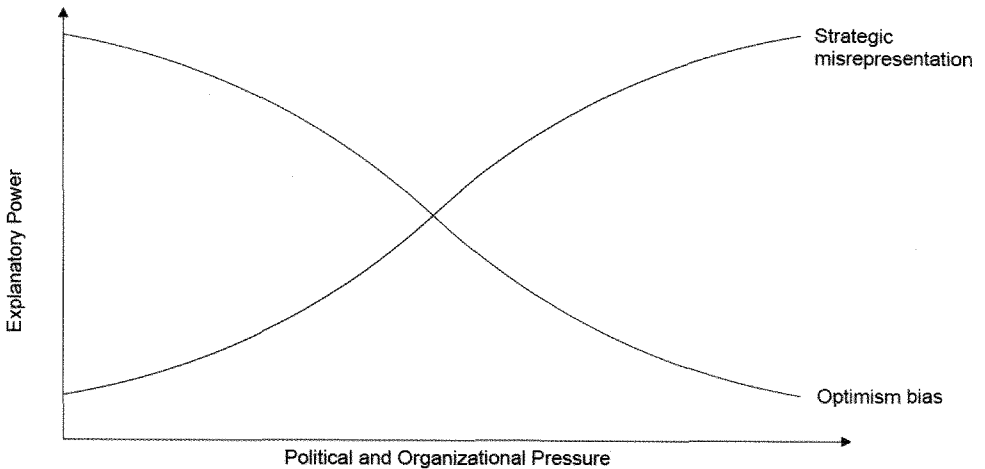


Truth and Lies About Megaprojects

Inaugural speech

Bent Flyvbjerg



September 26, 2007

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Mijnheer de Rector Magnificus,
Leden van het College van Bestuur,
Collegae hoogleraren en leden van de universitaire gemeenschap,
Zeer gewaardeerde toehoorders,
Dames en heren,

Colleagues, friends, and family,

The Dutch econometrician Henri Theil (1961) liked to study the accuracy of forecasts. Once he did a study of accuracy in Dutch weather forecasts. Much to his surprise he found that if the weather forecasting service, instead of doing its forecasts, had simply played an automated recording stating every day that "*the weather tomorrow will be like the weather today*," then the accuracy of predicted weather would have been higher than the accuracy actually achieved with the weather forecasts.

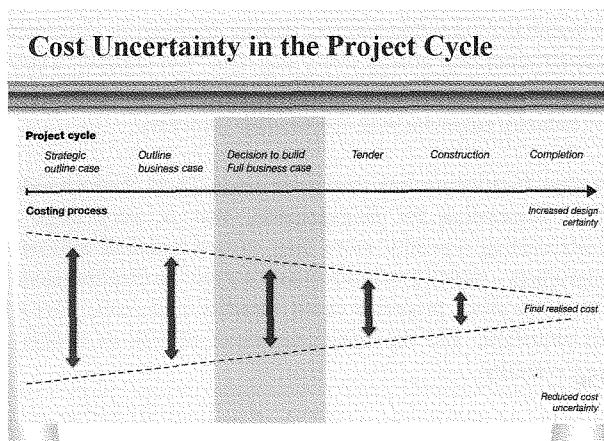
Accuracy in weather forecasting has improved since Theil. Unfortunately, the same cannot be said of forecasting for megaprojects, that is, very large infrastructure investment projects costing typically more than several hundred million dollars. One truth about megaprojects - which I will document below - is that forecasters misinform and sometimes even lie about projected costs, benefits, and risks. This results in cost overruns, benefit shortfalls, and the mismanagement of risk to a degree that often jeopardizes project viability.

Another truth about megaprojects is that if we were to follow Henri Theil's example and predict cost overruns (or benefit shortfalls) in megaprojects after the simple formula that "*cost overrun tomorrow will be like cost overrun today*," then we would achieve significantly more accurate cost estimates than are currently achieved. This conclusion is based on sound economic theory, which won Princeton psychologist Daniel Kahneman the Nobel price in economics 2002 (Kahneman and Tversky, 1979; Kahneman, 1994). On the basis of this theory my team in Denmark and I have developed a new forecasting method called reference class forecasting, which is now being used in a number of countries, including the Netherlands, to better predict megaproject performance (Flyvbjerg, 2006a).

In what follows I will:

1. argue that a major problem in megaproject policy and planning is the high level of misinformation about costs and benefits that decision makers face in deciding whether to build or not, and the high risks such misinformation generates.
2. explore the causes of mis or not information and risk, mainly in the guise of optimism bias and strategic misrepresentation.
3. present measures aimed at better policy and planning, including changed governance structures and better planning methods.
4. identify the most promising areas for further research, especially as they pertain to the Dutch situation and the Chair in Infrastructure Policy and Planning at Delft University of Technology.

The emphasis will be on transportation infrastructure projects. It should be mentioned at the outset, however, that comparative research shows that the problems, causes, and cures identified for transportation apply to a wide range of other project types including power plants, dams, water projects, concert halls, museums, sports arenas, convention centers, IT systems, oil and gas extraction projects, aerospace projects, and weapons systems (Altshuler and Luberoff, 2003; Flyvbjerg, Bruzelius, and Rothengatter, 2003: 18-19; Flyvbjerg, Holm, and Buhl, 2002: 286; Flyvbjerg, 2005a).



Cost Overruns and Benefit Shortfalls

Megaprojects generally have the following characteristics:

- Such projects are inherently risky due to long planning horizons and complex interfaces between the project and its context, and between different parts of the project.
- Decision making, policy, and planning are often multi-actor processes with conflicting interests.
- Often the project scope or ambition level change significantly over time.
- Statistical evidence shows that such unplanned events are often unaccounted for, leaving budget and other contingencies sorely inadequate.

- As a consequence, misinformation about costs, benefits, and risks is the norm.
- The result is cost overruns and/or benefit shortfalls with a majority of projects.

Based on a study my Danish team carried out on 258 transportation infrastructure projects worldwide, Table 1 shows the inaccuracy of construction cost estimates measured as the size of cost overrun.ⁱ For rail, the average cost overrun is 44.7 percent measured in constant prices. For bridges and the tunnels, the equivalent figure is 33.8 percent, and for roads 20.4 percent. The difference in cost overrun between the three project types is statistically significant, indicating that each type should be treated separately (Flyvbjerg, Holm, and Buhl, 2002; van Wee, 2007).

