MEANS TO STIMULATE R&D ACTIONS

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INTRODUCTION

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I will start with a few comments on the workshop itself. The title is "Means to Stimulate R&D Actions." Prior to this particular event today, we have had panel discussions and so forth, so this is a change of format for today's activities. You will note on the program that after this particular workshop, all else is a summary. This is, basically, the last shot you have to impact the conference results. I want to encourage a lot of interaction and a lot of resultant impact.

I would like to say that the theme of this workshop is: *be positive*. Let us not think of things we can't do, let us think of things we can do. So I would like to stress positive thoughts throughout. We are going to be informal—as intimate as it is possible to be. I believe that visual aids for something like this should be of an informative nature. I have tried to follow that example. You have been very interactive today. Roy Quillian's panel was a good example of that, so let's keep that action rolling.

Because we are at the end of the working portion of the conference, I thought it might be well to start this session off by reminding us of what some of the reasons were for putting this conference together in the first place. It was primarily designed to assess R&D required to answer *technical* and *economic* questions associated with the *availability* and *use* of *synfuels*. Our approach has been to bring experts together—which each of you are. That has certainly been done.

We are to focus on transportation fuels from coal and oil shale, assess the state-of-the-art of the technology and institutional factors to determine what R&D is needed and what strategies are appropriate. That is a big order, and it can't all be done in in a 2-day period. So, if you reduce it to a primary purpose, it would be to stress the R&D needs with respect to finished formulations of synthetic fuels. This obviously includes tradeoffs between compositions, engine design, and engine use. It is the whole "ball of wax" from resource to vehicle systems; it is not merely stressing finished fuel formulations.

If, in a simplistic manner, you think about the system that the finished fuel spec applies to, it is a *resource* (which I am going to call coal, oil shale, and something else, maybe biomass) carrying over to a *process* and out of that you get syncrudes which go to a *refinery* for finished product, to a distribution system and then to utilization.

As an observer to this conference, I have been listening and this is what I think I have heard:

> Postulate: *There are no problems associated with any process or product use for the flow schematic shown.*

Now, I want to refer you back to the title R&D Actions. Then, I want to ask a couple of questions. First, is my postulate true? Was I hearing things the way they really are? And if it isn't true, why not? What wasn't I hearing? What should I have been hearing? If it is not true, then what are the consequences? What really needs to be done for synfuels to be part of our near-term future energy stream? When and (obviously) how then would those things be done and at what cost?

Last night, when I attended the workshop, it reminded me of my school days where we did trigonometric identities. You remember your trig days, don't you? Someone put an equals sign up and said is that statement true or isn't it true? Last nights workshop was a trigonometric identity in processing; one side was *"make fuels"* and the other side was *"use fuels."* (The people with the question marks are DOE and DOD and maybe a lot ot others.) That schematic, that we showed before, could lead to this kind of structure. I ask myself, how could you make a postulate based on what went on? It sounded like the *"make fuels"* people were doing a lot of talking and they had major input into the things that were going on. The *"use fuels"* people weren't doing too much talking. They didn't have any comments of equal nature. The discussion certainly wasn't leading to a balanced equation. This can lead to many frustrations. But, then, you say, who is frustrated and why are they frustrated? Based on the comments that I was listening to, I would say the right hand side of the equation didn't seem to be too frustrated because they weren't saying too much.

I would like to start this workshop with something to think about as we work together today: the *conclusions* to the workshop. Here are some conclusions that I would like to offer:

- There are no problems, *get on with it. Mandate.* In other words, I am not going to do *anything* until I am *told* to do it so let us have *someone tell us to do it.* One way to do that is through regulations, of course. EPA has been pretty effective at that. What will provide me with an incentive? Is it a tax break or what? I need a motive. The other thing that I hear is that the *timing* is really not quite right, so I think that I will wait awhile. Maybe R&D can't be stimulated at this time or maybe there is a *lot* already going on and there isn't much of it being discussed.
- Fuel specifications were clearly spelled out as something that needs to be worked on. I heard someone say "environmental considerations," and they were talking primarily about pollutants. But, when you looked at today's movie you wonder; are other mines as safe as they have been reported? If on a large scale, what does that really mean? What are the societal implications in boom towns? We see people who are anxious to get someone moved into their town, but once that happens, you have a whole different set of problems. So there are *environmental* and *societal* considerations, I would suspect.
- I heard a lot about combustion characteristics. This was primarily by the university people today, and, every once in a while, someone else would discuss it a little bit. Clearly, there was a need identified to *define combustion characteristics.*
- Scale-up considerations were discussed: "If there are no problems, then there isn't any R&D needed." So, there was no worry about going from a very small pilot plant to a commercial-size plant. Yet, you could sense in the undercurrent that acid treatment and arsenic and a few other things might require looking into. No problem?
- Refinery optimization for finished synfuel products was not actually discussed, except to say that what has been done is not at all *optimized.* Work needed?
- Our keynote speaker started out by giving a very nice plug for the systems approach. But what you see going on is not really a systems approach. Should it be on here or shouldn't it?
- I didn't hear any new engines being spoken of. In this regard, I am presuming that the stratified charge is not a new engine. What I did hear was: *use oil shale.* There wasn't room to put economics on this chart. Economics wasn't very well-defined. Should it be?

From this point on, I don't have much to say, I am just a moderator. So, I want some response to some of the things that we have presented here. *Do you believe the postulate?* What are the *responses* to the questions? Are these *really* the results of what I have been hearing *or are there different results?* Which ones are *right* and which ones are *wrong*? Where should *others* be added? I didn't hear much of anything said about coal. Does that mean that it is really *not* a consideration for synfuel? Is *that* what is implied by *not* talking about coal?

