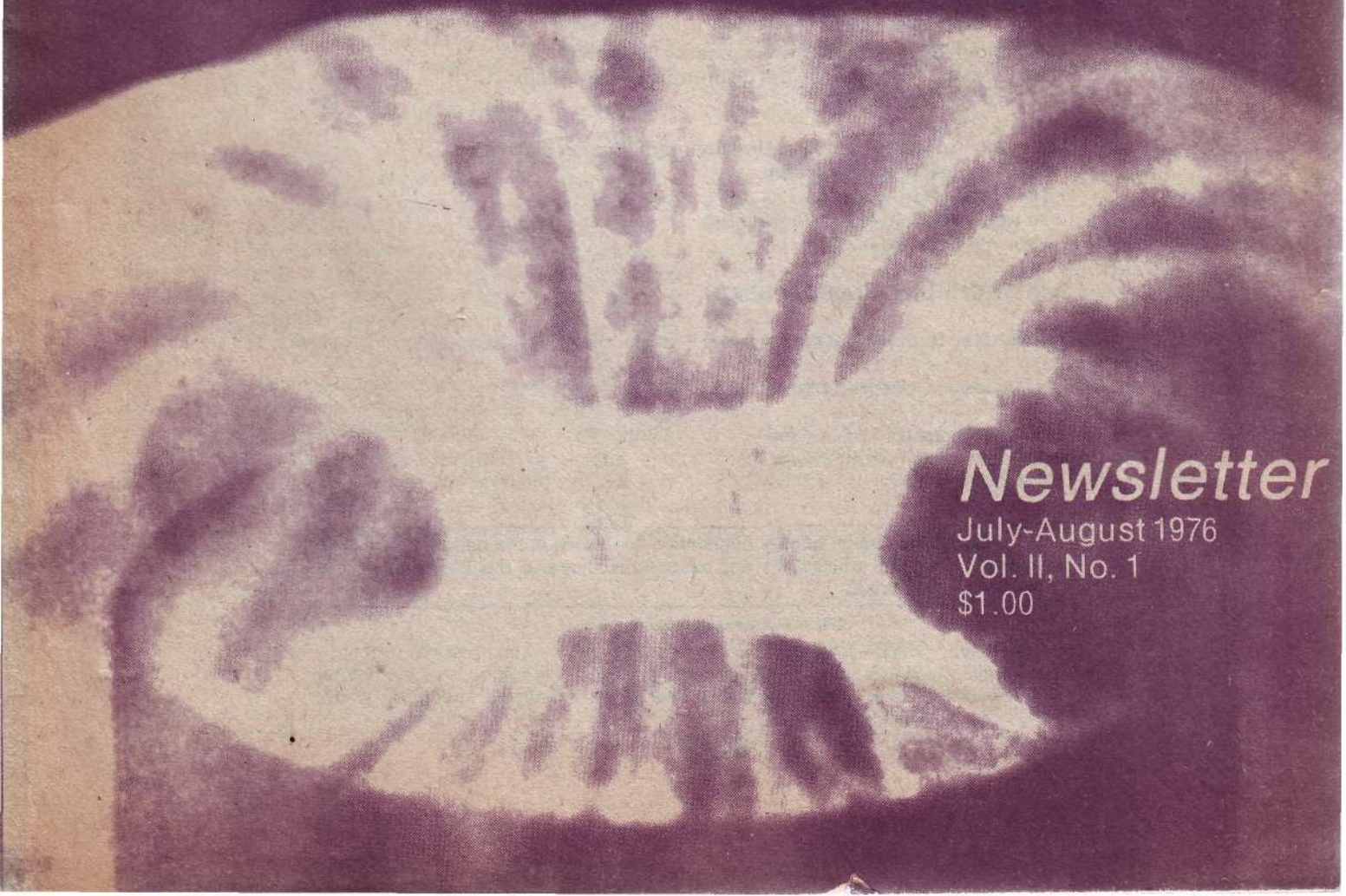
Fusion Energy Foundation

The Issue Is Progress

Highlights Of The FEF Chicago Conference

The Witchhunt Against Fusion



Newsletter
July-August 1976
Vol. II, No. 1
$1.00

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First Printing: 25,000 copies

FRONT COVER: Vortex filaments from the current sheath in the plasma discharge from a theta pinch machine. These filaments are very clear evidence of the natural tendency of a plasma toward organized and self-differentiated structure. Photo courtesy of Dr. Winston Bostick.

Fusion Energy Foundation Newsletter

Vol. II, No. 1
July-August 1976

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Editorial

The Issue Is Progress

The June Fusion Energy Foundation Conference, "World Development and the Transition to a Fusion-Based Economy," marked a turning point in the history of U.S. fusion development and of technological progress in general.

For the first time, a major public forum involving representatives of leading U.S. industries and a broad cross-section of technical experts broke through the prevailing constricted range of zero-growth energy-saving "development scenarios." Instead, these scientists and industrialists posed the issue of what humanity can — and, indeed, must — accomplish in this century if we are to realize present technological and scientific potentialities in the form of necessary global development.

