Retraining the Modern Civil Engineer

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SUMMARY

The article begins by addressing the questions, "Why Modern Engineering Requires Social Science?" and "What is Planning?". After these conceptual discussions the article reviews twelve practical tools which social science brings to the engineer. Having laid this practical and conceptual foundation, the article then describes a tested approach to training engineers in these tools.

Retraining the modern civil engineer

I. INTRODUCTION

Intense environmental conflicts and frustrations from managing them, have forced engineers to seek better understanding of why such conflicts are generated. Beneath the surface of seemingly irrational endangered species rescue operations, ecological doomsday jargon and developmentalist zeal, lurk major social value conflicts such as: public vs. private engineering; growth vs. no growth; economic vs. other social values; science vs. popularism; and technical vs. political values. Environmental conflicts of the 1970s have reaffirmed that civil engineering has major social effects and objectives beyond purely technical construction and narrow economic development. The engineer, trained and rewarded for technical excellence, is frequently frustrated with what are perceived as extra 'social or environmental design constraints'. However, far from constraints, broadening the social objectives of engineering presents new opportunities for engineering service, if one makes the effort to look. So how does the engineering organization with its primarily technical training and experience look for such opportunities?

At one end of the spectrum the engineering organization may hire new people; at the other, it can retrain experienced personnel. Practically, the engineering organization follows some route between these extremes. Indeed, by mid-career, experienced engineers have usually accumulated a wealth of knowledge about the social effects of their engineering work. This article outlines a practical and tested approach to training experienced engineers in the use of selected social science techniques. Its philosphy is to add tools to the existing tool-kit of the engineer-manager, and to build on his or her experience.

Over the last six years, such training has been developed for the US Army Corps of Engineers. In the United States, the Corps has major civil works missions in flood control, navigation, waterway regulation and water resources development along with military base construction. To achieve these missions, the Corps is decentralized around 38 districts, 12 divisions, and Washington level offices. Most of these offices include a range of engineering functions such as planning, construction and operations. Roughly 5% of the Corps' more than 20 000 employees are military officers and the rest are civilians. It is for this multi-functional and diverse organization that the following applied social analysis training was designed.

II. WHY MODERN ENGINEERING REQUIRES SOCIAL SCIENCE

Much of Civil and Water Resource engineering has been viewed primarily as structural intervention into the natural system. Such interventions are justified for the best of reasons—to minimize stress on the social system and to create new growth opportunities. While very useful, this view can be dangerously limiting. Engineering can subtly become the application of one set of solutions to many problems. Problems then become defined more in terms of a narrow understanding of possible technical situations than broader social needs. Engineering then adopts the role of defining social limits rather than assisting social dreams. This is a position fraught with conflict that can place engineers at odds with those whom they serve.

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In the industrial west, engineer-managers have recently been asked to develop alternatives that include direct management of the social as opposed to the natural system—water demand management and nonstructural design, for examples. In non-industrial countries large water projects are often explicitly designed to manage natural systems so as to achieve major social objectives. Actually, we know little of whether managing the social system or natural system is more efficient in delivering benefits, like creating growth opportunities and reducing potential social stress. However, project stoppages and public debate within the industrial world demonstrate that finding a practical balance point is difficult.

Historically, civil engineers, trusted with the keys of technology, have been leading instruments in the process of social adaptation and growth. They have been critical to what Jacob Bronowski, in *The Ascent of Man*, calls man's essential nature, "...the explorer of nature... the ubiquitous animal who did not find but has made his home in every continent". The civil engineer has recently been dubbed as a purveyor of old technology, a slave to technology fixes, or provider of solutions seeking applications. To the degree civil engineers act according to this image, they draw us to a future of deterministic entropy rather than one of evolutionary and visionary growth. As Samuel Florman notes, in the *Existential Pleasures of Engineering*, such a view denies the profession its creative and artistic historical roots. He says,

> "Analysis, rationality, materialism and practical creativity do not preclude emotional fulfillment. They are pathways to such fulfillment. They do not 'reduce' experience, as is so often claimed; they expand it. Engineering is superficial only to those who view it superficially. At the heart of engineering lies existential joy."

In the case of water resources, engineers actively participate in using water resources development to massively affect social behavior and in projecting how that behavior will affect water resources. Yet we know little of this interaction. Social scientists and economists have long recognized that the political–social structure is somehow related to the way we organize to supply and distribute water. In fact, water resource development has helped to transform previously blighted sections within numerous countries. Yet we know little of how current water resources development is affecting population and wealth distribution such as that around coastal and arid areas.