CONFERENCE

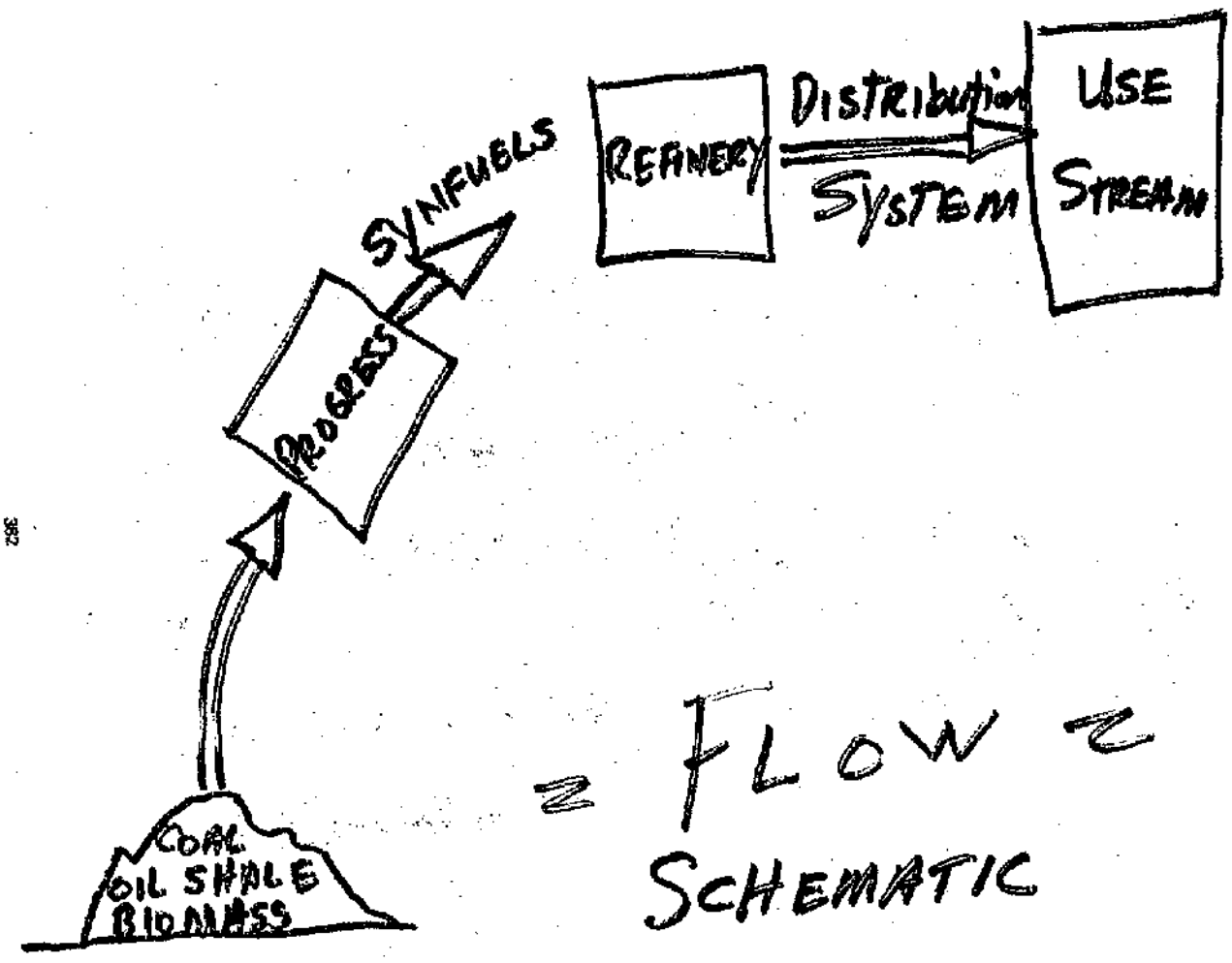
- DESIGNED TO ASSESS R&D REQ'D TO ANSWER TECHNICAL/ ECONOMIC QUESTIONS ASSOCIATED WITH AVAILABILITY AND USE OF SYNFUELS

OBJECTIVE

- BRING EXPERTS TOGETHER
- FOCUS ON TRANSPORTATION FUELS FROM COAL & OIL SHALE
- ASSESS
  - STATE OF ART TECHNOLOGY
  - INSTITUTIONAL FACTORS
- DETERMINE
  - WHAT R&D
  - WHAT STRATEGIES

PRIMARY PURPOSE

- DETERMINE
  - R & D NEEDS WITH RESPECT TO FINISHED FORMULATIONS OF SYNTHETIC FUELS
- INCLUDES
  - TRADEOFF CONSEQUENCES BETWEEN FUEL COMPOSITION ENGINE DESIGN, ENERGY USE
- OPTIMIZE ENERGY USE - RESOURCE TO VEHICLE SYSTEM