The large standard deviations shown in Table 1 are as interesting as the large average overruns. The size of the standard deviations demonstrates that uncertainty and risk regarding cost overruns are large, indeed.

The following key observations may be made:

- Cost overrun is found in all 20 nations and 5 continents covered by the study.
- 9 out of 10 projects have cost overrun.
- Overrun is constant for the 70-year period covered by the study, estimates have not improved over time.

Table 1: Inaccuracy of transportation project cost estimates by type of project. Constant prices.

Type of project	No. of cases (N)	Avg. cost overrun %	Standard deviation
Rail	58	44.7	38.4
Bridges and tunnels	33	33.8	62.4
Road	167	20.4	29.9

Table 2 shows the inaccuracy of travel demand forecasts for rail and road projects.ⁱⁱ For rail, actual passenger traffic is 51.4 percent lower than estimated traffic on average. This is equivalent to an average overestimate in rail passenger forecasts of no less than 105.6 percent. The result is large benefit shortfalls for rail. For roads, actual vehicle traffic is on average 9.5 percent higher than forecasted traffic. We see that rail passenger forecasts are biased, whereas this is not the case for road traffic forecasts. The difference between rail and road is statistically significant at a high level. Again the standard deviations are large, indicating that forecasting errors vary widely across projects (Flyvbjerg, Holm, and Buhl, 2005; Flyvbjerg, 2005b).

The following observations hold for traffic demand forecasts:

- 84 percent of rail passenger forecasts are wrong by more than ± 20 percent.
- 9 out of 10 rail projects have overestimated traffic.

- 50 percent of road traffic forecasts are wrong by more than ± 20 percent.
- The number of roads with overestimated and underestimated traffic, respectively, is about the same.
- Inaccuracy in traffic forecasts is found in the 14 nations and 5 continents covered by the study.
- Inaccuracy is constant for the 30-year period covered by the study, forecasts have not improved over time.

It is concluded that if techniques and skills for arriving at accurate cost and traffic forecasts have improved over time, these improvements have not resulted in an increase in the accuracy of forecasts.

Table 2: Inaccuracy in forecasts of rail passenger and road vehicle traffic.

Type of project	No. of cases (N)	Avg. inaccuracy %	Standard deviation
Rail	25	-51.4	28.1
Road	183	9.5	44.3

If we combine the data in tables 1 and 2, it is seen that for rail an average cost overrun of 44.7 percent combines with an average traffic shortfall of 51.4 percent. For twelve urban rail projects in the sample, for each of which data exist for both cost overrun and traffic shortfall, the average cost overrun is 40.3 percent and the average traffic shortfall is 47.8 percent. For roads, an average cost overrun of 20.4 percent combines with a fifty-fifty chance that traffic is also wrong by more than 20 percent. As a consequence, cost benefit analyses and social and environmental impact assessments based on cost and traffic forecasts, like those described here, will typically be highly misleading.

Channel Tunnel Ex Post Evaluation

- Actual costs = 2 x forecast
- Actual benefits = 1/2 x forecast
- Actual NPV = \$-17.8 billion
- Actual IRR = -14.45%
- Conclusion: "The British Economy would have been better off had the Tunnel never been constructed"



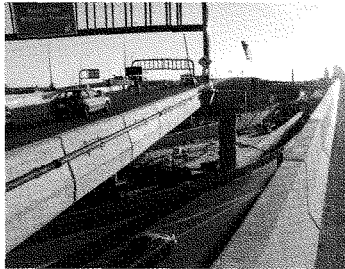
(Ricard Anguera, *Transportation Research A40*, 2006)

As an example, consider the Channel tunnel between the UK and France. Here ex-ante cost-benefit analysis showed the project to be viable, that is, the project had a positive rate of return. At the initial public offering, Eurotunnel, the private owner of the tunnel, lured investors by telling them that 10 percent "would be a reasonable allowance for the possible impact of unforeseen circumstances on construction costs." However, during

construction the 10 percent grew to 100 percent as actual costs ballooned to twice those forecasted. To make matters worse, after operations began actual benefits turned out to be only half the forecast. As a result the actual internal rate of return of the project is negative, -14.45 percent. The Channel tunnel detracts from GNP instead of contributing to it, leaving transportation economists to conclude that "the British economy would have been better off had the Tunnel never been constructed" (Anguera, 2006).

Other examples of projects with large cost overruns and/or benefit shortfalls are Boston's Big Dig, Denver's International Airport, the San Francisco-Oakland Bay Bridge retrofit, the Los Angeles metro, the UK West Coast rail upgrade and the related Railtrack fiscal collapse, the Humber Bridge, the Tyne metro system, the French Paris Nord TGV, Norway's Gardermoen airport, Copenhagen's metro, the Great Belt rail tunnel linking Scandinavia with continental Europe, Bangkok's Skytrain, Japan's Joetsu Shinkansen high-speed rail line, India's Surat-Manor toll way project, and Calcutta's metro. The list ends here only for reasons of space (for a longer list, see Flyvbjerg, 2005a).

Boston's Big Dig: 224% Cost Overrun, and Growing



In the Netherlands, we have only just begun to collect comparable data. Indeed, it is one of the key objectives of the Chair in Infrastructure Policy and Planning to help produce such data. The few Dutch data available at present tells us that construction cost overrun - again measured in constant prices from the time of the decision to build - is 44.9 percent for the almost completed HSL-South, 2.7 percent for the Betuweroute, and 27.2 percent for the Rotterdam metro. Thus the average overrun for the three Dutch projects is 24.9 percent, compared with 33.9 percent in a comparable benchmark of projects. Needless to say, data for more Dutch projects are needed before any firm conclusions may be drawn about project performance in the Netherlands.

Policy Implications

Misinformation about costs, benefits, and risks of the frequency and size described above - and the related cost overruns and benefit shortfalls - are a problem for the following reasons (Flyvbjerg, 2007):

- They lead to a Pareto-inefficient allocation of resources, that is, waste.
- They lead to non-democratic decisions.
- They lead to delays and further cost overruns and benefit shortfalls.
- They destabilize policy, planning, implementation, and operations of projects.
- The problem is getting bigger, because projects get bigger.

The policy implications are equally clear:

- Lawmakers, investors, and the public cannot trust information about costs, benefits, and risks of large infrastructure projects produced by promoters and planners of such projects.
- There is a strong need for reform in policy and planning for large infrastructure projects.

Before depicting what reform may look like in this expensive and consequential policy area, we will examine the causes of cost overruns and benefit shortfalls.