The conference, whose highlights appear in this issue, made clear that the only alternative to world development, on a scale commensurate with transition to a fusion based economy, is ecological catastrophe. Put in its simplest terms, disease resistance requires ample, inexpensive food, that in turn requires sufficient energy inputs in agriculture as well as industry. The required scale of investments to upgrade advanced sector industry and to pull Third World projects out of the low productivity-poverty cycle is also the only possible mechanism to provide the net social surplus (that is, profit) by which the necessary fusion development program can be financed.

This world development program, whose scientific and technical aspects were delineated at the conference and especially in the debate following Prof. Miley's presentation on the present status of fusion research, is exactly what prompted the attacks on fusion development and the FEF which surfaced around the conference. Continued organizing for this world development program, moreover, is the only way to squelch the anti-fusion campaign.

These anti-fusion shenanigans included two apparently contradictory aspects. On one hand, documents released by the Federal Bureau of Investigation (FBI) to the FEF, following requests under the Freedom of Information Act for Energy Research and Development Administration (ERDA) files on the FEF, label the FEF as "A front group" of the National Caucus of Labor Committees (NCLC). The files add that the FEF was set up allegedly to recruit naive "left-liberals" as information conduits for "foreign intelligence services," including those of the Soviet Union. It is further asserted that the FEF is trying to "divert" fusion scientists into pursuit of theoretical investigations when, according to ERDA-FBI experts, fusion development is strictly an "engineering" problems. (See page 26 for reprints of the FBI documents)

At the other end of the anti-fusion campaign, *Science* magazine attacked the present fusion research program for being too technologically cumbersome—just what the FBI-ERDA said it was not. *Science* magazine is the weekly of the American Association for the Advancement of Science, proponents of steady-state, zero-growth "solutions" to the crisis of development.

THE BATTLE GROUND

Our response to both these institutions is the same. Putting aside the questions of who put them up to it or why, the Chicago conference and the FEF publications lay down the gauntlet in the most important battleground — that of program and analysis. The conference highlights in this issue provide in summary form our findings, showing why the optimal development program is also both necessary and feasible.

We expect that the policies we have determined as optimal will be deemed by many as outrageous or simply impractical. From a historical standpoint, this is nothing extraordinary. The concepts that have advanced both the idea and the actuality of Progress have always depended on appropriate social circumstances for their realization. Herein lies the ongoing significance of the FEF Chicago Conference.

In mini-conferences and meetings throughout North America following the June Chicago conference, in countless discussions with skilled workers, engineers, and scientists in a score of industries and disciplines, there is tremendous excitement about the content of the Chicago conference and an immediate connection of the FEF program to the traditional American commitment to the idea of Progress. As the FEF is seeing everyday across the continent, fusion and world development have potential mass support, despite the dirty tricks and harassment of the FBI and their "scientist" friends. For the skeptics, we relate this incident. A reporter

for a major daily paper in the Camden, N.J. area refused to believe that anyone but specialists knew or cared about fusion power. The reporter went with an FEF representative to a local unemployment center where several dozen FEF Newsletters are regularly sold. An unemployed industrial worker, the first person questioned, told the astonished journalist: "Sure I know what fusion is. It's the technology of the future."

The time has come to transform this growing recognition of what is possible for world development into a clear-cut condition for political legitimacy. The only questions worth asking of any U.S. presidential candidate are: "What is your program for economic and scientific development? Does it satisfy the criterion of development by contributing to increasing productivity, rising living standards, and more creative work and leisure for the entire world's population? Does it anticipate and plan for the great transition to a fusion-based economy?"

As the Chicago FEF Conference made clear, even to those who disagree with the perspective of the Fusion Energy Foundation, the issue is *progress*.

Scientists, Industrialists Gather to Plan Science and Technology for World Development

The Fusion Energy Foundation conference June 21-22 in Chicago on world development brought together scientists, skilled workers, industrialists, bankers, and engineers to discuss the political, economic, and scientific requirements of achieving fusion power and thus a virtually limitless source of energy for world economic reconstruction.

The FEF Newsletter presents here the highlights of the conference presentations and discussion. Full coverage of the proceedings is available from the Fusion Energy Foundation in hard copy, and audio and video tapes.

An Overview Of The FEF Conference Proceedings

The Fusion Energy Foundation's conference on world fusion power development assembled a core of scientists, skilled workers, engineers, bankers and industrialists. During the conference's two days of rigorous presentations on the relationship between energy throughput and scientific and economic development, the assembled corporate and academic scientists and managers joined FEF representatives in in-depth discussion of the choice between fusion breakthrough and world holocaust.

Chicago Deputy Mayor Kenneth Sain greeted the conference on behalf of Mayor Richard Daley, "to bring with me the appreciation and gratitude of our chief executive for what your meeting here in Chicago will hopefully come up with — some solutions and program."

"The purpose of government," Sain told the conference, "is survival — to give people the means to survive, to live and work together and cope with the problems of life and hopefully bring about some solutions. There's nothing more important for particularly large urban centers in our country today than energy and the resources we need for our future. We have to plan adequately ahead for our people now, or we will find that we're thrust into the problem with no solution or no time to come up with it."