= FLOW =

SCHEMATIC

POSTULATE

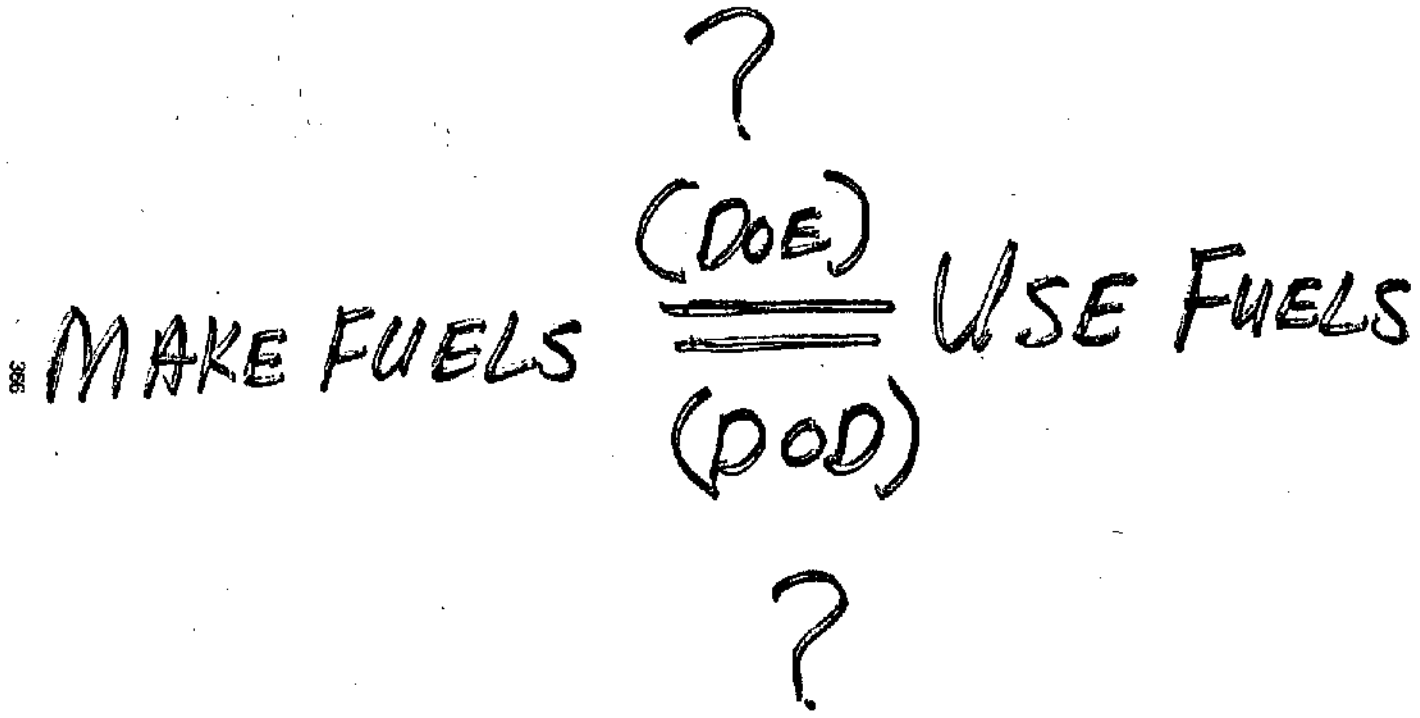
THERE ARE NO PROBLEMS ASSOCIATED WITH ANY LINKAGES, PROCESSES, OR USES FOR THE FLOW SCHEMATIC SHOWN!

WORKSHOP DESIRE

- IS POSTULATE TRUE ?
- IF SO - WHY ?
- IF NOT — CONSEQUENCES ----
- WHAT NEEDS TO BE DONE FOR SYNFUELS TO BE PART OF OUR NEAR FUTURE ENERGY STREAM
- WHEN ?
- AT WHAT COST ?

365

$$1-\cos^2\theta+\frac{\tan\theta}{\sec\theta}\stackrel{?}{=}\sin\theta(\sin\theta+1)$$


?
MAKE FUELS
(DOE)
(DOD)
USE FUELS
?

RESULTS:

- THERE ARE NO PROBLEMS - GET ON WITH IT
- MANDATE - REGULATE
- INCENTIVES
- TIMING - NOT RIGHT - WAIT
- R & D CANNOT BE STIMULATED AT THIS TIME - OR ----
- FUEL SPECIFICATIONS

RESULTS (CON'T)

- ENVIRONMENTAL CONSIDERATIONS (PRIMARILY POLLUTANTS)
- COMBUSTION CHARACTERISTICS
- SCALE UP CONSIDERATIONS - NONE
- REFINERY OPTIMIZATION FOR FINISHED SYNFUELS PRODUCTS
- SYSTEMS APPROACH - NOT REALLY
- NEW ENGINES - NONE
- USE OIL SHALE

OPEN DISCUSSION

Speaker 1:

I think your analysis of the situation is very sharp. I think there is a lot of R&D to be done on both sides if we accept a game plan that has been said here very often but not pursued. That is, the objective for the future against a tight energy situation is to get as much as we possibly can.

There is a rough job for the processing industry if somebody doesn't say, "You can make anything you want out of synthetic fuels just so long as it meets current engines and has the same specifications as everything you have been making since 1902."

So, I think the thing that has to be done if the synthetic liquid fuel industry is going to go is to provide it with a "vehicle" to pour into. I don't mean a wheeled "vehicle." The objective is to make as much liquid fuel as they can and make energy availability as efficient from the starting material as they possibly can. *That* is the incentive.

The other end is, ultimately, liquid hydrocarbons. Liquid energy is the prime and preferred source for something that either has to fly or move on wheels. So that is the engine situation. If the engine people are permitted to continue with the development of their vehicles at the present time and to look toward a reasonable future, they are going to need more fuel which can come from stationary powerplant petroleum fuels, replacing these with large volume production of synthetic fuels, coal slurries, etc. If this is done, then the refining industry or the producing industry can attain its objective of getting the most out of the natural resource. Also, the people in the engine business (by looking at synfuel performance in stationary powerplants) can get an idea of the R&D that they have to do to accommodate transportation engine fuel interface in a given period of time.