Policy Implications

1. Decision makers cannot trust information about megaprojects
2. There is a strong need to establish incentives and methods that would produce more reliable information



Causes of Cost Overruns and Benefit Shortfalls

Three main types of explanation exist that claim to account for inaccuracy in forecasts of costs and benefits: technical explanations, psychological explanations, and political-economic explanations.

Technical explanations account for cost overruns and benefit shortfalls in terms of unreliable or outdated data, the use of inappropriate forecasting models, honest mistakes, lack of experience on the part of forecasters, etc. This is the most common type of explanation of inaccuracy in forecasts (Ascher, 1978; Flyvbjerg, Holm, and Buhl, 2002, 2005; Morris and Hough, 1987; Vanston and Vanston, 2004; Wachs, 1990). Technical error may be reduced or eliminated by developing better forecasting models, better data, and more experienced forecasters, according to this explanation.

Psychological explanations account for cost overruns and benefit shortfalls in terms of what psychologists call the planning fallacy and optimism bias. Such explanations have

been developed by Kahneman and Tversky (1979) and Lovallo and Kahneman (2003). In the grip of the planning fallacy, planners and project promoters make decisions based on delusional optimism rather than on a rational weighting of gains, losses, and probabilities. They overestimate benefits and underestimate costs. They involuntarily spin scenarios of success and overlook the potential for mistakes and miscalculations. As a result, planners and promoters pursue initiatives that are unlikely to come in on budget or on time, or to ever deliver the expected returns. Overoptimism can be traced to cognitive biases, that is, errors in the way the human mind processes information. These biases are thought to be ubiquitous, but their effects can be tempered by simple reality checks, thus reducing the odds that people and organizations will rush blindly into unprofitable investments of money and time.

Three Types of Explanation

1. **Technical: Inadequate data and models** (Vanston & Vanston)
2. **Psychological: Optimism bias** (Kahneman)
3. **Political-economic: Strategic misrepresentation** (Wachs, Flyvbjerg)

Political-economic explanations see planners and promoters as deliberately and strategically overestimating benefits and underestimating costs when forecasting the outcomes of projects. They do this in order to increase the likelihood that it is their projects, and not the competition's, that gain approval and funding. Political-economic explanations have been set forth by Flyvbjerg, Holm, and Buhl (2002, 2005) and Wachs (1989, 1990). According to such explanations planners and promoters purposely spin scenarios of success and gloss over the potential for failure. Again, this results in the pursuit of ventures that are unlikely to come in on budget or on time, or to deliver the promised benefits. Strategic misrepresentation can be traced to political and organizational pressures, for instance competition for scarce funds or jockeying for position, and it is rational in this sense. If we now define a lie in the conventional fashion as making a statement intended to deceive others (Bok, 1979: 14; Cliffe et al., 2000: 3), it is seen that deliberate misrepresentation of costs and benefits is lying, and we arrive at one of the most basic explanations of lying that exists: Lying pays off, or at least political and economic agents believe it does. Where there is political pressure there is misrepresentation and lying, according to this explanation, but misrepresentation and lying can be moderated by measures of accountability.

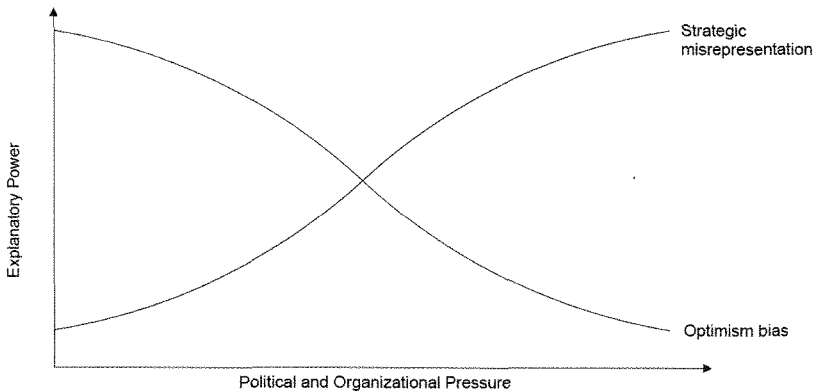
Space does not permit a detailed examination of how well each of the three explanations account for the data on cost overruns and benefit shortfalls presented earlier (for such an examination, see Flyvbjerg, 2007). Enough is to say that technical explanations must be rejected because they do not fit the data. In other words, if misleading forecasts were truly caused by technical inadequacies, simple mistakes, and inherent problems with predicting the future, we would expect a less biased distribution

of errors in forecasts around zero. In fact, we have found with high statistical significance that for four out of five distributions of forecasting errors, the distributions are biased and have a mean statistically different from zero.

This leaves psychological and political-economic explanations that both fit the data. The existence of optimism bias in planners and promoters would result in actual costs being higher and actual benefits being lower than those forecasted, as is actually the case in the dataset. Similarly, a strategic estimate of costs would be low, resulting in cost overrun, whereas a strategic estimate of benefits would be high, resulting in benefit shortfalls, exactly as the data show.

Figure 1 schematically sums up the relationship between psychological and political-economic explanations. Psychological explanations, which account for the data in terms of optimism bias, have their relative merit in situations where political and organizational pressures are absent or low, whereas such explanations hold less power in situations where political pressures are high. Conversely, political-economic explanations, which account for the data in terms of strategic misrepresentation, have their relative merit where political and organizational pressures are high - this being common for large, high-profile, public projects with many and powerful stakeholders - while these explanations become immaterial when such pressures are not present.

Figure 1: Explanatory power of optimism bias and strategic misrepresentation, respectively, in accounting for forecasting inaccuracy as function of political and organizational pressure.



Flyvbjerg and Cowi (2004) interviewed public officials, planners, and consultants who had been involved in the development of large UK transportation infrastructure projects. A planner with a local transportation authority is typical of how respondents explained the basic mechanism of cost underestimation:

“You will often as a planner know the real costs. You know that the budget is too low but it is difficult to pass such a message to the counsellors [politicians] and the private actors. They know that high costs reduce the chances of national funding.”

Experienced professionals like the interviewee know that outturn costs will be higher than estimated costs, but because of political pressure to secure funding for projects they hold back this knowledge.

Similarly, an interviewee explained the basic mechanism of benefit overestimation:

“The system encourages people to focus on the benefits, because until now there has not been much focus on the quality of risk analysis and the robustness [of projects]. It is therefore important for project promoters to demonstrate all the benefits, also because the project promoters know that their project is up against other projects and competing for scarce resources.”