But, Sain stressed, "I can't for the life of me believe that a country like ours that has been able to out-think and outproduce any civilization to date can't come up with a solution for our energy needs for the future. And I certainly can't believe that a country like ours, able to put together the skills and science and technology to construct thousands of pounds of destructive nuclear force for every human being in the country, can't find a solution for energy if we will it, if we commit ourselves to it."

He concluded, "I think it's tremendously appropriate that this search for alternatives is going on in our city. Many people would write the cities off and say they're of no use to us in the future, but to me the cities **are** our opportunities for the future."

ORGANIZING FOCUS

The tasks set forth in general terms by this representative of one of the United States' last old-line, constituency-based urban political machines delineated the organizing focus of the conference — what is required to ensure the survival of humanity, and what is necessary scientifically, politically, and economically to make these requirements reality. The participants in these deliberations included not only significant representation from industrial, scientific, and working-class layers at the conference and those unable to attend but following the conference proceedings closely, but also millions of Chicagoans via excellent media coverage of the FEF conference.

Among those attending the conference, which carried a registration fee of $100 per person, were representatives from the Caterpillar and John Deere agricultural implement companies, the Chicago area People's Gas Company, Sherwin Williams Paint Company, FMC farm machinery and chemical agriculture systems planners, and Babcock and Wilcox, a major heavy machinery producer. Also present were two top Soviet scientists who were representatives from the Soviet Academy of Sciences in Chicago for an official exhibit.

The conference was opened June 21 by FEF Director Dr. Morris Levitt's presentation, "Why Consider A Fusion Based Economy Now?," motivating the meeting's agenda by summarily situating the issue of energy resources in the current collapse of the world economy. Levitt was followed by FEF nuclear engineer Jon Gilbertson speaking on "Aspects of a Fusion Based Economy." "A fusion based economy isn't sending millions of workers out to dig up rocks to squeeze out shale oil," Gilbertson began. "It isn't destroying agricultural land in southern Illinois to dig up coal. It is a process of self-expanding

development, beginning with using fusion in conventional ways, for bulk heat, electricity, and so on, but, very rapidly, a revolution in the means of production through integrated industrial processing, for example, a combined steel and fertilizer plant, and through fusion-torch ionization and separation of basic raw materials from rocks, or almost anything."

After Deputy Mayor Sain's welcome to the conference, Dr. Dan Dvoskin, a researcher in agricultural economics at Iowa State University's Center for Agricultural and Rural Development, opened the discussion of world food and agricultural policy and the energy requirements for feeding the earth's population. "Everybody knows certain basic facts about agriculture," Dvoskin said, such as the fact that the advanced sector uses roughly 100 times as much fossil fuel for its agriculture as does the Third World, and produces three to five times more per acre. "Some people like (zero growth quack Barry) Commoner would argue that this shows inefficient energy use in agriculture," and that therefore low-energy labor intensive methods should be imposed. "Would they apply the same standard to the use of baling wire or the multitude of other inputs demanded to make even relatively primitive agriculture work?" Dvoskin went on to demonstrate that even a small percentage decrease in global energy use would knock out irrigation facilities in many parts of the world, cutting deep into food production and skyrocketing prices on what was left.

Next came Jack Seiler, an engineer with the firm of Advanced Machinery Company in Rockford, Ill., who presented his comprehensive engineering proposal for converison of U.S. auto plants to production of the tractors desperately needed to expand world food output. The consequences of the failure to carry through on development policy were chillingly demonstrated by the FEF's Eric Lerner and Dr. Gene Inch, who showed that world disease pandemics will soon be inevitable if nutrition. sanitation. and immunization levels are not quickly increased.

During the first day's dinner break, the farm machinery producers' representatives animatedly discussed the Seiler proposal against this backdrop of the necessity for its implementation. After attending FEF staffer Dr. Steven Bardwell's class on plasma physics for the Chicago Labor Party local that evening, they sat down and worked out a detailed costing of Third World tractor and fuel requirements. They arrived at the June 22 morning session with what they thought was an insoluble problem — how could the Third World ever afford to pay for both capital and fuel inputs, even on long-term credits?

The answer was provided by the next panel, a presentation by National Executive Committee member Uwe Parpart of the National Caucus of Labor Committees on "Financing World Development." The resources for fusion development and economic construction, he told the conference, can exist only in the political and economic context of recognizing the insanity of debt collection, and on that basis, the implementation of the U.S. Labor Party's International Development Bank proposal. Once rid of what Parpart termed "straitjacketed" thinking, it becomes clear that an International Development Bank (IDB) arrangement, as he detailed it, will provide the tens of billions of investment dollars necessary for worldwide development.

The next speaker, Prof. George Miley, the director of the Fusion Studies Laboratory at the University of Illinois's Nuclear Energy Department, gave a competent review of present fusion research progress and problems; he then said, "I'm still undecided if it's a good thing to combine the science and technology side and the economic and political side of fusion, like you do; but I'm glad to be here."