Responsible decision-makers, make assumptions about how the private sector perceives itself, about the relationship between savings and expectations and the capacity of the individuals to assume large capital investment. Yet we do little to verify such assumptions. Major programs cannot be adapted to regional differences such as between urban and rural or arid and wet regions without some explicit notion of social structure, attitude and opinion differences. Nevertheless, a tendency to design similar structures across regions persists.

In the United States, such realities have reduced trends to broaden social considerations in engineering projects and to include new disciplines such as anthropology, history, sociology and political science in addition to economics in the engineering organizations. Since this expanded social science input originally flourished under the National Environmental Policy Act (NEPA), it often inherited an image of negative assessment, project delay or bearer of bad news. Those days have passed. The new disciplines bring to the engineering organization rudimentary tools that help managers to understand their external environments; to cope with internal resource constraints; and to better manage uncertainty in aligning water with people. Through social impact assessment research and training, we have identified generic tools whose applications have had among others, the following payoffs for civil engineering management:

- increased efficient expenditure of resources by estimating implementation outlay costs.
- improved our ability to project acceptability of alternatives.
- identified new engineering missions, service opportunities and constituencies early.
- reduced the number, but made more representative the alternatives considered in planning.
- enhanced our ability to project conditions both with and without the project.
- improved our ability to describe likely social effects.
- improved ability to project construction phase impacts and suggest mitigation.
- defined new human and non-property based flood damages.
- enabled us to better project benefits to be derived from previously unemployed labor.
- provided innovative and practical means for constructive public involvement in project planning, implementation, regulation and operations.
- assisted the environmental evaluation process.

III. A NEW PARADIGM FOR PLANNING

Applying social science tools to engineering planning, and realizing the payoffs just described, is leading to a changing paradigm for planning. In some way, the confluence of Public Involvement (PI), Social Impact Assessment (SIA), and Futures-Forecasting (FF) represent what is new and what is supplementing older views of planning. It is this confluence that our training addresses. The training questions old principles derived from a mechanistic and linear view of science in which man and nature are separate. It is based on new tenets which help to explain how Public Involvement, Social Impact Assessment and Futures Forecasting are converging to redefine planning.

The tenets of the emerging planning paradigm include the following:

1. That planning creates as much as predicts the future. In theoretical physics investigators find that the instrument of measurement can determine that which we measure. So, too, in human systems.

2. That the validity basis of planning is found in an 'Inter-subjective-transfer of knowledge', not in an 'independent-observer' position. Reality is more a shared process of creation than an independent, observable fact.

3. That planning is as much political as it is technical. As Norton Long states,

> "The question is not whether planning will reflect politics but whose politics will it reflect...? Plans are in reality political programs... In the broad sense they represent political philosphies... ways of implementing different conceptions of the good life."

4. That the planner's role is to design 'win-win', rather than 'zero-sum' or 'lose-lose' alternatives.

5. That the way we forecast has major impact on the type of society in which we live. Put bluntly, do we forecast 'with' or 'for' the people?

Although neat, these tenets present a dilemma: to involve the public the planner has to know who is the public. To know who, the planner must assess impacts, and must understand perceptions, and needs. In short, open planning has resulted in public involvement programs which themselves *depend* on impact analyses, which in turn depend on the involvement programs.

This sounds like a vicious circle; you cannot solve the problem until you have solved it. Actually, it is a recognition that planning is not linear. That is, planning is not some activity which starts at one point and then gradually reduces to a final answer. Planning is iterative. Certain planning tasks are repeated, to varying degrees, throughout a planning process. Figure 1 is *one* way agencies in the United States have represented this iterative process. While four planning tasks are done within each of three planning phases, the emphasis among tasks varies in each phase. For example, the problem identification task is relatively more important in the plan of study than intermediate planning stage. With detailed plans, impact assessment programs are tailored to meet changing priorities within the evolution of a plan. This means that the techniques used for public involvement will vary. For example, hearings, feedback balloting and other media techniques work better in 'problem identification' than 'alternative formulation'. Workshops are better suited to alternative considera-

