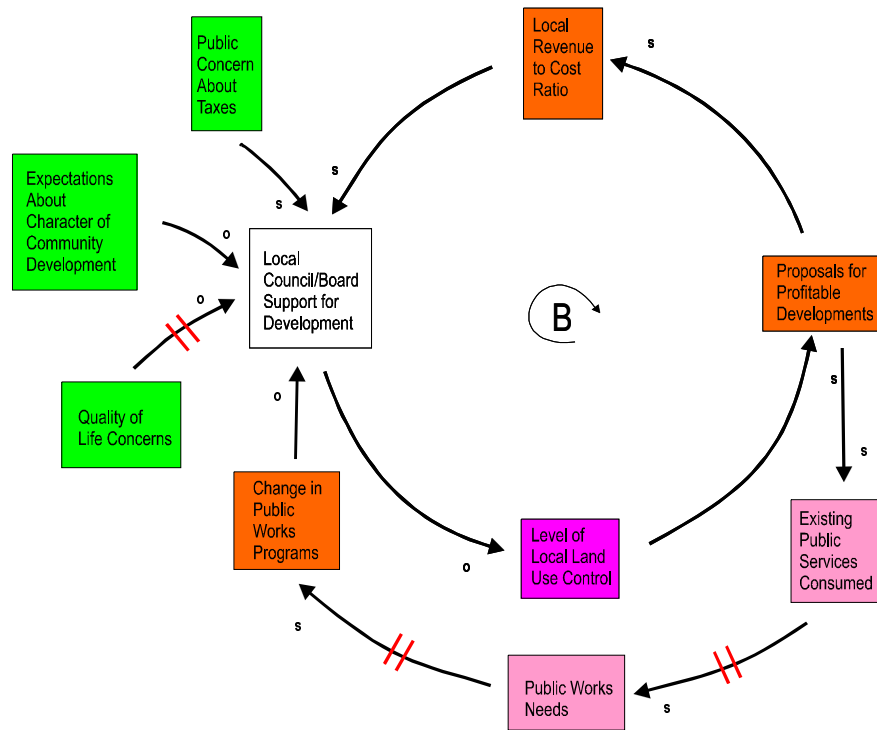


Figure 7

Local Development Loop
Economic and demographic changes drive the development cycle

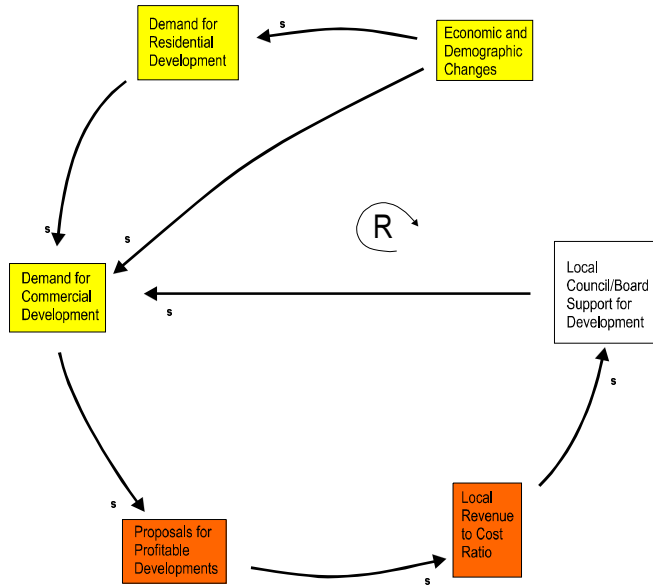
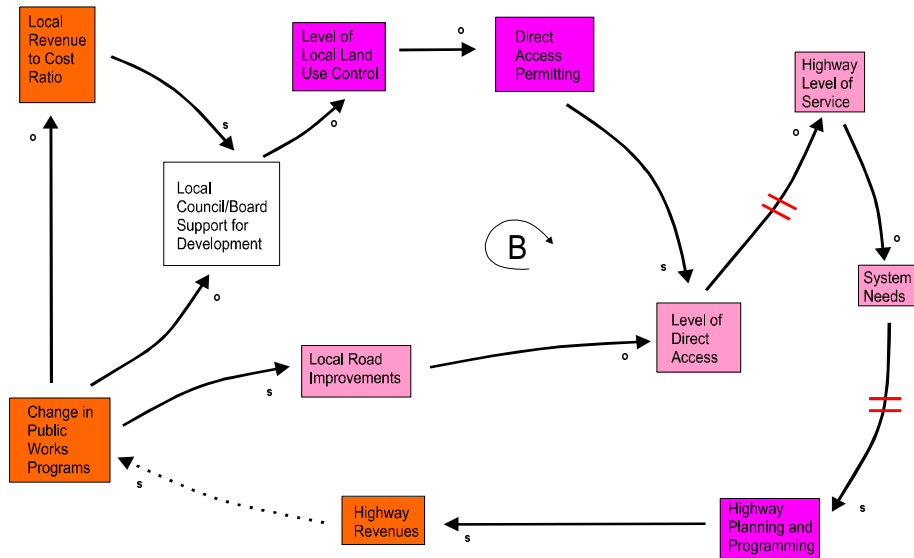