Miley was sharply challenged by one of the next speakers, Prof. Winston Bostick of the Stevens Institute of Technology's Physics Department, who pointed to the bureaucratic stifling of basic science by the Energy Research and Development Administration (ERDA) and scientists' complicity in this crime under just such rationalizations. Bostick also referred to the corrupting effect of this environment on younger scientists, "who rely solely on simplistic computer models of plasma phenomena and ignore actually important processes."

In response, Miley said, "I agree with the need for basic science, but the only way you can run a fusion program is to give it a definite mission orientation." Parpart replied, "What's crucial is to break down the dichotomy between 'mission orientation' and basic theoretical work. for the latter is the indispensable basis for progress in the former."

Miley concluded the discussion with praise for the "openness" of the FEF conference and for the Foundation's "leadership role" in the fusion effort.

The conference concluded Tuesday afternoon with a panel discussion on the scientific problems and perspectives for fusion development and plasma physics. Dr. Steven Bardwell, a plasma physicist on the FEF staff, began the session with a description of the consistent down-playing of scientific research by the present U.S.-ERDA fusion

The FEF's Dr. Winston Bostick (r) and Dr. Morris Levitt (l) are interviewed in Chicago by radio WBBM, a CBS affiliate.

program. "You have to be ready to waste money in the beginning, if you are going to save money," Bardwell said, in laying out the innovative and wide-ranging research programs that must be funded now if we are to develop the new ideas and understanding that fusion development requires.

Dr. Winston Bostick of the Stevens Institute of Technology, and a researcher in plasma physics for the last 20 years, described, in response to Dr. Bardwell, his belief that plasma physics had reached "the Pasteur era" in which the non-linear microstructures that more and more seem to determine the gross behavior of plasmas, must become the explicit basis for this expanded research.

Dr. Robert Moon of the University of Chicago, concluded the afternoon panel presentations with a first-hand description of the sociological atmosphere that was almost created during the Manhattan Project, and must now be generated if a crash program for fusion is to be successful. Dr. Moon reviewed his experience as a scientist for the last 50 years and said, "This is an exciting time — it's enough to keep you young forever."

Meanwhile ERDA itself was holding its counter-convention elsewhere in town, a free-admission meeting on energy policy called only days after ERDA learned of the FEF's planned conference. In contrast to the thoughtful and attentive audience at the FEF gathering, the crowd of ERDA bureaucrats and others — many attending "on orders" — at the government agency's conference on a smorgasbord of incompetent "energy alternatives" milled listlessly about the halls. An FEF-Labor Party delegation to the meeting promptly sold $27 in literature there and made scores of contacts.

BROADCASTING IMPACT

Only hours after the FEF conference ended June 22, the local CBS television affiliate WBBM aired a seven-minute news feature on the conference that began, "While Mayor Daley was addressing ERDA's conference on energy policy, Deputy Mayor Sain welcomed a fusion conference to Chicago." The segment described the potentialities of fusion power, featuring interviews with Labor Party Research and Development staffer Charles Stevens and the FEF's Prof. Robert Moon, and indicated the Soviets' lead in fusion research. A short, factual article on the conference appeared in this city's black community newspaper, the Daily Defender, and a radio news spot on the conference was also aired.

A videotape of the conference and a transcript of the proceedings are now in preparation to broaden the tremendous impact of the event. They will be used to take the conference deliberations into meetings planned at companies and universities around the U.S.

Welcoming Address by Chicago Deputy Mayor Kenneth Sain

The following welcoming address was delivered by Deputy Mayor Kenneth Sain on behalf of Chicago Mayor Richard Daley, June 21.

Thank you very much, Jon (Gilbertson), Dr. Levitt and the other members attending this world fusion conference in our city. I am delighted to represent our mayor and to bring with me the appreciation and gratitude of our chief executive for what your meeting here in Chicago will hopefully come up with — some solutions and programs.

As we all know, the purpose of government is survival — to give people the means to survive, to live and work together and cope with the problems of life and hopefully bring about some solutions. There's nothing more important for, particularly, large urban centers in our country today than energy and the resources we need for our future. We have to plan adequately ahead for people now, or we will find that we're thrust into the problem with no solution or no time to come up with it.

As a city concerned with the future not only of our city but of our country, when we talk about energy, we're talking about how to conserve it, how to manage it, and how to create it as resources for our future. I can't for the life of me believe that a country like ours that has been able to out-think and out-produce any civilization to date can't come up with a solution for our energy needs for the future. And I certainly can't believe that a country like ours, able to put together the skills and science and technology to construct thousands of pounds of destructive nuclear force for every human being in the country, can't find a solution for energy if we will it, if we commit ourselves to it.

I'm not an engineer, I'm not a scientist, I'm a lawyer but I can't believe that we can't create alternative sources of energy and resources for our people and for our future. It's for this reason, Doctor Levitt, that I'm delighted to be here to applaud the efforts of those attending to probe and search for those alternatives. We all know that they're there, it's just a matter of commitment for the future that we try to develop and create these.