Such a focus on benefits and disregard of risks and robustness may consist, for instance, in the discounting of spatial assimilation problems described by Priemus (2007). Competition between projects and authorities creates political and organizational pressures which in turn create an incentive structure that makes it rational for project promoters to emphasize benefits and de-emphasize costs and risks. A project that looks highly beneficial on paper is more likely to get funded than one that does not.

A Planner on Cost Underestimation

“[Y]ou will often as a planner know the real costs. You know that the budget is too low but it is difficult to pass such a message to the counsellors [politicians] and the private actors. They know that high costs reduce the chances of national funding.”

One typical interviewee saw project approval as “passing the test” and precisely summed up the rules of the game like this:

“It’s all about passing the test [of project approval]. You are in, when you are in. It means that there is so much focus on showing the project at its best at this stage.”

In sum, the study shows that for UK projects strong interests and strong incentives exist at the project approval stage to present projects as favorably as possible, that is, with benefits emphasized and costs and risks de-emphasized. Wachs (1990, 1986) found similar results for transportation infrastructure projects in the US. Local authorities, local developers and land owners, local labor unions, local politicians, local officials, local MPs, and consultants all stand to benefit from a project that looks favorable on paper and they have little incentive to actively avoid bias in estimates of benefits, costs,

and risks. Conversely, national bodies, like certain parts of the Department for Transport and the Ministry of Finance who often fund and oversee projects, may have an interest in more realistic appraisals, but until recently they have had only limited success in achieving such realism, although in the UK the situation may be changing with the initiatives to curb bias set out in HM Treasury (2003) and Department for Transport (2006).

Machiavelli's Formula

$$\begin{aligned}
 & \text{(underestimated costs)} \\
 & + \text{(overestimated revenues)} \\
 & + \text{(undervalued environmental impacts)} \\
 & + \text{(overvalued development effects)} \\
 \\
 & = \text{(project approval)}
 \end{aligned}$$

The studies by Flyvbjerg, Cowi, and Wachs falsify the notion that in situations with high political and organizational pressure the lowballing of costs and highballing of benefits is caused by non-intentional technical error or optimism bias. Both studies support the view that in such situations promoters and forecasters intentionally use the following Machiavellian formula in order to secure approval and funding for their projects:

$$(\text{Underestimated costs}) + (\text{Overestimated benefits}) = (\text{Project approval})$$

Using this formula, and thus "showing the project at its best" as one interviewee stated above, results in an inverted Darwinism, that is, the "survival of the unfittest." It is not the best projects that get implemented, but the projects that look best on paper. And the projects that look best on paper are the projects with the largest cost underestimates and benefit overestimates, other things being equal. But these are the worst, or "unfittest," projects in the sense that they are the very projects that will encounter most problems during construction and operations in terms of the largest cost overruns, benefit shortfalls, and risks of non-viability. The projects have been designed like that.

Inverted Darwinism

$$\begin{aligned}
 & \text{Max(B/C) at approval} \\
 \\
 & = \text{Max(benefit shortfall, cost overrun) at} \\
 & \quad \text{implementation} \\
 \\
 & = \text{Max (size and frequency of disasters)} \\
 \\
 & = \text{Survival of the un-fittest}
 \end{aligned}$$

Better Methods: Reference Class Forecasting

As should be clear, the planning and implementation of megaprojects stand in need of reform. Less deception and more honesty are needed in the estimation of costs and benefits if better projects are to be implemented. This is not to say that costs and benefits are or should be the only basis for deciding whether to build large infrastructure projects or not. Clearly, forms of rationality other than economic rationality are at work in most projects and are balanced in the broader frame of public decision making. However, the costs and benefits of large infrastructure projects often run in the hundreds of millions or even billions of dollars, with risks correspondingly high. Without knowledge of such risks, decisions are likely to be flawed.

When contemplating what planners can do to help reform come about, we need to distinguish between two fundamentally different situations: (1) planners and promoters consider it important to get forecasts of costs, benefits, and risks right, and (2) planners and promoters do not consider it important to get forecasts right, because "optimistic" forecasts are seen as a necessary means to get projects started. The first situation is the easier one to deal with and here better methodology will go a long way in improving planning and decision making. The second situation is more difficult, and more common for large-scale projects as described above. Here changed incentives are essential in order to reward honesty and punish deception, where today's incentives often do the opposite.

Thus two main measures of reform may be identified: (1) better forecasting methods, and (2) improved incentive structures, the latter being more important. Better forecasting methods are covered in this section, improved incentive structures in the following one.

3 Steps to Accurate Budgets

1. **Make reference class forecasting (RCF) mandatory**
2. **Punish inaccurate budgets, reward accurate ones**
3. **Have Ministry of Finance supervise and enforce points 1-2**

If planners genuinely consider it important to get forecasts right, it is recommended they use a new forecasting method called "reference class forecasting" to reduce inaccuracy and bias. This method was originally developed to compensate for the type of cognitive bias in human forecasting that Kahneman (1994) found in his Nobel prize-winning work on bias in economic forecasting (Kahneman and Tversky, 1979). Reference class forecasting has proven more accurate than conventional forecasting.

Flyvbjerg and Cowi (2004) developed the first instance of reference class forecasting in practical policy and planning for transportation infrastructure projects in the UK. In

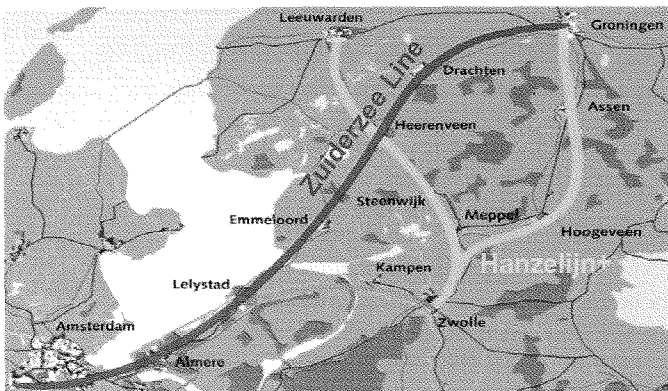
April 2005, based on a study by Flyvbjerg, Holm, and Buhl (2005), the American Planning Association (APA, 2005) officially endorsed reference class forecasting:

"APA encourages planners to use reference class forecasting in addition to traditional methods as a way to improve accuracy. The reference class forecasting method is beneficial for non-routine projects such as stadiums, museums, exhibit centers, and other local one-off projects. Planners should never rely solely on civil engineering technology as a way to generate project forecasts."