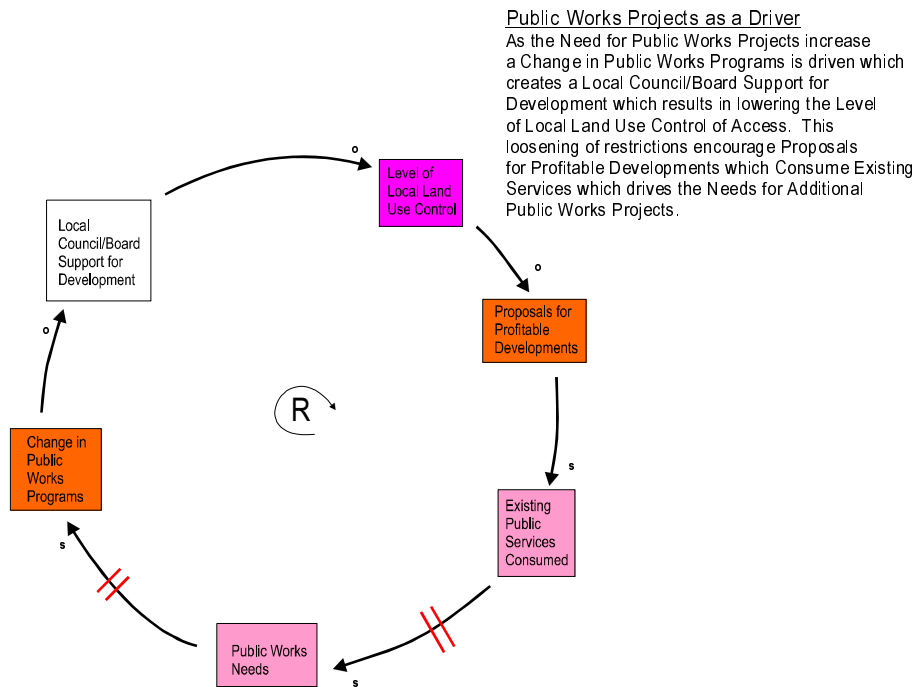
Figure 8



Potential Funding Cycles
Funding Balances Direct Access.
Process works slowly over time.
This is a series of Balancing Loops.

Local public works departments have similar issues that encourage cooperation. The county and local public works departments have similar experiences with development as do communities. Although their focus is on local public services such as streets, sewers, and parks, they also have to be concerned about the revenue/cost relationship. Public works departments may become a valuable ally if the cost of cooperation with Mn/DOT is covered or if they receive a valuable benefit (i.e., long term benefit of good design).