And, in conclusion, I think it is tremendously appropriate that this search for alternatives is going on in our city. Many people would write the cities off and say they're of no use to us in the future, but to me the cities are our opportunities for the future. The use of our cities I think is paramount in the future as far as conserving our resources and managing our energy for future needs. By joining together, we can come up with a solution that will not only meet the needs of the present, but will meet the needs of the future generations that will come to our country and live hopefully as we do and with the standard of living that is available to our people.

So, on behalf of our mayor and the members of our city council, we're delighted to welcome the conference to our city. We know you are going to be working very hard and trying to produce as much as you can in the short span of time, but we also hope that you will have an opportunity to enjoy our city.

Kenneth Sain is the Deputy Mayor of Chicago, Illinois. Mr. Sain is an important spokesman for the Midwest group of industrialists and is "heir apparent" to Mayor Richard Daley.

Why Consider a Fusion-Based Economy

by Dr. MORRIS LEVITT

The following are excerpts from Dr. Levitt's opening address at the Conference on June 21.

Welcome to this conference on World Development and the Transition to a Fusion-Based Economy .... We open this inaugural conference as humanity faces a decisive branching point in its history. At this moment, the human race is confronted with two alternative future modes of existence. On the one hand, the extension of current tendencies could lead us rapidly into one of the most severe periods of devolution that the species has ever experienced. On the other, we face the prospect of the most exciting period of development in world history.

Perhaps the best way for me to locate this for members of the audience is to ask those of you who have worked in technological or managerial scientific fields over the past decade or two to ask yourselves, "What sort of self-realization do I now get out of a standard, eight-hour professional work day?"

What I propose is that you compare your tangible sense of achievement in the larger world at the end of an eight-hour work day in 1976 to that same sense even five or ten years ago. Can you honestly say that you have the same sense of realization in terms of the effects of your work on the outside world as you did ten years ago?

I think that what has characterized working experience for many of us up to this point is a world view, or morality if you will, that is closely tied to the concept of progress. This sense of progress can be defined in any terms that you care to pose for yourself, but rests basically on the question of how the human species benefits from the activities we conduct on a day-to-day basis. This is the notion of progress.

Dr. Morris Levitt is the Executive Director of the Fusion Energy Foundation. Dr. Levitt has been a prominent spokesman for the policies of energy-intensive industrial and agricultural development and against the various Zero Growth and deindustrialization currents within particularly the scientific community. He has done important work in the history of physics, and is currently finishing a study of the 19th century founder of statistical thermodynamics Ludwig Boltzmann and the non-applicability of the Second Law of Thermodynamics for nonlinear systems.

DEVELOPMENT OR DEVOLUTION

Looking at the situation objectively, we now face a series of interrelated problems that have to do with the branching point to which I referred earlier — the branching point between development or devolution of the human species. If you review the present rate of investment in basic industry, the aging and replacement rate of basic productive implements in crucial industries such as steel, the overall level of productivity, the percentage of productive capacity in use today, and so forth, you will see devolution. If you shift your focus from the advanced sector to the Third World, you will find an extraordinary proliferation of the most dangerous types of debilitating disease, coming in synergistic form, with a scope and intensity that is quite unprecedented in modern times.

At the same time, there has been a truly unprecedented series of developments, particularly over the last year, in fusion and plasma research — the area of interest of the Fusion Energy Foundation. These advances are even more extraordinary when contrasted to the threatening indices I just mentioned. We will be going into greater depth during the conference on these danger areas and on the progress that has been made in fusion research ....

FEF HYPOTHESES

To go beyond a simple response to the various schools of zero growth by posing the opposite view, a view firmly grounded in the conception of progress, let me indicate for you what we understand to be working hypotheses of this conference and of the FEF in general. They can be roughly stated in four points that should form the basis for our deliberations here.