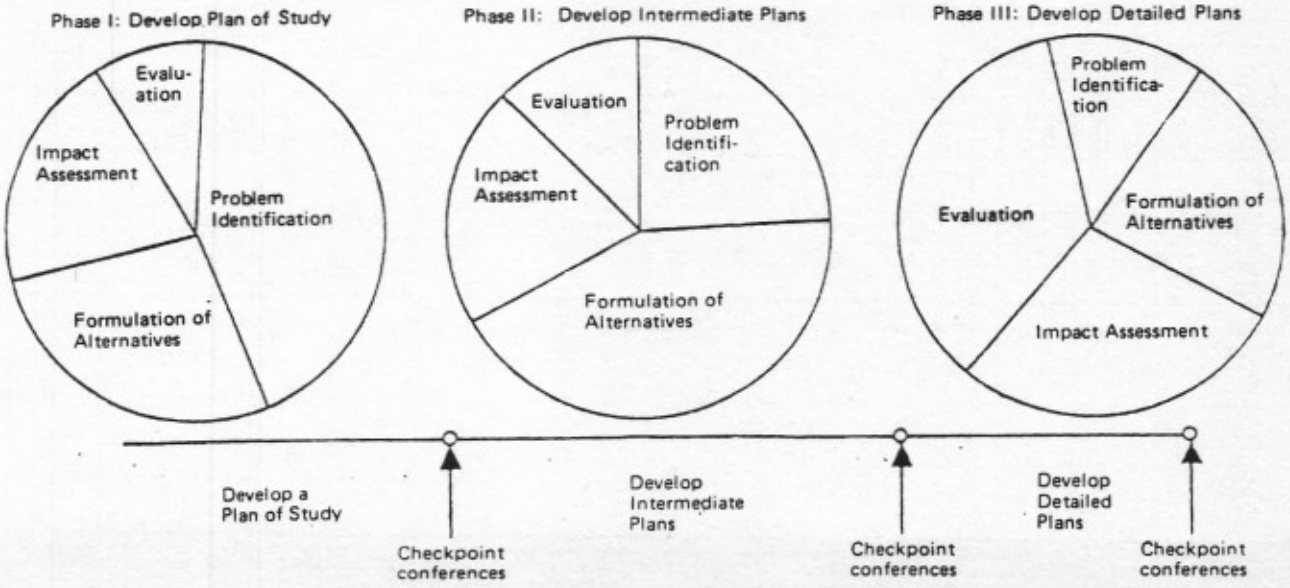

Fig. 1. Iterative planning process. (J. Delli Priscoli, *Public Involvement and Social Impact Assessment: Union Seeking Marriage.*)

tion and evaluation. Thus, the planning process itself encourages a mixed public involvement strategy. However, a mixed public involvement strategy will, in turn, force the planner to adjust the planning process to accommodate the varying forms of information resulting from the mixed techniques. Preliminary impact assessment information gained from survey research at the plan of study stage might be reformated for use in alternative formulation workshops in the intermediate plan stage.

Public involvement, social impact assessment and forecasting clearly interact in such a planning process. Planning itself impacts those for whom we plan. Public involvement, based on initial assessments of that impact, further clarifies those impacts stemming from the process of planning as well as those of the proposed solutions. Each activity is incomplete without the other.

IV. WHAT ARE THE PRACTICAL TOOLS SOCIAL SCIENCES BRING TO THE ENGINEER?

As experience with Environmental Assessment, Public Involvement and Social Assessment grew, we realized that many of the same tools were employed in each of these activities. While the Social Impact Assessment persons rarely coordinated with the public involvement person, they often would fall back into similar jargon and on similar tools. In some undefined way, these activities are more similar than different. From research, practical field experience and training we have classified these tools into 12 categories. Some of these are new in concept, while others only new in terms of their application to civil engineering. Taken together, they begin to define the practical side of the emergent planning paradigm described above and are what the modern engineer/planner is adding to his/her tool kit. Table 1 indicates how these tools are linked to Public Involvement, SIA and Forecasting; and Table 2 summarizes how these 12 generic tools may be used in the four phases of planning. These characterizations have emerged from interaction among researchers and field planners and currently form the heart of an applied social analysis training program for engineers in the US Army Corps of Engineers.

Taken together, Institutional Analysis, Policy Profiling and Value Analysis offer an alternative means to a questionnaire approach for assessing social acceptability of alternatives. Our institutional analysis manual presents a 10-step process that moves from describing existing study organizational environment through fiscal analysis to processes for assessing current and potential future institutional arrangements. The procedure can yield estimates of implementation outlay costs, basic data for cost sharing arrangements and information on what special institutional agreements are necessary for each alternative.