Figure 9



c. Developer Perspective

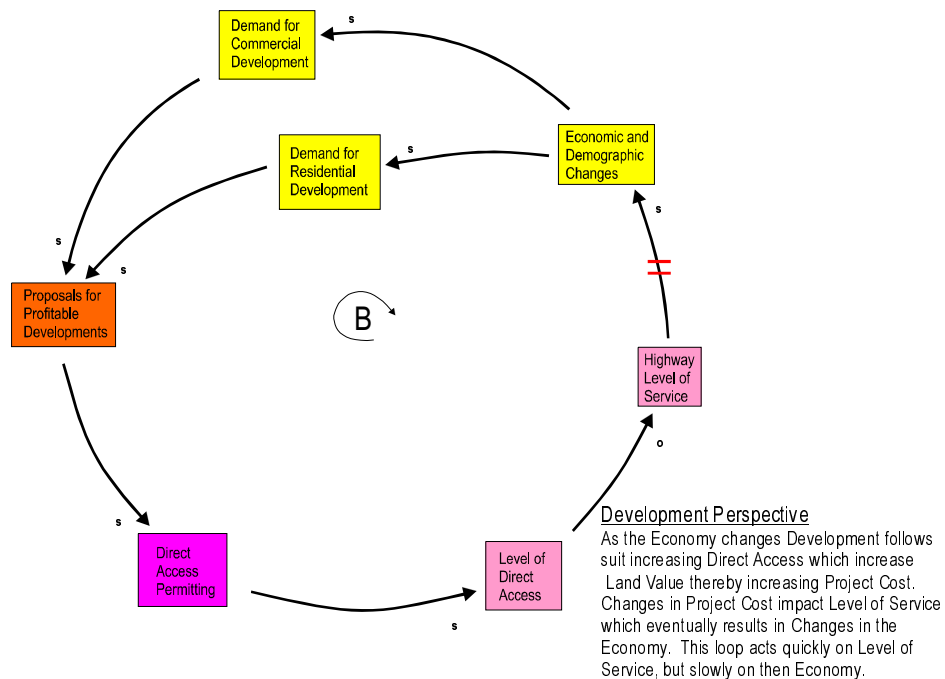
- ▶ A good economy supports development.
- ▶ Development occurs where the infrastructure (including highways) is available.
- ▶ Businesses need access to the busy highway so customers can see and get to them.
- ▶ Profitable ventures attract more of the same.

Mn/DOT encourages development proposals when they have direct access to good roads with plenty of capacity. Development proposals happen when the circumstances of demand and opportunity are in alignment. Part of the opportunity is the availability of high quality highway

service. Growth tends to extend along major highways for that reason. Access to the highway is essential to all development. Residential access can be indirect but commercial properties need easy access to the roadway in order to attract their market which usually comes to them in their cars. The closer commercial development is to the highway, the lower the cost to access that highway and the more likely they will be successful. The impact on the highway system eventually raises the costs and consumes the low-cost sites. Development then moves to a new area adjacent to a highway that still is able to provide an adequate level of service. How long the cycle continues in an area depends on many factors including the foresight and good design practices used.

Developers and communities benefit from access to the state highways. There is often a poor connection between the decisions made by the community and those of the state highway authorities. There is a separation between those who decide about access and the economic impacts of those decisions. Because of this disconnect, developers and communities can maximize their benefits by consuming highway capacity resources that they are not accountable for (i.e., externalizing costs).