It takes time to meet a future requirement. DOD has a legitimate reason for doing what they are doing now. But, unfortunately, this conference being "synfuels for transportation" actually is addressing the wrong thing *if they are thinking in terms of 10 years*. Synfuel for transportation in *20 or 25 years* is wonderful. Then you have R&D on both sides. If you don't, you have frustration. I am on the process side, that is why I am talking. Complacency on the other side (if we have to meet their engine requirements). They don't have any future fuels R&D because they must devote this effort to satisfying current EPA regulations. But, in regard to synfuels (if what we make is the same as what we have made for the last 25 years), they don't have any work to do.

Speaker 2:

We are very interested in doing research, but I don't think we can expect to have this magnificent new synfuel (or whatever it may be) in our engines in the short term of 10 or 15 years. I don't think we are going to have any magnificent new engines either. I think that the petroleum industry (or the energy industry) has done some good work and can conclude that the first place you might want to put synfuels, whether they be from coal or oil shale, is in those stationary powerplants whose fuels appetite is not as demanding as the fuel appetite of the transportation fuel consumers. DOE, I am sure, has come to the same conclusion. Then you can take the petroleum products that are currently going into those stationary fuels uses, send them back to the refinery, and convert them into trasportation fuels. In essence, extend the supplies of transportation fuels. Thus, we'll gain a lot of experience using synfuels.

I think Bill has got some real good points. I think that some of the directions in DOE (at least with respect to fuels from coal) are now being directed towards getting liquid fuels into stationary powerplants. That is (if it is true) a step in the right direction.

A. J. Parker, Jr.:

Could I impose on you for one more question?

You define a transitional scenario very well. What do you see after the transition is over? We are with the process people now.

Speaker 2:

I think that what we need is to maximize the energy utilization efficiency of the system, or to minimize the tons that have to be mined to move a

vehicle a given distance. To do that, we need to set up a systematic, iterative approach between the fuel users and the fuel suppliers. In this time period, when they are getting synthetic fuels for the stationary powerplants, we, the end users (working with some of the energy companies), could be taking this iterative approach. They will look at it as getting a fuel that is not gasoline or diesel fuel. Take the extreme: powdered coal. That is probably the most efficient way I could use coal (if I could use it). But I know right now that I can't use powdered coal on the *existing* engine. In this extreme case, how can I modify an engine to use powdered coal, still meet emission and fuel economy constraints, and still provide a system with which the public is satisfied? If I could do that, I would have a big achievement.

I am not too optimistic about that. So, I take the next approach. Where can I go from there? Let us try a liquid. What is the least refined liquid I can use for the transportation system? If that doesn't work, you keep heading towards the completely refined product—to current spec fuels. But, maybe you don't have to get there. If you have *time* to do this kind of research, you may wind up with a system which is more optimum in terms of energy utilization then going all the way to current spec fuels from coal or oil shale. I think, given enough time, we can do that.

That provides us with another thing I think the people in this audience would appreciate. This is an opportunity for some challenging research. If you are going to go to spec fuels, the end user really doesn't give a darn. There is no research involved there. The petroleum guy, the energy company guy, and the refinery guy might go out of their minds, but the challenge is not *ours*, it is *theirs* in that case.

Speaker 3:

I think one of the questions brought up earlier is that time is running out. I just came back from Florida. Gasoline is cheaper there than it is in Michigan. As long as gasoline is cheap and you go to the pump and it is there, I can still fill up with no lines or anything. It is easy to get. I think you are hearing a lot of the emphasis from the Navy and DOD. We are going to have to have fuel. DOE is going to have to go along with that idea too. You are going to have to have fuel for that fleet.

I can't get to work without fuel. I just drive 13 miles back and forth. When they talked about putting some stamps on me to stop me from getting to work, I wasn't even going to be *able* to get to work.

I think we need to move out. We need to move out with a resource that we *have*. I think that we have had a first go-around on that DOD project on shale fuel. The vast resource is there, and I am hoping for a vast supply of good, clean specification fuel so that I can get to work.

A. J. Parker, Jr.:

So, your point is look over processes and things that are available right now, select something and move out with it.

Speaker 4:

We seem to be getting to the same state that we are getting to in all of the conferences that we have: a lot of good researchers who are doing magnificent work on showing how well one could use a fuel that doesn't exist. I think that this is really the basic problem that we have to face. We are not really trying to define a goal or define what we can do. It would be fine to say we can produce 100,000 barrels of shale oil which by all definitions of English *isn't* synthetic fuel. It is a *modified* oil, and it rather bothers me that most of the time we have talked about shale as a synfuel when it really isn't and by no imagination could be a synfuel. I think the only synfuel that has been mentioned is methanol.

But I think we have to relate what we can do. I am quite sure that the automotive industry can produce an engine within the time scale that it takes to build *any* plant that is going to build *any* synthetic fuel (or whatever we call it). That is, from the time somebody breaks ground, they can start from scratch and come up with something that will use the fuel. In fact, they can wait until the plant is *looking* like it is being built before they start, and they will *still* be successful. So their jobs are a lot easier than anybody else's. The researcher has got some potential to lead him on a bit by saying what clever guys they are in doing something basically fundamental.

What can we do today? We can take oil shale. There are processes in the commercial demonstration stage which are producing some shale oil. But if we look at them now, the most optimistic fellow couldn't, with any sort of realism, produce anything until 1985. So there cannot be any shale oil basically until 1985.