Policy Profiling is a technique to assess impact of various individuals, groups and organizations on decisions that affect the engineering organization. It is most useful in situations where a small group of professionals must either reach a decision or assess the impacts of decisions on an external political–social environment. Based upon common sense and political science principles, the technique simply guides individuals through a systematic thought process, records their perceptions at crucial steps in the process and produces a net political assessment number that reflects the group's subjective judgment of the feasibility of actions. Among other things, it has provided a quick means to 'red-flag' controversial decisions from among several potential decisions that busy managers are likely to take.

Value Analysis is a generic category which covers numerous techniques such as value identification, display and trade-off analyses. To date,

TABLE 1. Practical tools of the emergent planning paradigm and the major planning activity in which they are used.

Twelve social science tools for assessing impacts	Planning activities in which assessment tools can be used		
	Forecasting Futures	Public Involvement	Social Analysis
Institutional Analysis		x	x
Policy Profiling			x
Values Analysis			x
Social Profiling			x
Content Analysis		x	x
Small Group Process	x	x	
Human Cost Accounting			x
Community Impact Assessment	x		x
Ethnographic and Field Analysis		x	x
Questionnaire Non-Parametric Statistical Analysis	x		x
Population Projection	x		x
Trend and Cross Impact Analysis	x		x

TABLE 2. Application of social science tools to major planning process activities.

Twelve social science tools	Planning process activities			
	Problem Identification	Alternative Formulation	Impact Assessment	Plan Evaluation
Institutional Analysis		x		x
Policy Profiling	x	x		x
Values Analysis		x	x	x
Social Profiling	x		x	
Content Analysis	x		x	
Small Group Process	x	x	x	x
Human Cost Accounting			x	x
Community Impact Assessment	x		x	
Ethnographic and Field Analysis	x		x	
Questionnaire Non-Parametric Statistical Analysis	x		x	
Population Projection	x		x	
Trend and Cross Impact Analysis	x		x	

research has produced background reviews of techniques and new advances in mapping values in a study area and use of this information to focus on fewer, but more representative, alternatives. Improved techniques in this area hold the keys to understanding relative-deprivation perceived by those impacted by engineering projects; to facilitating constructive alternative trade-offs, and; to increasing planning efficiency by focusing resources on items of high probable acceptance.

In the United States, Social Profiling has been the primary role for the new social scientists in the engineering organization. Consequently, we have sought to package ways to move beyond traditional Bureau of Census data 'dumps' and more clearly focus the social data which is gathered. Various alternative profiling techniques which stem from social science theory such as adoption of innovation are now available.

Letters, public comment and news media are some of the best information sources on the external political and social environment available to the typical US engineering organization. Since this information is rarely packaged in ways readily compatible to engineering planning, much of it is not fully utilized. Content Analysis techniques can routinely and inexpensively capture this data over time. Administrative and secretarial professionals can do the simple basic coding, which produces machine-readable outputs.

Often much of the information needed for social assessment is not readily available in standard statistical formats. Consequently much of it must be generated through various forms of public workshops. Small Group Process techniques including active listening skills, communication skills, and other group process skills, offer alternatives to questionnaires for generating needed value, opinion and attitude data. Descriptions of how to use these techniques, including some pioneered by the US Army Corps of Engineers, are contained in the US Engineer Institute for Water Resources 10-year public involvement compendium.

From the drive to quantify social effects, a new category of Human Cost Accounting has emerged. Based on the idea that property based values reveal only a partial damage prevention story, we have pioneered two new roots to Human Cost Accounting: quantifying psychological trauma damages prevented and behavioral damage prevented. In the first case, victims of flooding are analytically placed on a value trauma scale and trauma effects are related to American Medical Association levels of impairment. Degrees of impairment are translated into dollars paid by the United States Veterans Administration for comparable disabilities. In the second case, descriptions of household financial behavior are examined through questionnaires and that behavior is translated into economic disruption costs. Currently, a general methodology is being produced and a program begun to further test these techniques on small flood control projects that previously appeared economically marginal. The case study now completed shows greatly increased benefits beyond property values in communities with low home values.