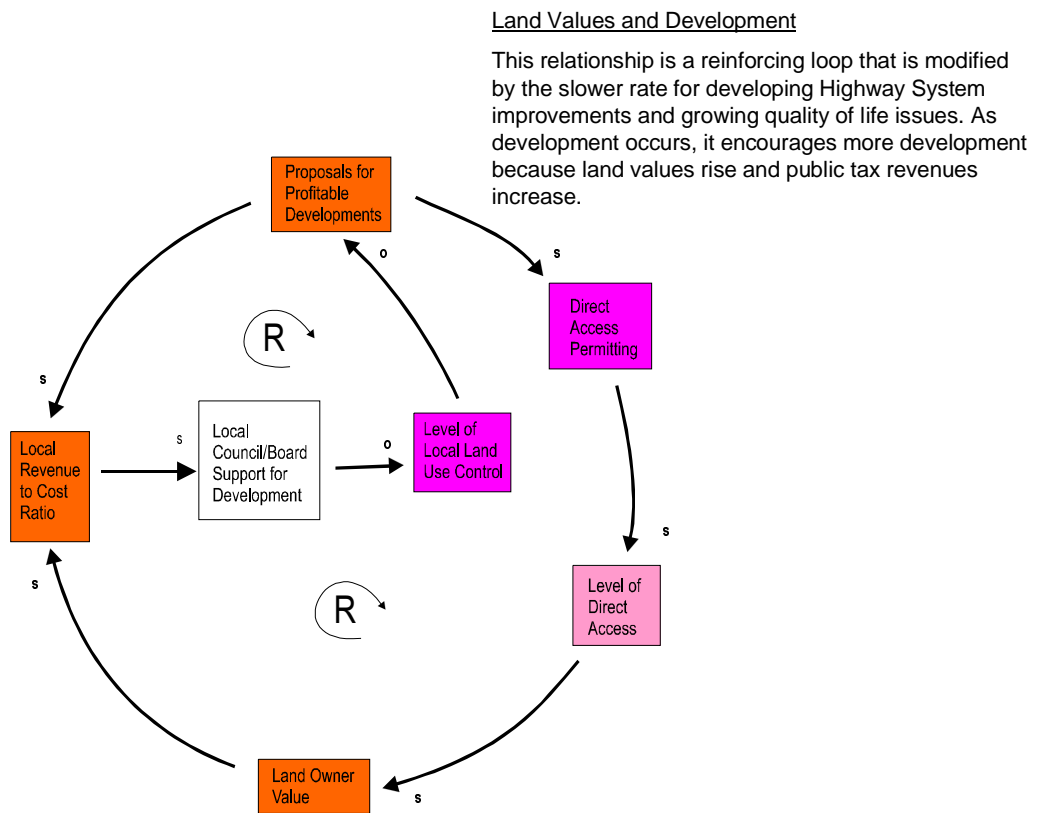
Figure 10



d. Land Owner Perspective

- ▶ Property values are directly affected by the proximity and quality of access to the highway.

Figure 11



e. Mn/DOT's Perspective

- ▶ Indiscriminate access decreases level of service (LOS) of the roadway.
- ▶ The capacity and the safety of the roadway are compromised.
- ▶ As LOS declines, need to invest in roadway maintenance and reconstruction increases.
- ▶ Improved highway capacity supports economic and demographic growth.
- ▶ The result is increased demand for highway access.

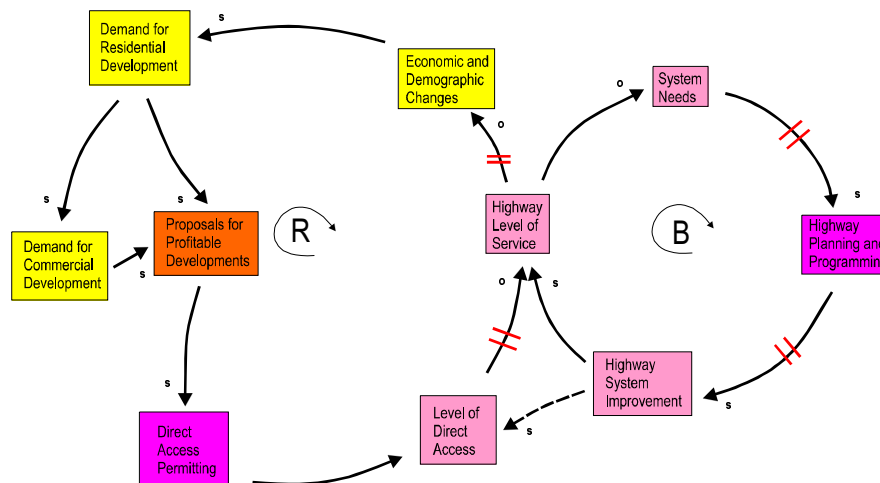
It all begins with the economic and demographic cycles:

Demand for access to the highway system is driven almost exclusively by the economic and demographic change cycles. These cycles can be fast acting and powerful. While there are national and regional characteristics, the impact on the highway system is experienced locally because every community has its own cycles and timing.

Mn/DOT experiences the economic cycles differently than the private sector does.