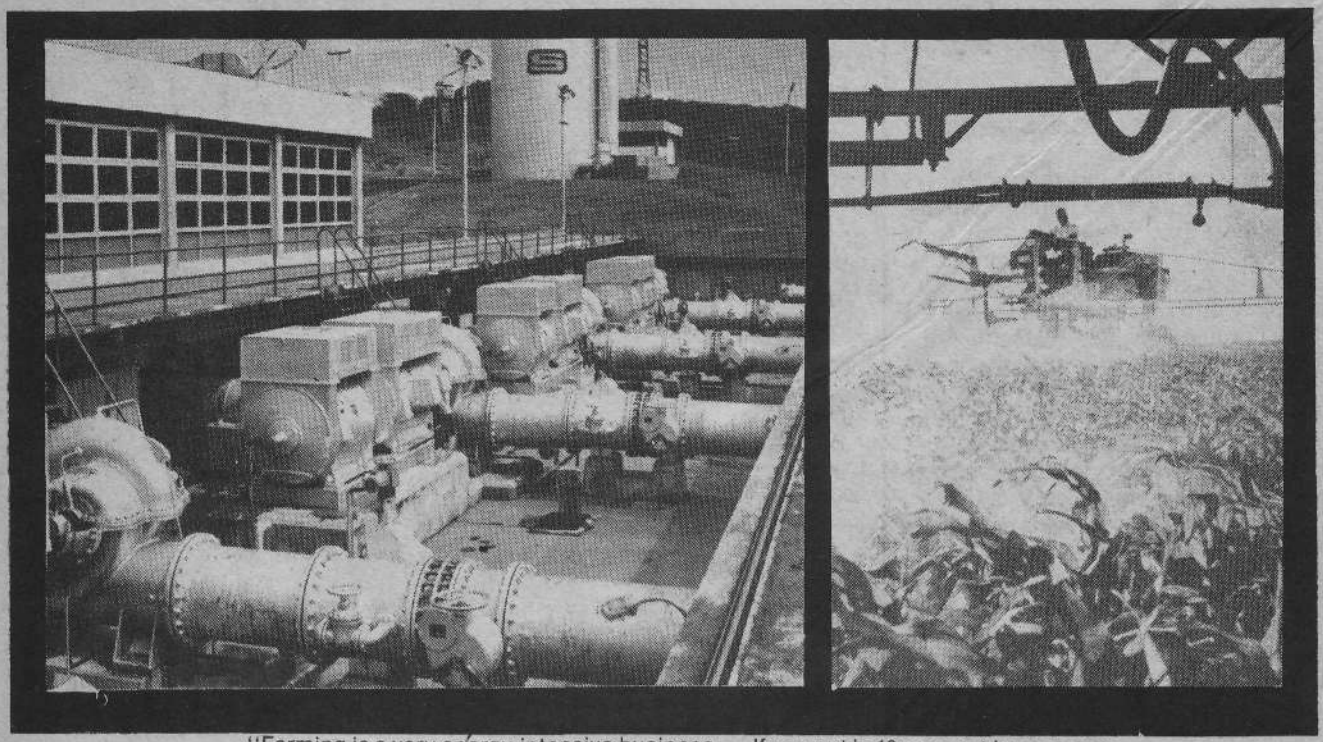
First, any program that makes a virtue out of the present policy of stagnation, calls for further slowdown in quantitative growth in general, and restricts the introduction of new advanced technologies is bound not only to exacerbate the present dangers facing us, but most likely to render the worst aspects of the situation irreversible in a very short time.

By contrast, the second working hypothesis holds that it is precisely the most rapid possible development and application of advanced production technologies that will make possible the reversal of the economic and ecological problems now threatening to grow out of hand.

Third, in considering the question of the interrelated development of the world economy as a whole there can be no competent development policy that is not grounded in the contention that there should be fusion reactors in operation at least by the end of the decade. To put it somewhat differently, it is not possible to specify an economic development program that will show marked overall improvement for all parts of the world economy and for the productivity and efficiency of the world economy as a whole, unless one considers this process of development as being transitional to a fusion-based economy.

Finally, based on the experimental and theoretical advances to date in fusion research and on the suggestions that have been made by knowledgeable members of the fusion community as to how to reorganize fusion research for the future, our fourth working hypothesis is as follows: If sufficient manpower and resources were committed to the effort to develop fusion reactors we could, in fact, have economically viable reactors on line, within a decade. There is no question that of everything we said, the last statement would be considered the most outrageous in many circles. I hope here that it is merely an eyebrow raiser.

To get a rigorous discussion of the validity of my assertion, the format of our conference will pose answers to the following set of questions: Is it the case that we are now at the threshold of economic and ecological catastrophe? How do you measure that? What are the consequences from the perspective of the continued proliferation of virulent forms of diseases if the fall in nutritional levels worldwide is not reversed? What immediate steps for world development should be taken, using technologies that are readily available and production techniques already at hand? Finally, should we reorganize the fusion research program? And how can we optimize progress in that area?



"Farming is a very energy-intensive business .... If you put in 10 per cent less energy it would completely wipe out irrigation in the (U.S.) Northwest .... "

Science and Technology Can Feed the World

by DR. DAN DVOSKIN

In the June 21 presentation excerpted here, Dr. Dan Dvoskin of the Center for Agricultural and Rural Development at Iowa State University drew on his research on the relationship between energy and agriculture, which he is now continuing with a very active group at Iowa State.

Let me say first that it is a great pleasure to be here, especially after having returned from another conference on energy and agriculture in St. Louis (sponsored by zero-growth guru Barry Commoner -Ed.). Those of you who had a chance to be there know that it was quite a show.

I think that that conference gave a very typical example of what we frequently hear about agriculture, especially energy use in agriculture. It seems to me that there is a great misconception about what farming and agriculture are. People think farming is something you do for pleasure — go out in the garden to get a suntan and some exercise. But in reality this is not what farming is all about.

Farming is a very energy-intensive business. I don't see anything wrong with this, although I know some people who would not agree. Let me just quote you a very short sentence from a recently published book by Dr. Barry Commoner: "Nearly all the horses have disappeared. The place of the plow has been taken by the tractor, which each year grows in size and power. Many farmers are now riding on 7-foot wheels and carrying air-conditioned cabs on their tractors."

