Summary of a Symposium on the Navigation Economic Technologies Program (NETS)

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An overview of the NETS Modeling Symposium

The Navigation Economics Technology (NETS) program is a multiyear and multifaceted set of studies to evaluate and develop a set of economic modeling tools that can be used to assess the economic costs and benefits of navigation projects. This memo summarizes the outcome of the NETS Modeling Symposium that took place on June 21-22, 2004. The symposium was sponsored by the Army Corps of Engineers (ACE), Institute for Water Resources (IWR) and was designed to review conceptual and practical designs and findings to date of studies and projects that have either been initiated or are in process. The goal of the symposium was to permit ACE, academic and non-academic participants to share, integrate knowledge and possibly identify and resolve issues in NETS related research. Some participants were present throughout the meeting, while others attended parts of the symposium to provide selected input.

The following items and studies were presented during the symposium:

- Introductions, Overview of NETS and Symposium (Keith Hofseth)
- HaborSym and the Glass Box Philosophy (Shana Heisey)
- International Spatial Forecasting of Grain Flows (William Wilson)
- Mid-America Grain Study (Kenneth Train)
- Pool Demands (Kenneth Boyer)
- Lock Efficiencies (Wesley Wilson)
- Appointment System (Don Sweeney)
- Closing Remarks (Wesley Wilson, Keith Hofseth)

Introductions, Overview of NETS and Symposium

During the introduction of the NETS program and the symposium, it was noted that though the NETS program has been discussed for some time, it was not until recently that funding was provided. Key individuals have been actively engaged in NETS research for 15 to 16 months. The symposium was described as supporting the development of robust plan development tools for navigation projects by sharing the vision of a nucleus of individuals and presenting ongoing navigation research, including assumptions and compromises. The hope was that the presentations would reveal how the Corps currently conducts particular analyses, identify areas of criticism to current methods, and ultimately outline how the Corps and its research partners plan to resolve areas of criticism in the analytical approaches.

NETS research was said to be structured around the 6-step Corps planning process: 1) Problem Identification, 2) Inventory and Forecast, 3) Plan Formulation, 4) Plan Evaluation, 5) Plan Comparison, 6) Plan Selection. It was noted that criticisms have typically been targeted toward individual planning steps rather than the planning process itself. The following sections summarize 6 studies that were presented during the symposium and the major issues or questions that were raised by participants. Participants were encouraged to ask questions and raise relevant issues regarding conceptual, data, econometric or computational details of each study. The questions and issues section that follows each study summarizes the key questions and issues that were raised

during the symposium and tries to point out any clarifications that were made. The aim is to bring these questions and issues to the forefront so that researchers may further review the issues. However, these sections do not attempt to provide a running list of verbatim or anecdotal responses to all questions and issues.

HaborSym and the Glass Box Philosophy

Presenter: Shana Heisey, IWR.

HaborSym is a simulation based decision support application that the Corps is in the process of finalizing for use in port improvement studies. HarborSym, like other decision support applications recently developed by the Corps, is designed with the intention of offering a wide range of generic application opportunities. Such decision support tools provide more flexibility and avoid the pitfalls of previous applications that were hard coded to specific projects and thus were of limited use once the particular project was completed.

The generic nature of the application is maintained by designing the embedded models to be data driven. In other words, more of the model functionality is driven by user input. A computation kernel then takes this input and simulates what could be expected in terms of benefits if specified navigation improvements were implemented. HarborSym in particular was designed to enable the evaluation of potential benefits of port based navigation improvements such as the widening of port entry channels. The HarborSym application and underlying model was built with the support of the Galveston District. With each application the model has underwent modifications that make it more generic so that researchers from other Districts can adopt it and use it.

Following IWR's "glass box" (as opposed to "black box") philosophy of trying to develop models whose internal implementation is known and fully visible, it is the hope that the computation kernel used in HarborSym can be reviewed for computational correctness. HarborSym has been designed with windows that permit analysts to see what is driving the model. The application's Graphical User Interface (GUI) also permits a user friendly option for mapping the study network and inputting data.