Mn/DOT experiences economic cycles as being relatively slow acting and the impact on the highway system is cumulative over time. A growing economy will increase system traffic levels which affect level of service and requires a programmatic response to increase capacity. It also results in increased revenue and, as long there is extra capacity in the system to provide for the increased traffic levels, the revenue will exceed the need. But as capacity is exhausted, this reinforcing loop becomes a downward spiral. Costs increase faster than revenues and are more resistant to correction. We are presently coming into that part of the cycle. Environmental requirements, increasing land values and growing expectations by highway users all act to dampen this cycle by increasing costs and decreasing support for funding increases.

Figure 12



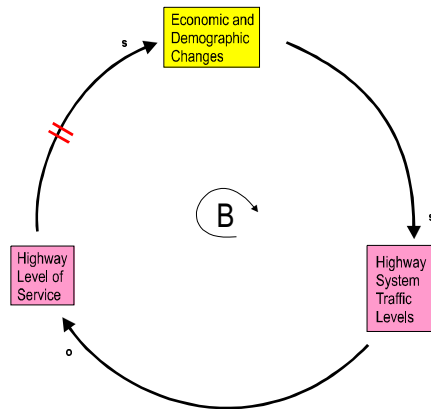
Engineering Perspective

If the Highway Level of service declines, the need for Highways increases requiring planning for System Needs, and provision of systems Improvements which in turn improve the Highway Level of Service.

Access Management from Mn/DOT Perspective

As Highway Level of Service Improves I encourages Economic Conditions opens Development Opportunities that result in more Direct Access. Increased Direct Access reduces Highway Level of Service over time

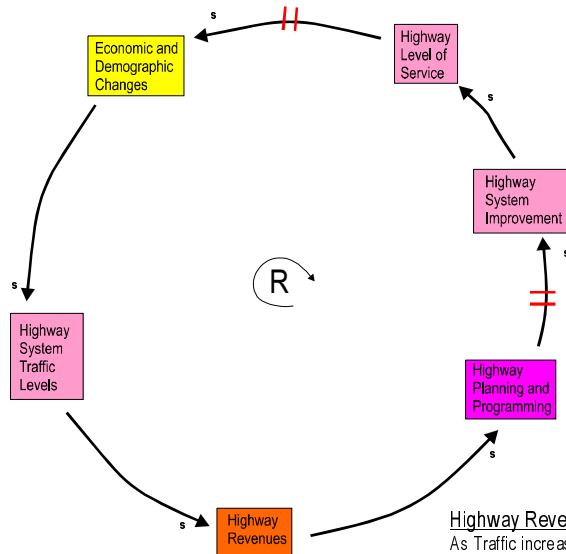
Figure 13



Highway User Perspective

Over a long period of time the effect of the Economy will change Traffic Levels which in turn will effect the Level of Service. This then will impact the Local Economy. This is a slowly developing loop

Figure 14



Highway Revenue Perspective

As Traffic increases, Highway Gas Tax Receipts increase allowing for increased System Planning and Improvements which improve the Highway level of Service. This encourage higher Levels of traffic.

VI. CONCLUSIONS

a. All interests have a common desire to maximize their economic return

1. Competing interests meet at the edge of the road. They all see specific benefits to development adjacent to the highway:

- ▶ Landowners --- Property values
- ▶ Developers --- Profitable development venture
- ▶ Community --- Growth and tax base
- ▶ County --- Tax base and infrastructure
- ▶ Mn/DOT --- Safety/road capacity/project cost

2. Everyone optimizes their own situation:

- ▶ The best overall solution does not always benefit everyone.
- ▶ Everyone minimizes their own immediate and visible costs.
- ▶ The name of the game is to externalize your costs.

b. Decision making is not coordinated

Decisions happen in many places:

- ▶ Development decisions happen in the private sector.
- ▶ Land use and community decisions are made at the local government level.
- ▶ Major highway decisions are made at the county and state level.

c. Access issues grow over time

- ▶ Large problems arise from many small uncoordinated decisions made over time.
- ▶ Development decisions only take one to two years.
- ▶ When the problem is apparent, the best solutions are no longer available.
- ▶ Highway projects take five years or more.