In 2006, the UK Department for Transport and HM Treasury decided to employ the method in the UK as an integral part of project appraisal.

Reference class forecasting consists in taking a so-called "outside view" on the particular project being forecast. The outside view is established on the basis of information from a class of similar projects. The outside view does not try to forecast the specific uncertain events that will affect the particular project, but instead places the project in a statistical distribution of outcomes from this class of reference projects. Reference class forecasting requires the following three steps for the individual project:

- (1) Identification of a relevant reference class of past projects. The class must be broad enough to be statistically meaningful but narrow enough to be truly comparable with the specific project.
- (2) Establishing a probability distribution for the selected reference class. This requires access to credible, empirical data for a sufficient number of projects within the reference class to make statistically meaningful conclusions.
- (3) Comparing the specific project with the reference class distribution, in order to establish the most likely outcome for the specific project.



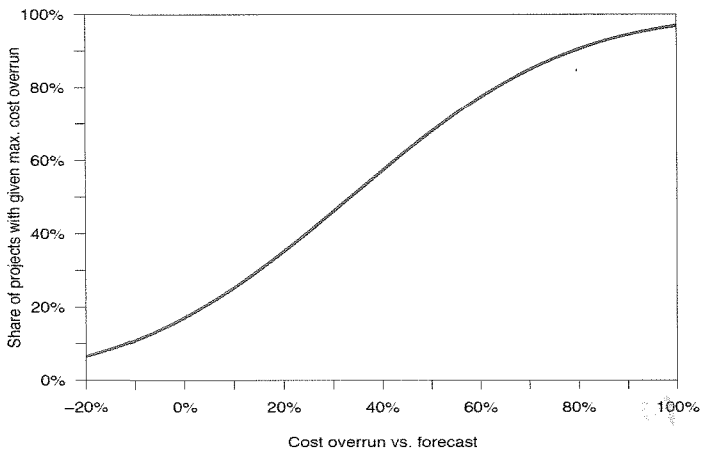
The first reference class forecast in the Netherlands was carried out in 2006 for cost and traffic projections on the proposed high-speed rail Zuiderzee Line project (Flyvbjerg, 2006b, 2006c). The cost forecast covered 123 km of new construction between Lelystad and Groningen.

As step one of the reference class forecast of costs - and in order to establish the outside view - a reference class of 68 comparable rail projects was established. As step two, the probability distribution of cost overrun in the reference class was found. The distribution is shown in Figure 2. Finally, on the basis of this distribution and the principal's forecast it was established that the expected construction cost of the Zuiderzee Line project was €5,660 million (2005 prices, not including rolling stock and VAT). This compared with the principal's forecast of €4,084 million. The difference between the two forecasts was explained mainly by the principal not including in their forecast risks of special wishes for scope changes and other uncertainties outside the scope of the project.

The reference class forecast of €5,660 million is the expected value of construction costs for the Zuiderzee Line project. This value thus involves a risk of cost overrun of 50 percent. The reference class forecast further established that if the decision maker was willing to accept only a 20 percent risk of cost overrun, which is the level required for instance in similar cost forecasts in the UK, then the budget should be €6,698 million, including contingencies at the 80 percent-level.

In sum, the reference class forecast for the Zuiderzee Line project predicted substantially higher expected costs and significantly higher risks of cost overrun than the principal's forecast. This is a common outcome of reference class forecasts. It is explained by the fact that reference class forecasts take all known, empirical risks into account, whereas conventional forecasts typically underestimate risks by not including all risks and by taking an "inside view" on risks.

Figure 2: Probability distribution of cost escalation for rail. Based on reference class of 68 projects. Constant prices.



The contrast between inside and outside views has been confirmed by systematic research (Gilovich, Griffin, and Kahneman, 2002). The research shows that when people are asked simple questions requiring them to take an outside view, their forecasts become significantly more accurate. However, most individuals and organizations are inclined to adopt the inside view in planning major initiatives. This is the conventional and intuitive approach. The traditional way to think about a complex project is to focus on the project itself and its details, to bring to bear what one knows about it, paying special attention to its unique or unusual features, trying to predict the events that will influence its future. The thought of going out and gathering simple statistics about related cases seldom enters a planner's mind. This is the case in general, according to Lovallo and Kahneman (2003: 61-62). And it is certainly the case for cost and benefit forecasting in large infrastructure projects. Among the many forecasts reviewed for the present study to estimate accuracy, not a single genuine reference class forecast of costs and benefits has been identified.

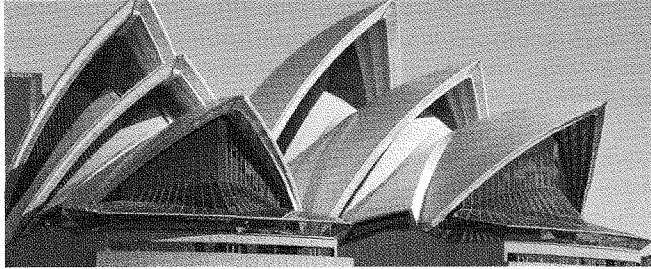
While understandable, planners' preference for the inside view over the outside view is unfortunate. When both forecasting methods are applied with equal skill, the outside view is much more likely to produce a realistic estimate. That is because it bypasses cognitive and political biases such as optimism bias and strategic misrepresentation and cuts directly to outcomes. In the outside view planners and forecasters are not required to make scenarios, imagine events, or gauge their own and others' levels of ability and control, so they cannot get all these things wrong. Human bias is bypassed. Undoubtedly the outside view, being based on historical precedent, may fail to predict extreme outcomes, that is, those that lie outside all historical precedents. However, for most projects, the outside view will produce more accurate results. In contrast, a focus on inside details is the road to inaccuracy.

Basic Logic of Reference Class Forecasting

- The next project will perform as the last 10–15 comparable projects (unless we have strong, documented reasons to believe otherwise)
- RCF bypasses both optimism and misrepresentation by taking an "outside view"

The comparative advantage of the outside view is most pronounced for non-routine projects, understood as projects that planners and decision makers in a specific place have never attempted before - like building a high-speed rail line in a country for the first time, or a new major bridge or tunnel where none existed before. It is in the planning of such new efforts that the biases toward optimism and strategic misrepresentation are likely to be largest. To be sure, choosing the right reference class of comparative past projects becomes more difficult when planners are forecasting initiatives for which precedents are not easily found, for instance the introduction of new and unfamil-

iar technologies. However, most large infrastructure projects are both non-routine locally and use well-known technologies. Such projects are, therefore, particularly likely to benefit from the outside view and reference class forecasting. The same holds for concert halls, museums, stadiums, exhibition centers, and other local one-off projects.