Community Impact Assessment has evolved as a clearly defined subset of more general impact assessment areas. It focuses on the influx of construction workers before, during and after peak construction. The planner estimates the phasing of construction workers, translates that into population increase in local communities, and estimates whether this influx will exceed the capacity of basic community services. Since estimates depend upon a number of subjective locational preferences and uneven population statistics, we have developed a national data base built on a survey of construction workers from

over 50 engineering construction sites. This data base, together with before, during and after case studies and a Community Impact Assessment techniques guide, assist planners in making initial estimates and managing the fear of the boom-bust syndrome.

An old social science technique and one frequently useful to the engineer is Ethnographic Field Analysis: when a planner 'walks the study area'. Participant observation can sometimes locate seemingly small items that may translate into larger project stoppage. These techniques are essentially sensing mechanisms to provide 'early warning' of the social environment. While it is difficult to train people in certain sensitivity techniques and while engineers are often uncomfortable with the validity of data provided, case study examples can be shared and general principles described. We have developed a simple short guide to principles of these techniques applied to the Corps.

Questionnaires are the most frequently over-used of social science techniques. Since their data provides a snapshop, it offers a good comparative static picture. When done sequentially, however, questionnaires are expensive and present financial and resources skill limitations to their use by the typical engineering organization. Even if personnel within the organization do not administer the questionnaire, contract monitoring itself requires considerable expertise. We have developed a brief overview package concerning their applicability to the engineering organization.

Frequently data from questionnaires and other sources is at a nominal or ordinal statistical level. This can be uncomfortable to the engineer, who often deals with interval level statistics such as regression analysis. While he/she brings to the engineer less familiar statistics which are appropriate to social values data such as contingency table inferences, the social scientist can also enrich the engineer's basic knowledge of the principal components of population projections.

In one form or another, population projections are the heart of planning. Although couched as objective, these projections are assumption based and value driven. The social scientist is familiar with techniques which may assist engineers and themselves, to clarify assumptions and value bases. Trend and Cross-Impact Analysis techniques are examples of such tools which also help planners make future projections. Various computer packages to assist the engineer in using these techniques are available.

Table 2 outlines how these tools may be used in typical planning process activities. The checks indicate where in the engineering planning process, we have experienced positive pay-offs from applying the tools. Having summarized the substantive 'what' of our social science training for engineers, we can now focus on 'how' to communicate this substance to experienced engineer managers.

IV. HOW IS THE TRAINING ACCOMPLISHED?

Implementing a social science training program has presented several challenges. For example, we frequently encounter attitudes such as; "this cannot be done"; "social science is irrelevant and unnecessary to engineering problems"; "my boss will not accept these 'way-out' activities", or; "we have no valid tools available.". The most significant challenge stems from the engineer's frequent view of his role as objective analyzer who stands apart from either the problem or its solution. While modern science has clearly questioned the validity of observer-phenomena distinctions, the old mechanistic view of science lingers. Since many of the social science tools which we teach assume a validity criteria of 'intersubjective-transfer of knowledge' rather than 'independent-objective' standards, the trainees often experience considerable discomfort concerning their professional roles.

Out of these challenges and experiences, we have formulated the following training goals:

1. To sensitize the engineer-manager to broader conceptions of his/her professional role as civil engineer.
2. To encourage attitude change of the engineer-manager toward how problems and solutions are defined.
3. To demonstrate currently available possibilities and opportunities to use social science tools.
4. To encourage the engineer-manager to apply some new tools in the course of his/her work.

In pursuing these goals, we have experimented with several training strategies. A two-tier organizational approach which: is highly interactive; provides 'hands-on' experience to the trainees; uses several recent and relevant case studies; includes evaluation, and follow-up; has been most successful. Within our organization, we also have established an exchange bulletin to encourage information sharing of social science approaches among engineering field districts. The two-tiers mean a two-day executive level and one-week field level tools courses. Both courses present similar substance but with different focus. The executive course strives to prepare executive-managers to look at plans and recognize what is not, but should be, in the plans. The tools course strives to equip field engineer planners with:

several practical tools, the judgment of where to apply these tools, and some experience with the tools.

Presently, we have developed executive courses for Public Involvement and Social Impact Assessment but not forecasting. We are currently experimenting with one executive level seminar which focuses senior management attention on how to understand and to cope with their social/political environment. This course articulates the essential themes, emergent from forecasting, PI and SIA, of new planning paradigms.