Other principal features of the application and internal model include the user's ability to build/define the system to be simulated and provide application parameters (navigation rules) for the system. Once the system has been defined and all parameters specified, HarborSym can simulate vessel movements through the system and capture vessel delay times. Comparing vessel delay times for with- and without-project conditions permits HarborSym to estimate potential benefits of proposed navigation improvements.

Questions and Issues

- During the presentation, a clarification was requested on exactly what the model does. In response, it was clarified that the model was designed to move vessels. Shipments lists are provided to the model and in turn the model processes the vessels through a defined system and calculates when a navigation rule would be violated and thus causing a delay.

- One participant wondered whether the HarborSym model was a WAM-based model. In response, it was mentioned that HarborSym was a data driven model and was similar to a WAM-based model.

- Clarification was requested on the meaning of "data-driven". Data-driven was explained to imply that many of the model's functional components are determined or influenced by user specified data inputted into the model.

- A question was raised regarding the model's forecasting capability. In clarification, it was mentioned that the model was not designed to perform forecasts but to run simulations. Commodity and fleet forecasts can however be used as inputs to the model.

- One participant inquired on the model's backcasting capability. Backcasting was said to be problematic in the model due to data issues.

- Participants asked whether the model and interface was geo-referenced and whether the different segments of the waterway system were mapped to scale. The presenter responded by mentioning that the system was geo referenced by the longitude and latitude positions of system nodes but it was not mapped to scale. One reason for not mapping the waterway segments to scale was because it allowed analysts to focus on the segments of interest by expanding these sections while minimizing those of less importance.

- Several inquiries focused on navigation rules and restrictions that are incorporated in the model. Participants wanted to know whether specific navigation conditions and rules associated with those conditions have been addressed in the model. For example, participants wondered whether navigations rules for different related navigation conditions had been incorporated. One participant wondered whether navigation rules were site-specific or pilot-specific as well. In response to all these questions, the presenter noted that in one form or another, it was possible to add nearly every conceivable navigation rule to the model. However, it was a question of resource and time optimization and determining what rules are essential and adequate for most types of project evaluations.

- With regard to whether users will have the ability to add external events to the model, the presenter indicated that a programmer would have to go back into the programming code to build a new rule.

- A question was raised on how uncertainty is treated. The presenter indicted that Monte Carlo simulations are used because of uncertainty.

- One participant observed that many of the questions raised were very relevant but applied to different hierarchies or operational perspectives. The participant warned of possible information overload if all these issues were addressed within one model. One possible solution was the development of a hierarchy of models. Each model would focus on a different level of detail. As an example, the Freight Analysis Framework (FAF) model developed by the Federal Highway Administration (FHA) was developed to simulate freight movements for the entire nation and was considered the baseline model. To accommodate regional and state level analyses, the FHA developed step down models to simulate smaller regional entities based on a hierarchy.

- Regarding HarborSym's applicability to other harbors, the presenter explained that HarborSym has the advantage of maintaining the same functionality. Additionally, the model saves time because the algorithms are the same. The hope was that once the current study was completed, the model could easily be applied to other harbors.

- Why was Tampa chosen for the case study? Why not New Orleans where there are more vessels? Tampa was chosen because it was manageable and has no seasonality. New Orleans has seasonality and other complications making it not suitable as an initial model study area. HarborSym model development and analysis is also tied to particular studies and funding.

- Consideration the prevalence of the cruise ships in Tampa Bay, one participant wondered whether cruise ships get any preferential treatment in the model. In response the presenter indicated that one of the rules in the model specifies the protocol of vessel preferences. A rule could be set so as that cruise ships are preferred.

- One participant was very pleased with the HarborSym model and its application. The participant's opinion was that if the model is implanted incrementally project by project, it should become the model of choice for channel widening applications.

Other Questions and Issues Not Directly Addressed

- Clarification was also requested on how delays are calculated.

- The participants wondered whether the MicroSaint software offered any benefits to the HarborSym model.