As we look at coal, it is possible tomorrow. In fact, there are a lot of specifications around for SNG plants which somebody can start building tomorrow once you get rid of the regulatory problems.

Convert coal and steam in a reactor to either methane or CO and hydrogen, which can subsequently be combined to make something else. We can make methanol and SNG methane in one plant very efficiently (approaching 70 percent) with some justifiers. But we have a coal product plant to do this. If we try to make *only* methanol, we lose. The least time anybody could take to build a plant from the time he goes on site is about 4 1/2 years for the first train of about 100 billion Btu's a day. So, again by the time you got over the first stages of getting some money and getting started, we are talking about approaching 1985 before there is anything known.

The only coal *liquids* we can think about making today are again by the recombination of CO and hydrogen through Fischer-Tropsch. There is no coal liquefaction plant that is anywhere near producing a design which can be built and be in operation before 1990.

So we have the interesting possibility that by 1985, if everybody moves in the right direction, there could be a variety of synfuel plants producing, fairly efficiently, fuel from coal and oil shale. Some of these will be liquid, and some will be gas. The significance of the date is that there is hope that sometime in the next month (or maybe even this week) natural gas won't be regulated in 1985. Nobody can build one of these plants at the moment because you can't hope to make methanol (which is unregulated) in a plant that you have to sell methane, which is regulated.

My last point here is about biomass. There are two sources of biomass. Some of these gasifiers really, in fact, consume wood. There is at least one which could consume mixtures of wood and coal. There are the simple old-fashioned producers which can produce synthesis gas from wood. There are, of course, the farmers from Nebraska, Illinois and everywhere else who (because they can't sell their wheat and corn to the Russians for more than $2.50) want to sell it for $3.50 a bushel to the people driving cars. I think this may be telling us what we have to do. If we can make some tables of what can be done and what has been done, maybe it will show us where the R&D has to go. By 1985, we have to have methanol engines working efficiently in terms of miles per gallon by taking advantage of the properties and efficiency in terms of miles per gallon by taking advantage of the properties and some of the work already done so that the loss in fuel volume is gained by the increase in efficiency because we know that we could make methanol now today. I think this is the direction we have to go. Let us not flounder because we are all in our own little pockets.

Speaker 5:

I am not very good at the big picture, but I do have a couple of R&D problems that we as a company need to solve. First, let me tell a little bit about what Exxon is doing. We have a process for making coal liquids using the Exxon Donor Solvent which has already been mentioned here. This is being funded about 50 percent by DOE and 50 percent by private industry. We expect to have a 250-ton per day plant under construction starting this year, and we hope to have it in operation at the end of next year. This will produce something like 500 or 600 barrels per day. We expect to run this for about 5 years and have enough data so that we will be able to build a full-scale pioneer plant. That is, a small refinery of about 30,000 or 40,000 barrels per day. Now, we have some problems that we would like to have solved.

One problem is that we know the material that we will get is going to be quite different from current petroleum. We aren't going to make any middle distillate at all. We are going to make nothing but gasoline and heavy fuel. The gasoline is going to be very, very aromatic, and the heavy fuel is also going to be very aromatic. It is also going to have a lot of heteroatoms in it. This situation is not too dissimilar from shale except that they are going to have a lot of middle distillates and not very much gasoline. But, they too have a lot of heteroatoms to worry about. If you take a look at the raw material that comes out, that too is fairly aromatic.

There is another thing that Exxon is working on. That is our pyrolysis liquids, also from coal. They are primarily a gasification plant, but they do make some liquids. The stuff that comes out of there are these pyrolysis liquids. They are a mixture of who knows what (a lot of oxygenated materials and a lot of other things). We haven't really characterized them very well yet.

So, one thing we would like to ask the automotive people is what sort of fuels can you *get by* with? We know that we can take these things and hydrogenate them; sooner or later, they are going to be satisfactory for running in today's engines. But that is not the problem at all. The problem is: we are going to give you a lousy fuel. Now, what kind of an engine can you give us that will allow us to burn the lousy fuel?

The other problem is we would like to have some simple tests so that we don't have to make several million barrels of this material for somebody to run in an airplane from coast to coast. We would like not even to make barrel quantities. If somebody says, "does this burn well in a Clever-Brooks burner for heavy fuel oil?" we say, "we don't know, how much do you need?" He says, "Well, at least three or four barrels." Three or four barrels is a *long time* if you are trying to make it out of a one-ton per day pilot plant. We would like to have something where we could get this sort of information on 50 cc's. If DOE could supply us with a whole bunch of small-scale tests that would allow us to get the sort of information that currently takes gallons or even barrels, why we would very much appreciate having that, too.

So there are two things we would like to have: small-scale tests from DOE and some indication from the automotive industry as to what kind of fuels they can get by with. How badly do we have to clean them up?

Speaker 6:

We have reached the point at which we should have started 2 days ago. It seems that the issue really is that yes, we can make the fuels look like current specs, but that is known. As a user, we *don't* have to do anything. We need some kind of an interactive program. I agree completely with what Speaker 2 said and with what has just been said. What we need is some kind of a program where we can evaluate a very dirty, messy fuel, but one that saves a lot of energy at the refinery. We need to do some testing on it, design a new engine for that, and go back and find out how much we have to give up: How much more refining we have to do, and how much thermal efficiency we sacrifice for energy gained at the refinery.

That kind of an interactive program I think is required. It needs to be done on engines that are important for the transportation sector (the highway transportation sector). That is why I feel that a lot of the discussion we have been having about distillate requirements (particularly for the military) have been interesting but have not been to the point.