Tables 3–5 outline the one week techniques training courses in Forecasting, Advanced PI and Applied Social Analysis. Three basic learning strategies are employed: lectures, hands-on workshops, and group activities. Monday, Tuesday, Thursday and Friday begin at 8.00 a.m. and finish approximately 5.00 p.m. with breaks in the morning, afternoon and for lunch. On Wednesday the agenda goes through lunch to about 1.30 p.m. when trainees have a free afternoon. Our experience shows that free time is crucial to maintaining a positive attitude toward the course and to sustaining the trainees willingness to participate. It also provides good time to explore the environs and reflect on a considerable amount of material experienced in the first two and one-half days.

As the Tables show, when lectures or presentations are used, they are followed by either a workshop or a group activity. The workshops and group activities encourage interchange and 'hands-on' experience which, in turn, enrich both the learning and confidence in the tools. Normally a skills workshop includes 8–10 people, lasts from 1 to 1½ hours and focuses on solving a problem using a tool or technique. Task workshop activities also include 8–10 people but are task oriented. The group is required to develop some joint output. Task workshop activities not only support standard simulation goals of training they also become major vehicles for students to experience and practice basic Group-Process Techniques. Both skills and task workshop activities include some type of report back to the total group. These report backs both assist information sharing as well as reaching cloture on the learning activity. Group activities are interactive sessions, such as these report backs, which include the total training group.

The simultaneous workshops offer skill building experiences. Each trainee selects one workshop from those available in an afternoon session.

TABLE 3. Applied Social Science for engineers.

Monday*	Tuesday	Wednesday	Thursday	Friday
• Needs Assessment (group activity) • Overview—Social Science in Engineering (lecture) *Problem Identification* (Theme) • ID of Publics and Community Influentials (group activity)	*Alternative Formulation* (Theme) • Political vs. Technical Decisions (lecture) • Generating Value Based Alternatives (lecture) • Using Public Workshops to formulate Alternatives (group activity)	*Impact Assessment* (Theme) • Case Study on How To Do A Community Impact Assessment (lecture) • Construction Worker Impact (lecture) • Land Use Forecasting (lecture)	*Plan Evaluation* (Theme) • Political Accounting and Policy Profiling (group activity) • Human Cost Accounting (lecture) • Institutional Analysis–Estimating Implementability (lecture)	*Policy Considerations* (Theme) • Water Conservation (lecture) • Social Issues Forum (group activity)
• Social Profiling (lecture) • *Simultaneous Skill Workshops on Data Collection* – Field work – Social profiling – Using nominal group techniques • Workshop Debriefings (group activity)	• *Simultaneous Workshops on Data Analysis* – Content analysis – Nonparametric statistics – Values-Mapping to build alternatives • Workshop Debriefings (group activity) • *Simultaneous Skill Workshops on Social Science Data Bases* SEEDIS CERL IWR • Workshop Debriefings (group activity)	• *Simultaneous Skill Workshops* – Forecasting Land Use – Cross Impact Analysis – Making Population Projections – Using Delphi Analysis • Workshop Debriefings (group activity) Free-time	• *Simultaneous Workshops* Specialized topics requested by participants • Workshop Debriefings (group activity)	• How to be effective back in field office (group activity) • Course Evaluation (group activity)

*Each day starts at 8.00 a.m. and finishes at 5.00 p.m. with a break for lunch, except Wednesday when the agenda goes through lunch to about 1.30 p.m. and afternoons are free-time.

TABLE 4. Advanced Public Involvement.

Monday*	Tuesday	Wednesday	Thursday	Friday
• Intro; Needs Assessment (group activity) • Planning Process (lecture) • Case Study Example (group activity) • Review Communications skill (group activity)	• Public Involvement and Social Impact Assess (lecture) • Designing meetings (lecture) • *Simultaneous Skill Workshops* – Selecting meeting format – Designing workshop – Scoping meetings – Facilitation • A thought process for PI (lecture)	• *Task Workshop* – Design a PI plan • Workshop Debriefings: Review and Critique of term plans (group activity)	• Formulating and evaluating alternatives (lecture) • *Simultaneous Skill Workshops* – Generating alternatives from public comment – Analyzing public comment content analysis – Working with the media – Using graphics • Conflict management (lecture)	• *Task Workshop* – Design a PI for total planning process
• Identifying Publics (lecture) • *Simultaneous Skill Workshops* – Id. publics – Profiling political issues – Institutional analysis – Active listening • Problem Identification (lecture) • *Simultaneous Skill Workshops* – Surveys and questionnaires – ID Public Values – Interviewing – Congruent and sending	• *Task Workshop* – 3 Teams Designs PI programs for the early phases of planning on selected case.	Free-time	• *Skill Workshops* – conflict management • Policy Issues of PI (lecture) • *Simultaneous Skill Workshops* – Role of Public affairs in PI – Case study – 'Specialized' topics	• Workshop Debriefings: • Review and critique of team plans (group activity) • How to be effective back in the field office (group activity) Course Evaluation (group activity)