- How is seasonality accounted for?

- In calculating arrival times do you put in Poisson distributions?

- How does this approach compare with running regressions on delay?

- How is time optimized?

- What would be the impacts of LNG, weekend rates, etc.?

Lock Efficiencies

Presenter: Wesley Wilson

The purpose of this study was to develop and estimate a model of lock performances of lock flotilla based on historical LPMS data. A flotilla is defined as a power vessel and a set of barges. Information gathered from this study would help understand factors that lead to variation in lock transit times and could be used to estimate lock processing times for different types of flotilla. Two types of locks were considered: single lockage and double lockage. In the single lockage, a flotilla approaches the lock, enters the lock chamber, gates are closed, the lock is filled then emptied, the gates open, and the flotilla exits the lock chamber. Extra steps are required for a double lockage. Furthermore, there are two lockage types established: consecutive and straight locks. LPMS data analyzed for this study reflected data for the Upper Mississippi River where there is a total of 29 locks and where approximately 50 percent of the locks are double cuts.

The econometric model used for this study regressed processing times as a function of lock and flotilla characteristics among many other factors. The factors included observable or directly measurable phenomena, such as lock width, length, lift and age and generally non-observable or harder to measure factors such as river conditions and lock master rules. At the time of the symposium, models generated were preliminary and the signs of the coefficients were not all

obvious or logical. There would be a need to further understand the lockage technologies and processes before really understanding the LPMS data. Further analysis would look at vessel effects, firm effects and equilibrium changes over the geo space.

Questions and Issues:

- Participants asked for an explanation clarifying the meaning of "firm effects" and wondered whether each lock can be considered a firm. The presenter explained that firm effects could be the result of locks processing different tow companies hauling commodities down the river. Presenter was also in agreement with a suggested notion of considering the different locks as separate firms.

- After the clarification on the meaning of firm effects, one participant suggested that one possible way of capturing firm effects was to include all locks in the model and then determine whether each lock is significant. Significant locks could then be further investigated. The presenter was in agreement with this approach. The presenter elaborated by indicating that when group-lock type dimension dummy variables were removed from the equation and replaced with individual locks dummies, the model showed a very small but positive increase that is statistical significant. However, the presenter indicated that the problem with separating the lock effects is that it becomes very difficult to return back to the dimensionality question. The presenter explained that he would like to maintain the grouping effects and then explain away the other differences in locks with observed data.

- An issue was raised on why the study needed to incorporate dimensions. The presenter explained that there was a need to be able to answer policy questions such as, "We have 600' locks, what happens if we have 1200' locks?"

- One participant noted that a variable that was not addressed is depth over sill. This varies from lock to lock and determines the speed of the approach. In addition, instead of using LPMS exclusively to look at the WCSC data, it was recommended that locks be inspected for sill depth to determine the sill depth that will allow vessels to maneuver faster. The policy decision would then become - if you have a deeper sill, can move more tonnage per lockage.

- Participants wondered whether there were recreational vessels at locks and whether mixed a lockage would produce a slower processing time for exit/entry times assigned to commercial vessels. It was agreed that recreational component may affect lockage times. A member of the audience suggested that there were all kinds of externalities other than single and double cuts that affect processing times. It was also noted that these were very seasonal.

- One participant suggested that the study team also look at commercial vessels that have no recreational components as opposed to mixed lockages that could embrace both commercial/recreational.

- The presenter mentioned that the study team had calculated the variables to identify rules from the data but had not been able to determine any systematic application of the rules. One participant suggested that looking at each of the steps would reveal systematic patterns.

- As a caution one participant warned that that the system is set up with defaults and that people who work on the locks sometimes tend to enter default entries due to work overload.

- In one participant's belief, the data on lock approach times is the most important determinant of lock cycle time followed by filling and emptying times in estimating and explaining variability in locking time. The inclusion of upstream/down stream dummy variables was also suggested.

- It was also suggested that some discussions be initiated with Upper Mississippi and Ohio River Corps analysts since they have been through this analysis before. They could provide some valuable insights.