The factors that support good access management come into effect after it is too late. Over time, increasing cost of service, consumption of public (and private) road capacity and diminishing quality of life act to moderate the local desire for development projects. By the time these factors come into play, opportunities for access management practices become expensive retrofit projects.

Mn/DOT's time lines are too slow to respond to the local development cycle. There is a significant difference between the speed and timing of local development and local decision making compared to Mn/DOT's decision and implementation cycle. Often a road project is on

the books for seven years or more before it gets built, while a private development can be built in a year to 18 months. The development cycle will not slow down so the challenge is for Mn/DOT to find a way to respond to it.

Figure 15

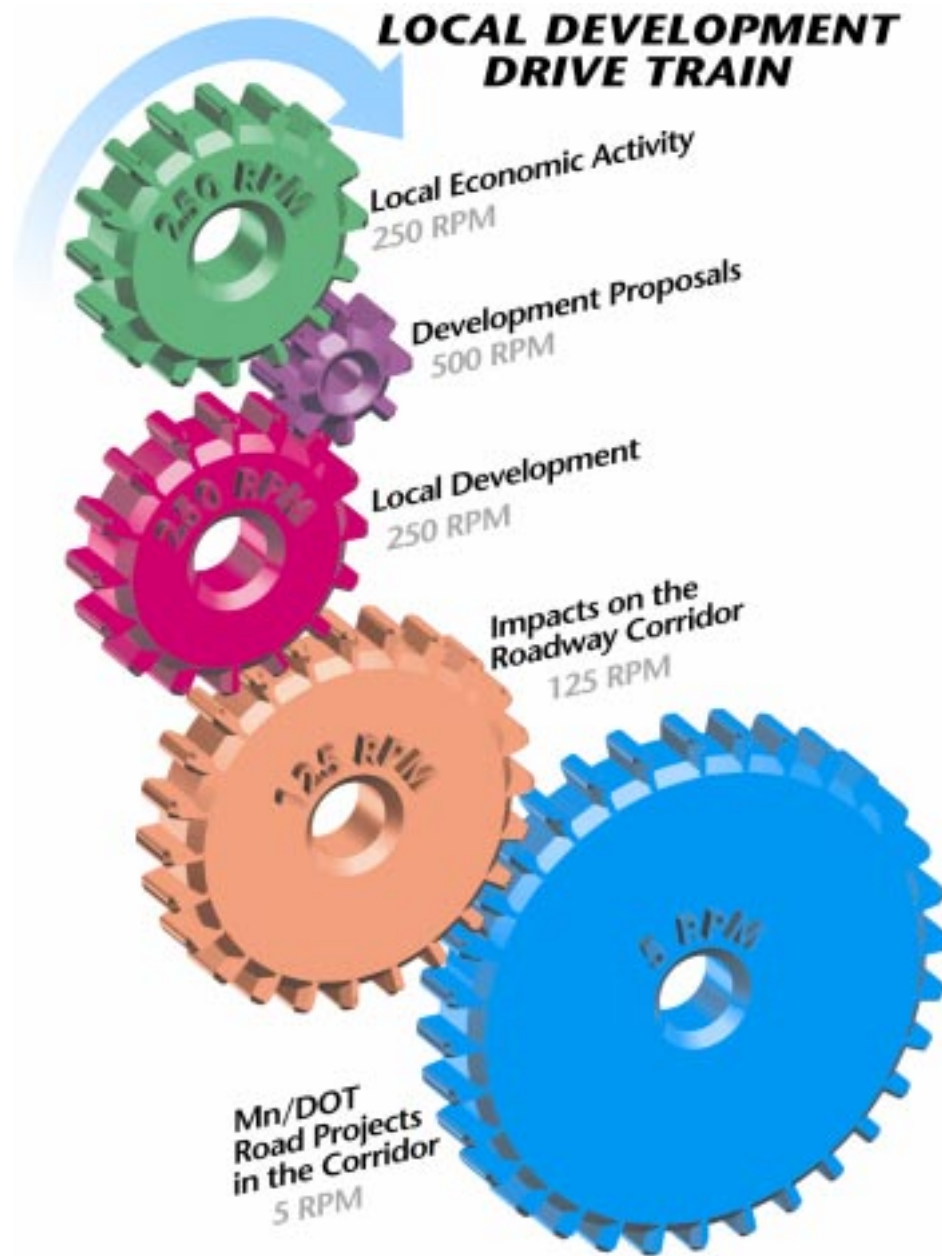
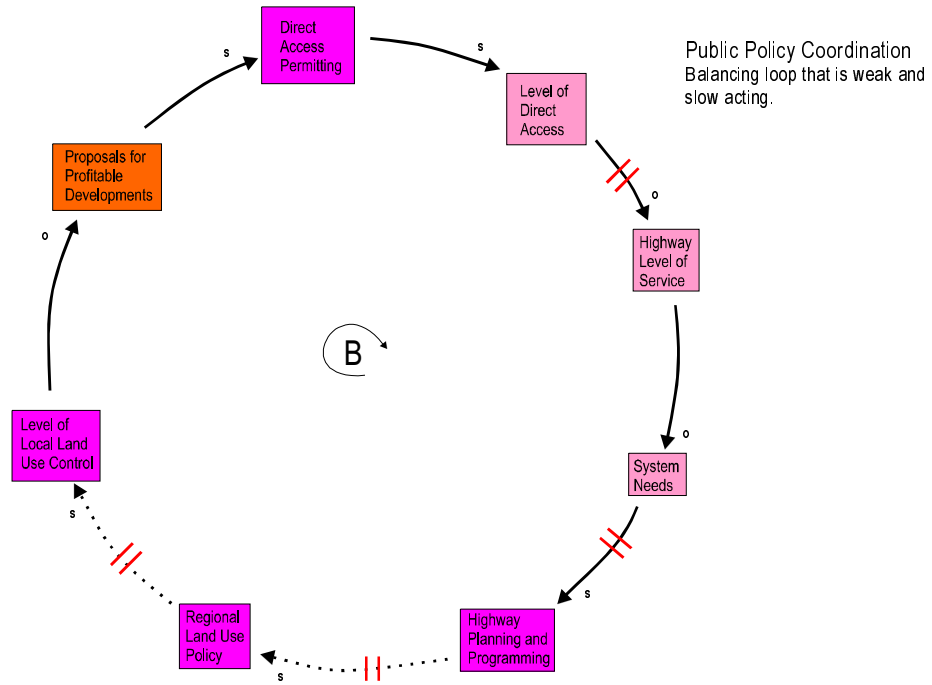