ENERGY AND AGRICULTURE

Let me say a few things about what we might call the differences between traditional and modern farming.

First of all, energy in agriculture could be divided into solar energy, fossil energy, draft animal energy, labor energy, and in some cases organic material which is burned to supply energy. The real difference between traditional and modern farming is the amount of fossil energy in relation to other forms.

Traditional agriculture is characterized by very low fossil fuel needs, low yields, and the low standards of living which result from this. We also find as a result that the cost of food is very high. In addition, farmers in developing countries are living at subsistence levels and hardly making a living.

A person looking at modern farming will see that it is based on very extensive uses of energy for machinery, irrigation, fertilizers, pesticides, and, of course, transportation for the import of goods and export of produce to the marketplace. Modern farming allows us to produce with high yields, allows the farmer to make a good standard of living, and allows us to obtain our food for low cost relative to other commodities.

Let me give you a comparison of modern farming energy use and traditional agriculture energy use, to show how energy is distributed between fossil and other fuels. In the case of Mexico, less than 8 per cent comes from fossil fuels, whereas in the United States almost all the energy in agriculture is fossil fuel energy. For every unit of energy used in Mexico, the U.S. uses 91 units of energy but as for yields of corn, U.S. yields are five times that of Mexico. A very similar situation

exists with respect to rice production. In comparing the Philippines with the United States, again the U.S. used considerably more energy to produce yields three and a half times that of the Philippines.

Anyone who looks at those numbers could make different interpretations, since there are some people who, in my opinion, draw very wrong conclusions. As an economist I would not expect to find any different relationship, and if I did, I would conclude that either my results were wrong or that there was something very wrong with the economy. You would expect that an economy that has very plentiful sources of energy would use more energy relative to other resources.

Unfortunately, some other economists disagree with that interpretation. Let me quote one economist who says: "Now that we are facing an energy shortage, we might do well to measure efficiencies in terms of output per unit of energy, instead of output per unit of labor." Doing so reveals that U.S. agriculture does very poorly.

You read that sort of stuff and you start wondering. Two years ago we had the great baling-wire shortage, but this economist did not suggest then that we measure agricultural efficiency in terms of baling wire. We have crises all the time. We had the environmental crisis, we have the energy crisis, we have the economic crisis, the social crisis, and finally the sex crisis, especially in the U.S. Congress. Nobody suggests that would effect an efficiency measurement!

ENERGY CUTS INCREASED COSTS AND LESS FOOD

To put things in perspective, I want to show you some results of the studies we have done at Iowa State. Basically it is a study which evaluates the impact of various energy scenarios on U.S. agricultural production and tries to envisage what the impact of energy shortages, high energy prices, increased exports, etc. would be.

First of all we have base runs which we use as comparisons. Second we tried to do what Barry Commoner almost suggested we do, which is minimize energy used in agricultural production. We have an energy graph where we pose the use of energy in agricultural production at only 90 per cent of the base run, which means that we force an overall reduction of 10 per cent in energy use in agricultural production. Then we have high energy prices, where we double the price of energy compared to the base run...

Charts 1 and 2 show the impact of an energy reduction of 10 per cent. Basically the charts show the distribution of irrigated acres.

Dr Dan Dvoskin is a staff member at the Iowa State University Center for Agricultural and Rural Development. Dr. Dvoskin is a leading agricultural economist whose group at Iowa State is now completing a study on the economic impact of energy reduction on agriculture.

10% Less Energy Will Wipe Out Northwest Irrigation

Figure 1

Location of irrigated cropland

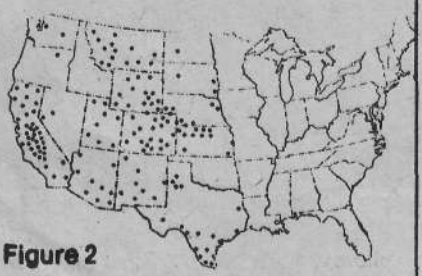


Figure 2

Reduced irrigated cropland under a 10 per cent energy reduction.

Dr. Dvoskin's charts show the reduction in cropland in the Northwest, the northern plains of Texas, Oklahoma, Kansas, Colorado, and New Mexico if energy in agricultural production is cut by 10 per cent. The energy cutbacks have an equally devastating effect on food costs, as shown in Figure 3.

irrigation is hardest hit by the energy reduction policy. You can see that if you put in 10 per cent less energy it would completely wipe out irrigation in the Northwest, including such activities as feed grains, wheat, and soy beans. It would also severely hit irrigated agriculture in the northern plains of Texas, in Oklahoma, Kansas, and some of Colorado and New Mexico.

Similar is the impact of such energy policies on land use. If we are going to reduce energy to agriculture we are going to have to increase the amount of land that goes into agricultural production.