International Spatial Forecasting of Grain Flows

Presenter: William Wilson

This presentation reported on the preliminary findings of a study that is analyzing the major changes in international grain trade to 2025 and beyond and the implications for transportation infrastructure planning. The study uses a spatial equilibrium model to forecast future grain flows. Some of the motivations for the study included interest in the general outlook of the industry, the reliability of longer term world grain flow forecasts, impacts on Upper Mississippi grain flows, impacts of consumption, competition and uncertainty/risk over time.

A review of the world grain trade shows that there have been many long term large scale transportation infrastructure projects that have relied on long term projections of grain flows. These projections have focused on areas such as export trade, barge traffic growth and have been based on past history. Such projection studies often assume constant proportions of trade flows over time. A general observation of these historical studies reveals that most of these studies have generally over-projected future grain flows. Most of the studies have also ignored risk or may have incorporated risk using a scenario based analysis but have failed to define what the risks are.

There are three main issues that are impacting world grain trade: China consumption (amongst others), Ethanol, and Brazil. Import demand for grains in China is forecasted to grow significantly in the next 10 to 25 years. A dramatic increase in the U.S. domestic corn demand for ethanol is also forecasted in the next 10 to 25 years. Most models have under estimated the impact of Brazil. Infrastructure investment in Brazil is significantly reducing shipment costs from Brazil.

Questions and Issues

- During the presentation one participant pointed out that there are things that influence the forecast that have distributions (i.e., can be considered random variables). This was acknowledged in the affirmative.

- Another participant cautioned that when dealing with forecast error, one needs to be very careful because the real phenomenon one may be trying to predict may be influenced by distributions that are really unknown.

- One participant was concerned about one study conclusion suggesting that corn production is shifting west and north of the existing Corn Belt. Such a trend would mean that corn production was being moved into regions with shorter growing seasons and lower rainfall. Plant breeders will face a real challenge with the introduction of new significant uncertainties. The participant thus suggested checking with plant breeding and production specialists.

- With regards to the spatial equilibrium model that looks at cost minimization and long-run competitive equilibrium, a question was raised about who's costs are being minimized? The

presenter indicated that the study was looking at world costs of all shipping countries i.e., all actors in the industry.

- Commenting on the use of cost reductions as a way of simulating investment cost in infrastructure, participants wondered whether using a profit maximization approach would offer similar results. One participant suggested that the use of profit maximization, rather than cost minimization may be more applicable for modeling purposes. The presenter was more of the opinion that such would be true if there was only one actor in the industry.

- In consideration of the amount of land that can be brought into crop production, a question was raised on whether land is interchangeable. The presenter indicated that land is interchangeable, subject to technology.

- Is agricultural production sustainable in poor lands? It was noted that much of Brazil's land is poor, and agricultural production on those lands may not be sustainable (slight difference, but 'poor lands' may connote lands in poor countries).

Other Questions and Issues Not Directly Addressed

- An issue was raised on whether the study considers alternate mode/route substitution.

Mid-America Grain Study

Presenter Kenneth Train

This study analyzed data from two surveys of shippers and developed mixed logit models from this data to determine price elasticity. The presenter highlighted the importance of understanding price elasticities of shipments on the inland waterway system. Motivation for this study was to develop a grain transportation model that is academic, usable and reflective of how shippers make decisions on what mode of transportation to use. The first model, termed the "tow cost" model analyzed 1,800 shipments. For each shipment the model determines the quantity that is being shipped and calculates the cost of shipment by barge and by the least cost alternative. The model stipulates that grain shipments would stay on the barge until the cost rises up to the least cost overland alternative – then shipments move over land by alternative mode.

The problem with this model is that it extremely convenient but not realistic. Two main problems were pointed out. First, as the cost of shipping by barge rises, one would expect to see a gradual migration of shipments to the least cost overland alternative--this is not the case in the tow cost model. The second limitation is that even though it may be cheaper to ship using the least cost overland alternative, some shippers still choose not to switch for various reasons.