Improved Incentives: Public and Private Sector Accountability

In the present section we consider the situation where planners and other influential actors do not find it important to get forecasts right and where planners, therefore, do not help to clarify and mitigate risk but, instead, generate and exacerbate it. Here planners are part of the problem, not the solution. This situation may need some explication, because it possibly sounds to many like an unlikely state of affairs. After all, it may be agreed that planners ought to be interested in being accurate and unbiased in forecasting. It is even stated as an explicit requirement in the American Institute of Certified Planners' Code of Ethics and Professional Conduct that "A planner must strive to provide full, clear and accurate information on planning issues to citizens and governmental decision-makers" (American Planning Association, 1991: A.3). The British Royal Town Planning Institute has laid down similar obligations for its members as have organizations for planning professionals in other countries (Royal Town Planning Institute, 2001).

However, the literature is replete with things planners and planning "must" strive to do, but which they don't. Planning must be open and communicative, but often it is closed. Planning must be participatory and democratic, but often it is an instrument of domination and control. Planning must be about rationality, but often it is about power (Flyvbjerg, 1998; Watson, 2003). This is the "dark side" of planning and planners identified by Flyvbjerg (1996) and Yiftachel (1998), which is remarkably underexplored by planning researchers and theorists.

Forecasting, too, has its dark side. It is here that "planners lie with numbers," as Wachs (1989) aptly put it. Planners on the dark side are busy not with getting forecasts right and following the AICP Code of Ethics but with getting projects funded and built. And accurate forecasts are often not an effective means for achieving this objective. Indeed, accurate forecasts may be counterproductive, whereas biased forecasts may be effective in competing for funds and securing the go-ahead for construction. "The most effective

planner," says Wachs (1989: 477), "is sometimes the one who can cloak advocacy in the guise of scientific or technical rationality."

In this situation, the question is not so much what planners can do to reduce inaccuracy and risk in forecasting, but what others can do to impose on planners the checks and balances that would give planners the incentive to stop producing biased forecasts and begin to work according to their Code of Ethics. The challenge is to change the power relations that govern forecasting and project development. Better forecasting techniques and appeals to ethics won't do here; institutional change with a focus on transparency and accountability is necessary.

As argued in Flyvbjerg, Bruzelius, and Rothengatter (2003), two basic types of accountability define liberal democracies: (1) public sector accountability through transparency and public control, and (2) private sector accountability via competition and market forces. Both types of accountability may be effective tools to curb planners' misrepresentation in forecasting and to promote a culture which acknowledges and deals effectively with risk.

Improved Accountability

Principle:

- Align incentives to reward accurate and punish inaccurate budgets

Example, UK Dept. for Transport:

- 50% of cost overrun within estimate to be paid by local authority
- 100% of cost overrun above estimate to be paid by local authority

In order to achieve accountability through *transparency and public control*, the following would be required as practices embedded in the relevant institutions (for the full argument, see Flyvbjerg, Bruzelius, and Rothengatter, 2003, chapters 9-11):

- National-level government should not offer discretionary grants, but instead "block grants," to local infrastructure agencies. Discretionary grants create perverse incentives. Block grants ensure that every dollar spent by a local authority on one type of infrastructure reduces their ability to fund another.
- Forecasts should be made subject to independent due diligence.
- Forecasts should be benchmarked against comparable forecasts, for instance using reference class forecasting as described in the previous section.
- Forecasts, due diligence, and benchmarkings should be made available to the public as they are produced, including all relevant documentation.
- Public hearings, citizen juries, and the like should be organized to allow stakeholders and civil society to voice criticism and support of forecasts.

- Scientific and professional conferences should be organized where forecasters would present and defend their forecasts in the face of colleagues' scrutiny and criticism.
- Projects with inflated benefit-cost ratios should be reconsidered and stopped if recalculated costs and benefits do not warrant implementation. Projects with realistic estimates of benefits and costs should be rewarded.
- Professional and occasionally even criminal penalties should be enforced for planners and forecasters who consistently and foreseeably produce deceptive forecasts.

To achieve accountability in forecasting via *competition and market forces*, the following would be required, again as practices that are both embedded in and enforced by the relevant institutions:

- The decision to go ahead with a project should, where at all possible, be made contingent on the willingness of private financiers to participate without a sovereign guarantee for at least one third of the total capital needs. The objective is to protect the taxpayer from risk and create pressures on performance.
- Forecasters and their organizations should share financial responsibility for covering cost overruns and benefit shortfalls resulting from misrepresentation and bias in forecasting.
- The participation of risk capital should not mean that government reduces control of the project. On the contrary, it means that government can more effectively play the role it should be playing, namely keeping the project at arm's length as the ordinary citizen's guarantor for safety, environment, risk, and a proper use of public funds.



Whether projects are public, private, or public-private, they should be vested in one and only one project organization with a strong governance framework. The project organization may be a company or not, public or private, or a mixture. What is important is that this organization enforces accountability vis-à-vis contractors, operators, etc., and that, in turn, the directors of the organization are held accountable for any cost overruns, benefits shortfall, faulty designs, unmitigated risks, etc. that may occur during project planning, implementation, and operations.

If the institutions with responsibility for developing and building major infrastructure projects - including parliaments and cabinets - would effectively implement, embed, and enforce such measures of accountability, then the misrepresentation in cost, benefit, and risk estimates, which is widespread today, may be mitigated. If this is not done, misrepresentation is likely to continue, and the allocation of funds for infrastructure is likely to continue to be wasteful and undemocratic.

Towards Better Practice

Fortunately, after decades of widespread mismanagement in megaproject policy and planning, signs of improvement have recently appeared. The conventional consensus that deception is an acceptable way of getting projects started is under attack, as will be apparent from the examples below. The largest megaprojects are now so big in relation to national economies that cost overruns, benefit shortfalls, and risks from even a single project may impact the finances of an entire country or region, as happened for Greece with the cost overruns for the Athens 2004 Olympics and for Hong Kong with the benefit shortfalls for its international airport upon its opening in 1998. Lawmakers and governments begin to see that national fiscal distress is too high a price to pay for the conventional way of planning and designing large projects. The main drive for reform comes from outside the agencies and industries conventionally involved in infrastructure development, which increases the likelihood of success.