DOE can play a very valuable role in granting contracts to define what they know about fuels and how much energy it takes to produce fuels of different levels of refinement and making those available to the engine builders. In turn, we can find out how much efficiency we have to give up to accommodate those fuels in some future engines.

It is very important for the engine builders to know if there could a 5-percent savings in total energy in 15 or 20 years if we started now to build a totally new engine for that. We need to know if we *have* to build that new engine. We are trying to make decisions about totally new engines, like Stirling engines for example. We make those decisions based upon thermal efficiency of the engines themselves, using *current* fuels. Maybe the decision would be totally different if we knew that, sometime in the future, there would be a fuel available that would save us 5 percent energy at the refineries. We *don't have* those fuels to make that trade-off study and we *need* them. I feel that this is the most important thing that we should get out of this conference.

Speaker 7:

My background has been more on lubricating oils than fuels, mainly because in the last 6 years we have been engaged in taking sperm whale oil out of our transmission oil. I reflect on many of the comments that are made here relative to specifications. We are a little naive to think that just because we can meet a certain specification, the oil

will perform in an engine. I think Commander Lukens alluded to this in his project. He stated, very importantly, that we want to get this oil into engines to see if the specification is really meaningful. I think we should pay particular attention to this comment. The specification has been built up from experience but has always come from a petroleum oil base. When you start coming with a new base, you may well have a completely different set of problems. I think we have had some experience in the last couple of years in going to no lead gasoline that we have had to make changes in the lubricating oil. That wasn't because the spec was wrong, it was because of the incompatibility that, it appeared, had to be taken care of. Those are the problems associated with the engine and the transmission that I am afraid of. What are these unknowns that we start to get into?

That is why I am very thoroughly convinced that we have got to do a lot of testing. This is frightening, because in just taking sperm oil out of our oil it cost us a tremendous sum of money. We used the sperm whale oil as an additive to prevent chatter or breaks in transmissions. When we start to test this oil, we have to start with short-term tests and performance for a whole flock of different-sized engines. We have to look at cold-starting characteristics, white smoke, and black smoke. We have to look at wear. Lubrication of the injection pump has been pointed out before and plugging of nozzles for example.

The spec won't necessarily tell us that that is going to be a problem. I just see a tremendous test program. But, still, I think it is going to be necessary for us to go into that to tell if our specifications are still meaningful.

Speaker 8:

The question still comes back to one main point. We are all interested in testing the fuels, but what fuel should we be testing? From everything I can read or see, if you consider coal, methanol and oil shale, you are talking about a maximum quantity that we could produce by the year 2000 of something like 10 percent of our petroleum needs. Put your own figure in if you want to. Yet, what we are talking about today is testing these pure oil shale-derived fuels. Isn't it realistic that you are going to be mixing these things as blends in the refining process? So shouldn't DOE or someone be running 100 thousand barrels (or whatever we need) of fuel in which we mix and run as blends and what is coming out of the end being whatever that finished product might be?

Somebody has to make a study of *what kind of refining process is required*. How bad can that coal-derived liquid be in terms of cost and efficiency of the process for a given fuel coming out in the end? Then, let us address *that type* of fuel.

However, is there another side to it? Is that not the way it is going to be done? We can test fuels until we are blue in the face as engine manufacturers. If we are not testing anything at all representative, isn't it an exercise in futility? So, I would pose the question, what kind of fuels are we going to use and should we address those?

Speaker 9:

I am going to talk from a shale developer's point of view, and not necessarily from my company and my partner's point of view. Currently, there are four or five shale projects that have a reasonable chance of moving into the commercial phase. Each has taken a quite different approach to marketing the products from these pioneer plants. SOHIO, on one hand, has looked very heavily towards the military. Occidental is looking towards blending to refineries in the utility market. Union is looking into a utility market and then, I think, go into upgrading. The TOSCO-ARCO people have always looked towards building universally a premium fuel that is acceptable as a real premium utility fuel, or a really widely acceptable refinery feed. I don't think the breaking point in any of these projects has been acceptability of that initial 50,000 to 100,000 barrels per day into a market. There are other breaking points including environmental, economical, and political factors that are holding these projects back.

Now, as the industry expands and goes forward, I hope that we would optimize that spot in the market place that shale oil best fits, whether it would be in advanced engines which aren't available today that will burn on lower specification fuels, or we find some niche that the shale oil fits into particularly well. But, as we stand now, what we need to do is get the road blocks of today's pioneer plants out of the way. We should get on

with the construction of these plants and then, with the availibility of the material on a continuous basis from commercial plants, I think we can more logically approach this optimization process. What I would hate to see is the development of the industry held back. In looking for this extra dollar or two per barrel, we might be able to gain by the optimization process.

Speaker 10:

A lot of studies have been put out about that if you do this, or make a wide cut fuel, or you do that, you *change the amount of energy at the refinery*. Then, I have been to meetings where there will be an opposing person who will say *that is not so*. He will say that if you talk about the refinery *I have* or about the refinery *I am going to build* then you *may* save energy on the one you are *going* to optimize and build. I don't think you can get any answer and maybe the refinery people can tell you whether there is a *best* way to cut down refinery energy use.