The "essence" model addresses the first of those limitations by developing an elasticity of quantity shipped with respect to barge shipments costs. The essence model removes the rigidity of the price at which shippers decide to switch from the barge shipment mode and thus produces a downward sloping demand curve. There are some general assumptions about the shape of the demand curve (convex, concave or straight line) but the model in general modifies the shape of the demand curve from the initial "tow cost" model. Such changes have major implications because the benefits of a project are entirely determined by the shape of the demand curve. For example, a project whose purpose is to reduce barge costs caused by congestion could be justified under the "tow cost model" and yet not be justified if the "essence" model is assumed. The "essence" model typically produces fewer benefits due to the downward sloping demand curve.

The "survey" model addresses other factors that make shippers continue to use barge transportation despite the cost being higher. The demand curve for the survey model is estimated based on data collected through surveys and is not assumed. The demand curve for the "survey" model shows that there would still be a demand for barge transportation even when shipment costs are greater than the least cost overland alternative. Just like the "essence" model, some benefits are lost. However extra benefits are generated from shippers who still stay on barge after barge costs exceeds overland costs. So the model suggests that in reality benefits could go either way.

Finally, there are 1,800 separate demand elasticities for these models--one for each shipper. Choosing a single elasticity would require an abstraction. The current study uses a separate elasticity for each shipper as revealed by their previous choices.

Questions and Issues

- Participants requested the definition of a shipper and noted that the term was being used rather loosely. Participants also wondered whether there existed a list or directory of shippers that use the waterway. The hope would to use such a list as a population from which to select the survey sample. In response the presenter indicated that the survey population was obtained from a USDA list of elevators and supplemented with a trade association membership list. The presenter further indicated that the research team had not yet defined the universe of shippers.

- As a follow up one participant noted that in North Dakota, there are 400 elevators and only 5 shippers. The participant also noted that the definition of shipper is not exactly clear. In the past, shippers were always thought of as originators of grain. Now, shipping decisions, modal choice, is made by somebody other than the originator.

- One attendee pointed out that there should be a differentiation between shippers and carriers (they are not necessarily the same). The presenter acknowledged this and reiterated that the term shipper was not strictly defined.

- A concern was raised about self-selection bias and whether the survey was based on a random sample. The presenter acknowledged such concerns but pointed out that one has yet to define what the universe of shippers is to be able to determine whether this was a biased sample. With regards to the randomness of the sample, it was agreed that there was a self selection bias on responders. The presenter further explained that the study puts more effort into getting more representative samples.

- In one participant's opinion, the study team needs to find a way to collect a sample of observations that is truly representative of the river shipment population and its alternative modes, routes and markets. The participant further suggested that the current study was woefully short on river shipments, though the anticipated data on 100 barge shipments if provided would help greatly.

- Considering current day elevators going out of business, a question was raised on whether grain elevators should be the target survey participants? In response it was indicated that what the study was aiming for was a model of the underlying decision process. It was not clear whether it really matters who makes that decision. The general understanding is that shippers describe the process in the same way.

- A question was raised on how travel times are incorporated into the analysis. In response, it was mentioned that changes in travel times are only reflected through costs in the current models, while this study shows they have an independent effect.

- An issue was raised on whether the study considers a shift to trucking. In response, the presenter indicated that there is a limitation on how much the highway can handle. The presenter indicated that a shift to trucking can be captured through programming an increase cost of trucking, which would then feed back into the model.

- One participant questioned whether it was reasonable to assume that barge and rail elasticities are the same. The presenter suggested that the barge and rail elasticities would be similar because a person, having chosen to ship by barge, would likely be less time sensitive. Since rail transportation is also relatively slow, one can infer that the same person's rail elasticity would be similar.

- Referring to the term "elasticity," the presenter cautioned that the term was sometimes used too loosely. For this study it referred to the percent of shippers who switched mode of shipment.