In 2003 the Treasury of the United Kingdom required, for the first time, that all ministries develop and implement procedures for large public projects that will curb what the Treasury calls - with true British civility - "optimism bias." Funding will be unavailable for projects that do not take into account this bias, and methods have been developed for how to do this (Mott MacDonald, 2002; HM Treasury, 2003; Flyvbjerg and Cowi, 2004). In the Netherlands in 2004, the Parliamentary Committee on Infrastructure Projects for the first time conducted extensive public hearings to identify measures aimed at limiting the misinformation about large infrastructure projects given to the Parliament, the public, and the media (Tijdelijke Commissie Infrastructuurprojecten, 2004). In Boston, the government sued to recoup funds from contractor overcharges for the Big Dig related to cost overruns.



More governments and parliaments are likely to follow the lead of the UK, the Netherlands, and Boston in coming years. In fact Switzerland and Denmark are already underway. It's too early to tell whether the measures they implement will ultimately be effective. It seems unlikely, however, that the forces that have triggered the measures will be reversed, and it is those forces that reform-minded groups need to support and

develop in order to curb deception and waste. This is the "tension-point" where convention meets reform, power-balances change, and new things may happen.

The key weapons in fighting deception and waste is critical questioning, accountability, and better methods. The professional expertise of planners, engineers, architects, economists, and administrators is certainly indispensable to constructing the infrastructures that make society work. Studies show, however, that the claims about costs, benefits, and risks made by these groups usually cannot be trusted and should be carefully examined by independent specialists and organizations. The same holds for claims made by project-promoting politicians and officials. Institutional checks and balances should be developed and employed. The key principle is that the cost of making a wrong forecast should fall on those making the forecast, a principle often violated today.

The conventional mode of planning and designing infrastructure has long historical roots and is deeply ingrained in professional and institutional practices. It would be naive to think it is easily toppled. Given the stakes involved - saving taxpayers from billions of dollars of waste, protecting citizens' trust in democracy and the rule of law, avoiding the destruction of spatial and environmental assets - this shouldn't deter us from trying.



Ten Promising Areas for Further Research

With the Netherlands' emphasis on being the "gateway to Europe" there is hardly a European country with more transportation infrastructure per square kilometer than here. That - combined with the fact that the Netherlands has a long-standing international reputation of being champion of rational planning and research - led me to expect that in this country I would encounter an abundance of good data on actual costs and benefits of transportation infrastructure. In fact, this was initially a main reason for my professional interest in the Netherlands.

I was in for a surprise, however. So far it has been unusually difficult to find data on the actual performance of Dutch transportation infrastructure. It is unclear where, how, and

which data exist, and what would be the best way to gain access to the data for research. Apparently, it is rare that anybody stops to ask and answer questions such as: what did this piece of infrastructure actually cost and how does this compare with its forecasted costs? What are actual revenues compared with those forecasted? What are actual environmental and social impacts compared with the impacts predicted in environmental and social impact assessments? And, finally, how does the actual benefit-cost ratio hold up against the predicted ratio? Is the project that was viable on paper also viable in reality?

Only with the Duijvestein Committee in 2004 were such questions asked and data for a few projects were collected. But it was not enough to draw solid, scholarly conclusions about the general performance of Dutch transportation infrastructure, past and present.

Obviously, if one doesn't study performance, it is difficult to understand and improve it. And this appears to be the situation. This is a problem for both policy and research. At present, the knowledge-base is simply not there.

Thus the first and most important area for further research as seen from a Dutch perspective is the collection and analysis of data on performance in terms of costs and benefits for a sample of minimum 10-15 large-scale infrastructure projects in each of the categories bridges, tunnels, railways, motorways, and highways. Data on airport and seaport projects would also be welcome. On the basis of such data actual performance could be compared with predicted performance and one would get a good idea of how well reality meets intentions. Furthermore, the Dutch situation could be benchmarked against the international situation, for which we are also collecting data, and better reference class forecasting for Dutch projects would be made possible. Potential problems and successes could be identified. And, finally, lessons could be learned about how better to understand the dynamics of this very expensive sector of the Dutch economy and how to - and not to - develop and implement future large-scale transportation infrastructure projects.

Promising Areas for Further Research

1. **Close knowledge-gap for Dutch projects**
2. **Document and explain performance in private versus public projects**
3. **Test and develop theory: principal-agent, governance, multi-actor**

My colleagues and I intend to carry out this research. I see it as a main purpose of the chair at TU Delft. We have been able to collect data on actual and predicted performance in transportation infrastructure projects in more than 20 nations. Thus we see no reason why we should not be able to do the same in the Netherlands. Especially because our research is sponsored by the Ministry of Transport, Public Works, and

Water Management, who is also the main source of data and thanks to whom the data that exist will be made available.

A second important area of further research is answering the question of whether transportation infrastructure is most effectively provided by the public sector, the private sector, or a combination of the two, that is, by so-called PPPs, public-private partnerships. This question is particularly interesting because it has both deep theoretical and practical import, for instance regarding private versus public sector efficiency in the allocation of resources. Today, the research that would make possible a solid, scholarly answer to this question does not exist, not only in the Netherlands or Europe, but globally. Instead, the position taken by different groups regarding the use of private versus public capital in transportation infrastructure provision is highly ideological and/or driven by self-interest.

It has always been the task of research to attempt to sort ideology and interest from fact. This seems particularly important for infrastructure at present, because capital funds, banks, and pension funds are flocking to infrastructure to invest surplus capital without a clear understanding of the risks involved. This happens to a degree where analysts' talk of an "infrastructure bubble" has become too common for comfort, especially if you consider that your future pension is on the line!

Seriously, my group and I are collecting data on the risks involved in PPPs and on the question of whether privately financed infrastructure performs better than public infrastructure. Again the task is difficult, but this time expectedly so. Data on performance in privately financed infrastructure are not easily accessible, because private companies typically consider such data to be business secrets. Nevertheless, my group and I are having a go at this research. The question, its possible answers, and their theoretical and practical significance are simply too interesting to be left alone.

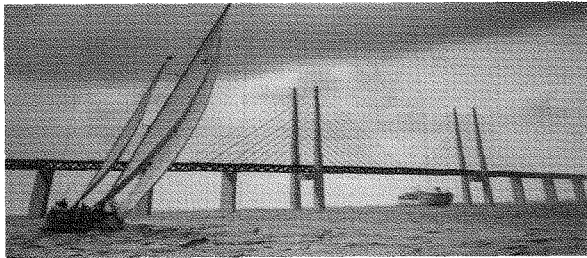


Third, further research on the causes of misinformation in megaprojects is desirable, including phenomenological in-depth studies of the processes that generate misinformation.