Figure 16



VII. POTENTIAL APPROACHES

a. Potential System Changes

- a. Tie the highway and local community decisions and funding impacts more closely together.
 - Exchange information about impacts of decisions
 - Establish consequences and benefits of access management decisions
 - Do coordinated comprehensive planning
 - Develop programs that tie the interests of state, county and city together
 - Review policies that inhibit investment by private and local interests in projects that support economic development and provide for appropriate access.
- b. Forecast and monitor development cycles to get ahead of them.
 - Develop key indicators of pending growth such as housing permits and prepare regular forecasts of where purchase of access control and/or land use regulations will be needed.
 - Review policies and programs to identify adjustments that need to be made.
 - Provide forecast information to Mn/DOT and local officials to help them understand the issues and encourage early action.
- c. Develop and promote road/community design approaches that have a long-term benefit for both the highway system and the community.
 - Do coordinated comprehensive planning
 - Develop and provide technical support for communities on the growing fringe so they can respond to early growth in their areas.
 - Do a pilot study with a community to demonstrate alternative designs that deliver capacity and still meet the community's needs.
 - Seek cooperative efforts to retrofit access and highway design in coordination with the redevelopment cycle of the community.
- d. Develop a Mn/DOT approach to access management that allows for a regulatory, programmatic response within the time line of the development cycle.
 - Develop engineering guidelines, model ordinances, and zoning regulations that encourage consistency in the practice of access management.
 - Establish a funding source and program for the implementation of preventive access management practices.
- e. Speed up the highway balancing cycle to better address the development cycle.
 - Create a smaller cycle that can respond in the same 12-18 month cycle and that is integrated with the community decision making.
 - Start earlier in identifying critical development cycles so that Mn/DOT can partner with the local communities to take timely action.