- One participant suggested that investment be considered not only for possible cost effects but also for potential service quality effects. In other words, if you have an investment, it will not only affect costs. It may also affect the service quality. Therefore the shift may also occur as a result of service quality affects.

- One participant recommended that the study also investigate shipper's option based on the question, "what would you have done if the costs decreased by say 10 percent?" The participant suggested that a question would provide some information on the downside.

Other Questions and Issues Not Directly Addressed

- With regards to survey responses, are participants responding to a short-term closure, and change in cost?

- How big is a shipment?

- Is it true that for a large numbers of shippers, there is no alternative?

- May want to include stated preference in consistent way.

- How did grain get to that particular elevator? Is there a discount/premium that starts commodity down a particular path? Is there a precursor event?

Pool Demands

Presenter: Kenneth Boyer

The objective of this study was to use aggregate water transportation data to develop a model that makes sense of the elasticity of demand for transportation on the Upper Mississippi – pool level demand. The study used LPMS data to trace barge movements up and down the river to determine the general origin-destination trends of barges. Compared to other modes of transportation, the Corps' waterway transportation data is very unique and robust.

Among the criteria for a good model is that it should be based on plausible decision settings and modifiable spatially. Classic problems associated with freight transportation demand estimation is that some data are confidential, rates are quoted at much higher levels of aggregation than quantity, and that the choice set can be complex.

The choice setting for grain shipments was considered to be reasonable in terms of variables:

- How many acres
- Level of effort to devote to crop
- How much of crop to harvest
- When to release the harvest
- Whether to deliver harvest to the river port or different location
- Which pool
- When to load harvest on barge to ship to the gulf.

Based on this choice setting, the study outlined three sources of "choice flexibility" of shippers if prices of river services got too high:

- Delay shipment
- Economize on use of river transportation
- Cut all upper river use and use alternative shipping modes

The initial modeling attempts have produced interesting results but have not yet established consistent results. Several issues still need to be reviewed. For example the impact of system leakages to local use, grain shipments to the Pacific Northwest, and intermodal transportation substitutions in shipment decisions.

Questions and Issues:

- Participants asked whether price is treated as exogenous. The presenter responded in the affirmative stating that the analysis will be evaluated at a pool level so price will be exogenous.
- With price being treated as exogenous to the model, one participant wondered whether the argument is that those demands will not have an impact on price. The presenter agreed with assumption explicitly clarifying that those demands would not have an impact on price through congestion.
- A participant pointed out that there two rate components. The mill rate has not changed much since 1984 because they have either increased efficiency or there is an oversupply of towboats. The participant suggested that demand for particular styles of equipment varies. For the Illinois Waterway, because of draft restrictions, rates are on the high side and there is a discount for using deep draft equipment. The participant also noted that the rates used in the study were realistic.

- One individual suggested using the differences between the Chicago Board of Trade price, Gulf price or Minneapolis price of grain as an alternative approach other using the rates currently used in the study.

- It was suggested that to the extent that the market is competitive, the bid price of grain from pool to pool should reflect transportation costs.

- One participant reasoned that there is likely to be bias in each pool and suggested that the direction of the bias be determined.

- One symposium attendee asked whether one would economize by delivering to the lower pool when prices are high. The presenter responded in the affirmative.

- On the question of whether seasonality was captured in the analysis, the presenter responded stating that seasonality was difficult to show. One seasonal pattern suggests that if shipping charges rise then the parameter describing how harvest relates to shipments is going to decrease.

- Participants recommended that 2000 LPMS data not be used for analysis because it represents the first year of a new data system and might have problems.

- One participant warned about the accuracy of reported data on design draft. The design draft is based on industry reporting a 50% error rate. The draft is either based on the vessel's first trip or what the industry supplied. The participant cited examples of cases (Ingram and ACBL) where half of the barge design drafts are incorrect. The participant commented that this problem is less prevalent in tank barge data especially if the vessel has been inspected by the Coast Guard.