Speaker 11:

I think the answer to this question is fairly straight forward, in one sense. If you ask a specific refinery, on the basis of its size, it can do certain things. Better than half of the domestic refining industry is composed of plants of less than 60,000 barrels a day production; they are all little ones. This is 50 percent of our capability. The name of the game is the less process energy you have to put in between the crude you receive and the product you dump at the gate, the better off you are. The process energy goes into upgrading the octane number (when you take the lead out). Or, when you have a 91 clear and along comes EPA and says you need the miles per gallon within the next couple of years, the only way you can go is high compression ratio or turbocharge and all of a sudden 91 begins to look like 95, and then we could go the Italian route and say 99. Then, everytime you look at a clear octane going from what we used to have as 83, you are losing refining energy. So, straight distillate fuel is the easiest thing you can get and that is why the old oil engines could run on crude out of Central Illinois or West Texas light. So, the energy loss in a refinery is strictly dependent upon how much you have to put into processing. Processing says the tighter the specs, the more energy you use to get from crude to barrel.

The biggest thing really is to back off and look at the investment in refining industry and recognize that 50 percent of them are little guys. Don't look at our big plants.

Find out what the *key topics* are in the specifications that, as you back off, save you energy.

Speaker 12:

If you ask the automotive people what is the cheapest car they can make if they didn't have to do 0 to 60 in six seconds, if you didn't have to carry five people and seven suitcases, if you didn't have to have a no-damage barrier crash at 60 miles per hour, if you didn't have to stop within 5 feet from 100 miles per hour, you couldn't build a go-cart. So, what you have to spend on what you make depends upon what people either *require as a specification* or begin to look for as a *need* like an air conditioner or radio and upholstery.

I think this not only applies to the auto industry but also to the tractor industry. These things become more expensive when you have air conditioners in the cabs. The old two-runner, crank-type tractor has changed so they are in the same boat we are, GM is, Ford is, and everybody else. So *specifications* set the cost of your energy needs.

Speaker 13:

I don't have a comment, I have a question for the university session. Their period was cut short this morning, and there was not time for adequate discussion specifically from the professors as to what they felt the university research program could do to help *accelerate the availability* of alternative fuels for the future. This is really what we are all after. The question was never addressed at the university session. It has been addressed at all of the others.

We know the approaches that are being taken, but what we need (or at least what this conference could benefit from) is an expression of opinion from these professors on where the fed

eral, the industry and the university R&D programs might go to assist and accelerate the availability of these future fuels.

Speaker 2:

I am not associated with a university, but I have got an input on this. I think one of the areas with the most crying need for research (be it at universities or industrial organizations) is on the mechanism whereby *particulates* are generated.

I think if we are going to get fuels which are highly aromatic, we are going to have problems with particulates. I think if we are going to use diesel engines, then (depending on where the fuel is going to come from) we are going to have problems with particulates. I think the brain power at the universities could really make a contribution in this area.

If you can get down to some basic work and some basic understanding of the mechanisms, it might apply generally, regardless of where the fuel comes from. If you are going to work on specific fuels from coal or oil shale, they are not going to be able to do anything. But I think right now there may be something that they can do at the university level—not even in an engine. Maybe you have to get outside the engine. You have to do it in a more fundamental fashion. I think that is a place where they can really help everybody.

Speaker 14:

I guess I can agree completely with what Speaker 2 just said, but I don't think it is the role of the university to do engine research because we have lots of people in industry who are doing that kind of research. I think that the university can make two contributions:

The university has time to sit down and *design fundamental experiments* which simulate the key controlling processes in the engine combustion process. I think that it behooves the university professor to try to do that—to design model experiments.

The other thing that I think the university can do is spend time interpreting the results of both positive and negative experiments. In other words, perhaps something gives you a negative result. The question is *why*? I think that is where the universities can help.

Speaker 15:

What Speaker 14 just said reinforces what I was trying to say this morning. We are really not constituted to give you the quick answer that people are looking for here. We are more constituted to take an objective look over a longer period of time. We are forced into a longer period of time because of the way a university operates. But we can look at these very *fundamental* kinds of problems, and I also like to think we could perhaps look at some of the *high risk* problems. Indeed, a negative result is not all bad. It gives you a place to start to work toward a positive result.

So I can't give you any quick, simple answers because it just doesn't work that way in a university. We are those people who have to sit down and ponder for awhile. (That is why you haven't heard from me much earlier. I have been pondering.) These are the kinds of things that I can do, and I think other people in the universities have these same kinds of feelings and approaches to the problem.

Speaker 16:

You know very well that teachers always have something to say. I would bring to the attention of the group that there is a SCORE organization in the nation, and it stands for Student Committee on Responsible Engineering, I think. It relates to designing an energy-efficient vehicle with acceptable drivability and safety. I think that it is important for us to recognize that the universities are a source.

I was a little disappointed this morning to see a key factor left out of the presentation. That factor is that the vitality and creativity of the universities are really what is great. I think this is what we are suffering from here. Institutions in my mind in many instances are monuments to past problems. I really think this country has "institutionalitis" when it comes to dealing with this alternate fuels issue. Yet, I feel that we need to cooperate.

I have had the privilege to be in Scandinavia and Germany, and to deal with the Japanese. It is my assessment that the universities and the government and industry are more antagonistic in this society than any of these other countries. If we don't cut it out, we are going to wind up at the end

of the pole. I am really seriously concerned. One can see where it came from. It certainly came out of Vietnam, Watergate, and so on. There is a serious distrust among us, and the press is part of this problem. But I do think that we have got to get together and work together. Just getting together and mouthing the same old problems is not enough. I would call your attention to this.

Quite a few of us were there at Henniker, and the question came up very clearly from the government asking industry, "what do you need from us to get going?" Give us a *base price on energy* that we won't lose our shirts on, and let us go. Let us try to produce the synthetic fuels from coal, oil shale, agricultural wastes, but simply guarantee a base price on energy.