*Each day starts at 8.00 a.m. and finishes at 5.00 p.m. with a break for lunch, except Wednesday when the agenda goes through lunch to about 1.30 p.m. and afternoons are free-time.

At the completion of each workshop session, one attendee from each workshop briefs the total training group on major learning points experienced in each session. The total group is then free to question and comment. While trainees are often familiar with some of the techniques, some need to experience more than the 'one-per-session' which they chose. For these trainees, a library file of audio-visual tapes of other workshops and television monitors are available for viewing during free hours. If an initial assessment by instructors indicates the need, selected workshops will be repeated.

Thursday afternoon, specialized workshops are literally created 'on the spot', in direct response to trainees' needs. Early Thursday morning, group needs, which are identified during Monday morning's needs assessment, are reviewed and new needs are added. Instructors tailor special workshops to items which the group feels they need but which have not yet been adequately addressed during the week. For those needs which instructors cannot adequately address at this time, references and special follow-up are provided. In some cases, individual trainees have specific problems in their home office which need consultation. These are identified at this stage and dealt with by those instructors who feel competent in the problem area.

One week of intense and active training produces good feeling, comradeship and fresh plans. However, by Friday trainees are beginning to look toward Monday back at the office. We try to capture the enthusiasm and transfer it to preparing for the transition from training environment to work environment in one of the last group acitivities on Friday. Students participate in an exercise that helps them define how the material of the training course can make them professionally more effective in the organization.

Generally, two principal instructors, supported by numerous subject matter specialists during the week is adequate to successfully complete the courses. The instructors should be versatile enough to adequately facilitate most of the work-

TABLE 5. Forecasting Techniques.

Monday*	Tuesday	Wednesday	Thursday	Friday
• Intro; Needs Assessment (group activity) • Forecasting and Managing uncertainty (lecture) • Forecasting and organization Needs (lecture)	• Time Series and Travel Forecasts (lecture) • Government OBERS Forecasts (lecture) • *Simultaneous Skill Workshops* – Population Projections – Using OBERS – Shift-share Techniques • Workshop Debriefing (group activity)	• Group Process Techniques in Forecasting (lecture) • Delphi Forecasting (lecture—group activity) • *Simultaneous Skill Workshops* – Community service forecasting – Land Use Forecasting – Water Demand Forecasting • Workshop Debriefing (group activity)	• Modeling and Simultation (lecture) • *Simultaneous Skill Workshop* – Trend impact – Cross-Impact KS–IM/SIMCOV • Workshop Debriefing (group activity)	• Building Scenarios (lecture) • *Task Workshops* – 3 teams build scenarios of selected case study
• Forecasting Case Study (lecture) • Case study (group activity)	• *Skill Workshops* – Time-Series Techniques – Data Bases (lecture) • *Simultaneous Skill Workshops* – Using CERL base – Using SEEDIS base – Using DRI base • Workshops Debriefing (group activity)	Free-time	• *Simultaneous Skill Workshops* – Bustrap Forecasting – Applying time series • Workshop Debriefing (group activity) • Econometric Models (lecture) • Skill workshop – Econometric Modeling – 'Specialized' topics	• *Workshop Debriefing* – Teams report – Back scenarios • How to be effective back in field office (group activity) • Course evaluation (group activity)

*Each day starts at 8.00 a.m. and finishes at 5.00 p.m. with a break for lunch, except Wednesday when the agenda goes through lunch to about 1.30 p.m. and afternoons are free-time.

shops, group activities and lectures if the need arises. More importantly, instructors must be well versed and experienced in the principles and practice of group process.