Fourth, we need to test and develop existing theories against the empirical evidence, for instance principal-agent theories, governance theories, multi-actor and stakeholder theories, and theories of contested information.

Fifth, there is a need for more ex-post economic evaluations of specific projects, like Anguera's (2006) study of the Channel tunnel mentioned above. At present, ex-post studies are all too rare, which hampers learning. Only when ex-ante predictions are tested against ex-post outcomes, is it possible to begin to understand whether the assumptions underlying infrastructure policy, planning, and theory hold up in practice and what the causes are of success and failure.

Sixth, the same holds for our understanding of environmental and spatial impacts of infrastructure, where we also need more research. Environmental impact assessments are produced ex-ante by the cubic meters, but very little ex-post auditing is done to establish whether actual impacts are similar to those predicted. Once more, this lack of feedback impedes learning. In fact we know surprisingly little about actual environmental impacts of large-scale transportation infrastructure and their causes and possible cures, except in a few cases like the Øresund and Great Belt links, where environmental groups forced authorities to take post-auditing and environmental management seriously.



Seventh, we need more research about performance of transportation infrastructure in different parts of the world, in order to better understand geographical differences in infrastructure provision in terms of costs, benefits, and risks. This includes studies of newly industrialized and developing economies, and of which theories best explain possible geographical differences.

Eighth, in-depth studies of success stories in large-scale infrastructure is an essential area for further research. This would be studies of the few projects that are built on time and budget and deliver the projected benefits. A main purpose would be to develop a "theory of success" that would help us better understand and even replicate the factors that produce success. Conversely, we also need to understand the phenomenon of "lock in," and how to avoid it, i.e., the common occurrence that at an early stage stakeholders get overcommitted to a project and see it through to implementation, even when recalculated benefit-cost ratios and other markers indicate that the project should be aborted or redesigned and reassessed.

Ninth, in modeling, we need research on the root causes of why traffic models consistently produce highly inaccurate forecasts for large-scale transportation infrastructure projects. There has been no improvements in accuracy for the 30 years for which we have data, despite all investments in and talk about the development of better models and the collection of better data. We need to understand why and what can be done about it.

Last but not least, we need to better understand the role of lying in policy and planning. As shown above, planners of large-scale transportation infrastructure are on record stating that they deliberately misinform about the estimated costs, benefits, and risks of planned projects in order to get the projects approved and built. In addition, there is other evidence that indicates foul play. However, we are generally trained - and we train our students - to focus on truth and rationality in policy and planning. This is for good reason, because policy and planning in a democracy are supposed to be based on truth and rationality. There is an "obligation to truth" written into most democratic constitutions.

This is the normative position, however. What if the empirical position tells us that policy and planning make use of misinformation and lies as much as of truth and rationality, as appears to be the case for large-scale transportation infrastructure projects? Then we need research on lying in policy and planning. And we need to collaborate with our colleagues in philosophy to answer the fascinating question of under which circumstances it is logically possible to lie about the future. This, therefore, is also an important area for further research.

At Delft University of Technology, initially my main focus will be on the first two of the ten areas of further research, i.e., performance in Dutch projects and PPPs. However, I will make an effort at initiating research in other areas as funds for more PhDs and postdocs become available. I would very much like this work to be a collaborative effort with you, my new colleagues at TU Delft, and I would therefore like to end my presentation with an invitation.

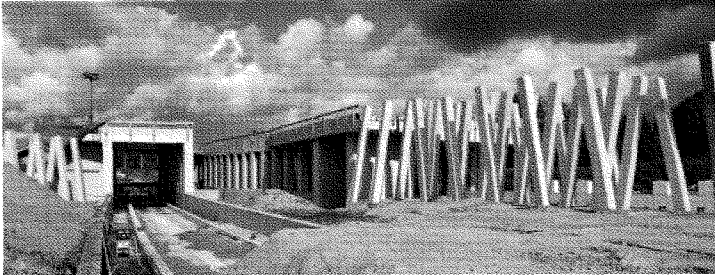
Many of you do work relevant to large engineering projects and many such projects are subject to the types of cost and benefit risks described earlier. If, in your work, you see areas of possible collaboration, let's sit down and see whether we can describe a PhD or postdoc of joint interest and get the work going. This also holds if your suggestions fall outside the ten areas of further research described above.

Engineering, economics, planning, policy analysis, management, and ethics are all relevant to understanding megaprojects. Whatever your perspective is, I invite you to join forces with us and bring it to bear upon megaprojects in order to understand better the anatomy of this fascinating animal.

Finally, it is my pleasure to express my gratitude and thanks to the people and institutions who have made the Chair in Infrastructure Policy and Planning possible. This is the Ministry of Transport, Public Works, and Water Management, and here

especially Dr. Eric Bussink. It is Delft University of Technology, especially professor Hugo Priemus, former Dean of the Faculty of Technology, Policy and Management and professor Bert van Wee, Head of the Section for Transport Policy and Logistics' Organisation. Thanks to my colleagues at TBM and TLO for giving me such a warm welcome, and thanks to all of you for attending my inaugural speech today. I really appreciate it.

Thank you very much!



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ⁱ All costs are construction costs measured in constant prices. Cost overrun, also sometimes called "cost increase" or "cost escalation," is measured according to international convention as actual out-turn costs minus estimated costs in percent of estimated costs. Actual costs are defined as real, accounted construction costs determined at the time of project completion. Estimated costs are defined as budgeted, or forecasted, construction costs at the time of decision to build. For reasons explained in Flyvbjerg, Holm, and Buhl (2002) and Flyvbjerg (2005b) the figures for cost overrun presented here must be considered conservative.--Ideally financing costs, operating costs, maintenance costs, and scrapping costs would also be included in a study of costs, constituting a measure of life cycle costs. It is difficult, however, to find valid, reliable, and comparable data on these types of costs across a large number of projects.

ⁱⁱ Following international convention, inaccuracy is measured as actual traffic minus estimated traffic in percent of estimated traffic. Rail traffic is measured as number of passengers; road traffic as number of vehicles. The base year for estimated traffic is the year of decision to build. The forecasting year is the first full year of operations. For issues of ramp up, see Flyvbjerg (2005b).