I keep wondering how we do generate more momentum in this sense. Here is another way of looking at it. Indeed, if we had put 10 cents per gallon gasoline tax on at the end of the oil embargo and dedicated it like we have in times past to solve a problem (we have put men on the moon), we would have 50 billion dollars of research invested in alternate fuels today. I think we would have had these plants.

I don't know how we get the universities, government, and industries together to produce these things. So I am interested in the university doing its bit, and we *can* do bits and pieces. But we have a major road block that collectively we have to run at, or I think we are going to have to leave our homes and roam around the countryside for want of food. I think we have to shape up on that. I don't quite know how to do it, but I am very serious in what I say about it.

Speaker 17:

I would like to respond to this question because it was maybe buried in some of the things that I said this morning and that you have heard me speak about once in a while. I think the problem was that, when you addressed the question to Henniker, it was put perhaps to government; it was the *wrong side* of the government. The problem with it is that we keep talking "technologist-to-technologist." We technologists can't give you that 10 cents per gallon. We technologists better find out how to talk with the *other half* of the government. We have to find out how to talk to the politicians and the lawyers.

Now, that is only part of the situation. Obviously, we have to talk with each other, too. But this is a very vital proposition, and I think maybe it should be one of the things that comes out of this. There are mechanisms that we need that need to be addressed (and that are perhaps part of our frustrations). But the question is, who is it that we really need to be interfacing with to get moving with this situation?

Speaker 18:

I would like to get back here for just a moment to what Speaker 13 asked: what kind of inputs can universities provide?

What I keep hearing here is a reference to energy. It is like I tell my kids in the classroom that if we believe in the first law of thermodynamics, we don't have an energy problem. We are taught from the very beginning that energy can conserve quantity. We have as much energy today as we have ever had. We just change it from form to form.

So really what we are talking about is *available* energy. Let me give you an example. We heard Speaker 1 talk about the energy in refining. Consider for a moment that if you had the choice of using energy in one form or another, what choice are you going to make? Suppose you had the choice of using electrical energy or using a flame from a waste stream of gas, and we had the same number of Btu's to affect the same thing. Which are you going to choose? Well the answer is obvious! You will probably choose the flame because the electrical energy is all available. It can all do a useful task.

So what I am leading up to is this, I think the universities can help. We all agree we want to get on with it. We want to get a plant on stream. But there are going to be some hard decisions that have to be made to get these plants on stream. I think universities can help to evaluate by making some of the analyses. They can look at it, not only from the energy approach, but also from the second law approach (is this the better way to go or is that the better way?). They can look at it not from the first law and not from purely an energy standpoint, but from an available energy standpoint. I think that we have to get this somehow into the equation.

Speaker 19:

I think the question that was addressed about what one can do with a *small* amount of fuel (and its relation to the universities) and, the fact that Dick Wheeler is here is a great coincidence. Around the time when I was an associate (around 1949-1951), a great group of people was operating within Ricardo's of Shell and London University who (using small support tubes and little compartments) were able to do some tremendous amounts of work for the fundamentals of combustion. It seems to me, at the time, we used to do a lot of work on a very small amount of fuel. He was a lot closer to it than I was. I was one of the engineers on the teams. The chemists were doing most of the work, but maybe he would like to make some comments on *how small* a quantity of fuel you can actually use in the atmosphere of academic research where with a little tube you can learn a lot from a little fuel. The students who are working on it can also learn a lot about the basics.

Speaker 20:

The reason that we did that work was the munificence of the Shell Company. Far from using 50 milliliters of sample, I was utterly appalled, myself, and kept sending requirements up to Thornton for ten 50-gallon barrels of normal hectane which I had to ship in from Phillips in the States at some enormous price.

I seriously think that the situation then was that Shell was making a great return on its capital; it wasn't taxed out of sight. It was really extremely well-funded. We lived very well on it for instrumentation. We could buy all of the best stuff of the time, and I am everlastingly grateful to that company for its munificence. Of course, there was a historical reason for that, and that was one of the first men in the oil industry worldwide who really understood the value of research was Sir Robert Wiley Cohen, who was the boss of Shell the First World War. It was really Sir Robert Wiley Cohen who put Ricardo's on the mark, and that is why we have this relationship with Shell. Don't think that I am doing a Shell plug, it just happens to be Shell history.

The one thing I would like to say (which is of a slightly different tack) is why is it that the Naders of this world can get in there and exert such leverage on Washington? Why is it that all patriotic Americans who know the real facts of the situation can't get any message through? I think the reason is that Nader gets to the American people through TV and the media. He gets to them. Why is it that people who know the true facts and the awful warning which we have heard around here that the Americans are not really patriotically enough inclined to this problem in the way that the Chinese are and the Russians?

I think that Speaker 16 was a little bit inclined to criticize this country against Germany. Don't forget that Germany had the Bodermeindhoff gang that came straight out of the university. I think there is a lot of subversive activity again in Europe, particularly in Britain. This message in Europe isn't necessary because of the American discovery of oil in the North Sea. It was American funded and technologically developed. That allows us to forget this problem, but it is only that we are forgetting it for a very short while. But you have to get through to the American people and warn them of what could happen to their kids who can suffer from this thing, if we don't really make it. Europe will go down with it. We are really linked to this problem.

A. J. Parker, Jr.:

I do have some closing comments. I want to thank everybody for their active participation in the workshop.

The last several comments were suggesting; how can a group like this (that are experts and are knowledgeable and do have a message) make their message more effective? There has been some conversation on that. What I would like you to do is not discuss it now at this workshop, but think about it and put any comments at all you have down on a piece of paper that would relate to that subject and mail your comments to Gene Ecklund. He will be glad to give you his address and receive your input.

Thank you.