While using outside consultants is necessary, the main instructors who provide the continuity over the week should be from the sponsoring organization. This provides credibility. Students can see that the organization is serious about the techniques and hasn't just 'shipped them out' to some consultants. An instructor team of one line-person and one-consultant is a good alternative. However, the organization should strive to produce line-personnel capable of such instructions.

The technique of using several support consultants reduces overhead and consequently student tuition fees. The deadening 'road-show' syndrome of experts paraded in and out, hour after hour, day after day is avoided by the use of two main instructors, as well as the varied course agenda activities. These one week courses are best suited to 25–30 trainees but have been successfully run for up to fifty trainees.

Much of the training success depends on reaching the correct target audience. In large decentralized organizations, this can be difficult. Basically, there are two options; bring the trainees to the course or bring the course to the trainees. Bringing trainees to the course, mingles employees from diverse geographic regions and other organizational functions. This diversity when brought together in interactive-training is often very broadening to the trainee. However, the trainee can feel isolated and somewhat lost upon return to the home office. Bringing training to people in the field offers team building advantages. Those who work together daily, can share the training experience. The cases used in the courses can be drawn from the specific office. Consequently, the immediate relevance of training can be enhanced. Also, overall travel costs are usually substantially reduced by bringing instructors to the field site.

Since meaningful Social Assessment and Public Involvement activities must be relevant to key decisions, training for both is closely linked to the interactive planning process described in Tables 3 and 4. The Forecasting Course while using the same learning philosophy, focuses on a series of discreet analytical techniques (Table 5). Many of those charged with forecasting are less concerned with management and the decision process than with analytical tools.

The Advanced Public Involvement course

(Table 4) is the most process oriented of the three. It emphasizes group process and communication techniques and shows how the more analytical social science tools can support such activities. The course simulates an actual planning process using a case study. Students go through the week in three teams simulating the key planning process steps and developing appropriate PI techniques at each stage.

Both the social science and forecasting courses (Tables 3 and 5) focus on techniques and demonstrate how group process and communication techniques can support the analytical. These courses use several case studies during the week but do not actually simulate the planning process as does the Advanced PI course.

However, the Social Assessment course (Table 3) focuses on one of the planning tasks each day. Substantially, the Forecasting course moves further into refined mathematical and computer techniques, while the Social Assessment course moves across numerous disciplines such as organizational behavior, sociology, psychology, political science, and anthropology.

Typically, an executive seminar is designed to: sensitize managers to the need for public involvement or social assessment; to make executives aware of available tools; and, to build confidence in applying such tools. These seminars are designed to meet both time constraints and other management needs. Therefore, the seminars concentrate on approaches, philosophies, design and evaluation. They are geared to produce commitment and support from management which translates down through the organization.

Table 6 describes a typical executive seminar. It is 2 days long and utilizes highly interactive approaches to learning. Lectures, when used, are brief and followed by some group activity. Two task oriented workshops provide 'hands-on' experience in designing public involvement programs and choosing appropriate PI techniques. Throughout, the assumption is made that executives bring vast experience to the seminar. Therefore, instructors are as much 'facilitators' who share and direct a transfer of knowledge among participants as they are 'givers' of knowledge.

TABLE 6. Public Involvement: Executive Seminar.

Day 1	Day 2
Morning	
• Intro: Needs Assessment and Nominal Group Process Demonstration (group activity)	• Integrating PI into Planning: A thought process. (lecture)
	• Alternative Techniques of Public Involvement (lecture)
• Planning and Political Decisions (lecture)	• Identifying Techniques of Public Involvement (usually group activity)
• Identifying Decisions that require Public Accountability (group activity)	• Designing effective meetings (lecture and small group activities)
• Identifying Values in Planning (group activity)	• Small group debriefing (group activity)
Lunch	
Invited Speaker	
Afternoon	
• Impact of Decision Making Style on the Public (lecture and group activity)	• Designing a Public Involvement Program (small group activity)
	• Small group debriefing (group activity)
• Coping with conflict (lecture and group activity)	• Executive PI Role: being effective (lecture and group activity)
	• Evaluation (group activity)

CONCLUSION

This article has focused on three questions: Why social science is relevant to engineering? What social science tools are available? and, How might training proceed? More complete explanation of the substance and training process are available elsewhere. The article capsulizes conceptual arguments, provides a taste for substance and, outlines a successful model of training engineer-managers in social science techniques. The author is eager to share the experience of others who have walked this challenging and rewarding interdisciplinary path.

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