- Questions were also raised on the impact of grain being diverted to Pacific Northwest in response to lower freight rates there. And if so, whether there is a need to divide the growing region: one part that is dedicated to the river, and the other to the Pacific Northwest. Furthermore, participants wondered whether there would be any movements over time in the boundary between what goes to the river and what goes to the Pacific Northwest.

- One participant's concern was how the study team would determine the spatial boundaries of the areas shipping by barge, without digging into the relevant transportation cost specific to the individual shippers across space. The boundaries should represent shippers with zero rent.

Appointment System

Presenter: Don Sweeney

This study evaluated ways of reducing congestion at locks. The study uses a MicroSaint discrete event simulation model. The study was initially sponsored by the Institute of Agriculture Policy who sought to increase the carrying capacity on the inland waterways.

The current system of moving barges through lock relies on a first in first out approach. Such a system tends to result in long waiting times during peak demand periods. Several alternative demand management strategies had previously been reviewed to see if they would be suitable for reducing waiting times at locks. Strategies such as the introduction of congestion fees would burden the weak barge industry. Small scale measures of reducing congestion were found to be more appropriate. The use of an appointment based system was identified to be the most promising due to its minimal burden on the barge industry and taxpayers.

As part of this investigation, a model was developed to simulate barge movement through the lower five locks of the Upper Mississippi system. The model used for this study was a first-cut, discrete-event simulation model (using MicroSaint) that was used to model locks 20 to 25 of the Upper Mississippi River (5 lower, most congested locks of system). The other model being developed is the very detailed team model that will be used for the final analysis.

Three classes of traffic were defined for the model: multi-cut commercial tows, single-cut commercial tows, and everything else. The study modeled the river as a closed system with a finite number of barges. The vessels are fed into the system based on historic data and are then allowed to operate in a closed system. Three types of lockages were considered:

- Direction of travel (up bound or down bound).
- Class of traffic (multi-cut, single cut, etc.)
- Lockage type (fly, turn back, and exchange).

The model application uses a Graphical User interface to ease data manipulation and an animation screen for visual effects. It is the Corps' intention to introduce some GIS features to the application.

The simulation model developed was shown to be an effective way of evaluating potential benefits of introducing an appointment-based system. A simple prioritization scheme of selecting the tow that will lock the most quickly was shown to industry cost approximately $4,000,000 per year.

Questions and Issues:

- One attendee indicated that the industry stipulates that they have fog, high current, problems with paperwork, and that they can not even get a lock within a day on upper end of system. The question presented was, how precise will they have to be to get locking times and whether there was anything to the contention that can not make these appointments.
- Some participants wondered whether some barges have GPS systems these days. It was agreed that high-end vessels tend to have GPS systems.
- On the question of whether the study team planned to introduce/analyze recreational vessels, the presenter responded in the affirmative.
- The differentiation of vessels into various vessel classes was of interest to symposium attendees.
- One participant suggested that the study team take a look at gaming to determine what would happen for example when one uses small tows that use less horsepower.
- It was noted that if one was to enforce the current rules in the model, the results would be reduced delay times.

Closing Remarks

Upon addressing outstanding issues and comments regarding studies that were presented, coordinators of the symposium thanked all who were in attendance. Noting that all the presentations were ongoing research studies, it was hoped that the presentations and ensuing

discussions benefited both the presenters and all others who attended the symposium. The spotlight was then shifted onto future research for the NETS program.

Future research for the NETS program was characterized to be focused around key features associated with understanding navigation transportation economics and developing equilibrium models. Focusing on these features was said to enable the identification of problems or hindrances to understanding navigation transportation economics. Among the key features associated with understanding navigation transportation decisions are: the types of decisions and how shippers make shipping decisions; the trading partners of the U.S. receiving agricultural products; the theory of market area competition and the dispersion of grain elevators; how much is processed through an agricultural terminal; procurement and bid prices; and the competitiveness of rates on the inland waterway system. The coordinators of the symposium mentioned that there many ways of tackling problems areas and any research results, models developed and conclusions would advance the goals of NETS program. In closing, the coordinators encouraged participants to provide written comments and invited those who were interested join in furthering the NETS program.