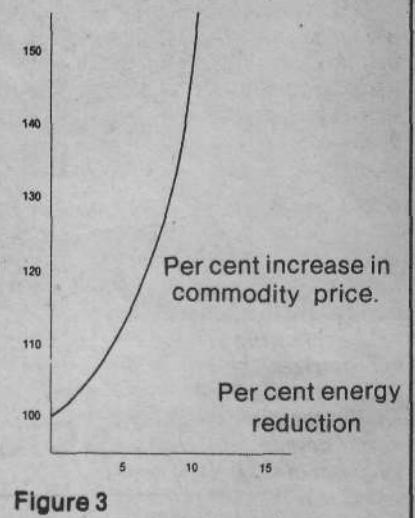


Figure 3

If energy use goes down, food prices go up.

If we measure the impact of those policies on the cost of food we get the alarming curve in Chart 3 which shows an increase in commodity prices in response to different energy reductions. You can see that substantial increase in food cost for every percentage reduction in energy use.

So essentially the consequences of energy shortage, of energy crisis on U.S. agriculture, can be summarized by these charts. If you try to adopt some of the suggestions that were proposed at the St. Louis conference — moving back, using more labor-intensive prodution processes — I think what we would find out that first of all we would save very little energy. On the other hand the cost of food would increase substantially, our farmers would suffer substantial reductions in their income, and production might not even be able to meet the domestic food needs of the U.S., not to mention any increase in exports.

The Fusion-Based Economy: What It Might Look Like

The fusion-based economy and the transition to it will require the most scientific and technological advances, the most capital-intensive and the most energy-intensive development that has ever existed. In order to insure the attainment of such an economy by the end of the century, we must quickly increase investment and national commitment into the development of fusion reactors and the wide range of related technologies by orders of magnitude from where we are now.

It is a well publicized fact that the exact opposite is now true. Investment into research and development has been decreasing continually over the past two decades: We are not at all appropriately investing in our future survival!

This investment in fusion and related technologies must happen simultaneously with massive increases in energy consumption of the currently known reserves of, primarily, fossil-fuel energy sources, such as coal, oil and gas, and with the expansion of industrial and agricultural output to magnitudes well beyond those now existing. The exhaustion of such "known" energy resources over the next 10-20 years can be done now from an "energy reserve" standpoint if a commitment is made to develop the essentially infinite resources of fusion energy.

The commitment to develop fusion energy and the industrial technologies that this encompasses is not just a commitment to expanded funding of research laboratories. It is a complete, across-the-board commitment by government, all levels of industry, and other institutions to transform what now exists to a much higher level of activity.

The following article, originally published in Vol. I, No. 6 of the FEF Bulletin, summarizes the major points of Mr. Gilbertson's June 21 presentation to the Chicago conference, "The Fusion-Based Economy: What Might It Look Like." Mr. Gilbertson discussed in detail the integrated high technology industrial processes made possible through fusion development, and the fusion torch solution to the problem of scarce resources.

by JON GILBERTSON

A small handful of scientists and engineers in the United States, along with an even smaller handful of money, has been involved in looking at what a fusion-based economy would mean. Most of the effort to date involves getting an overview of the possibilities for integrating industrial processing around fusion reactors and identifying the various ways for accomplishing this integration. The results of even these cursory studies have made it very clear that fusion reactors not only represent an inexhaustible source of energy for mankind in the conventional sense, that is, heat and electricity, but in addition provide a vast resource of new energy forms through the plasma medium often referred to as the "fourth state of matter."

This medium, the fusion plasma, will totally revolutionize and transform industry to the form necessary to permit human society to make that leap forward to the next higher manifold required for our survival beyond the year 2000. Absolutely necessary for this transition over the next two decades will be unprecedented rates of consumption worldwide, and particularly in the advanced sector, of the conventional energy resources such as oil. In the latter half of this period, fusion reactors will be providing significant amounts of thermal and electrical energy as well.

The integration of industrial processing around fusion reactors will occur in essentially two phases. The first will be the upgrading and advances in processing that will result with the availability of large amounts of thermal and electrical energy. This will directly involve the conventional heavy, chemical, and material processing industry, particularly those processes that will require future power inputs greater than 100,000 MWt. These include iron ore production, aluminum production, ammonia production (particularly fertilizer), cement production, and hydrogen production.

Total thermal and electrical power requirements for these applications in the United States have been estimated by Steinberg, et al. (1) to reach 2.1×10^6 MWt and 768,000 MWe respectively after the year 2000, and these are likely to be low predictions. In addition, fusion reactor thermal energy can be applied to processes that are not presently utilized because large sources of cheap thermal energy are not now available. These are high temperature processes operating at 1500^0 C or higher and include, for example, acetylene production, nitrogen fixation, carbon dioxide decomposition, and water decomposition.

The second phase of industrial integration will occur through the use of the high-temperature plasma directly and the new energy forms that are made available. Since this will represent the real transformation of industry as we now know it, many of the future possibilities are unknown at this time and will be discovered over the next time period. Some work has been done, however, again by a vanguard handful of scientists and engineers, and has already opened the door to some mind-boggling prospects for future skilled industrial workers.

The nucleus of these prospects is an original study performed by Eastland and Gough in 1970 (2) on a new approach to pollution and energy use based on the idea of using a "fusion torch," that is, high-temperature fusion plasma. This concept has since been expanded by Sabri (3), Steinberg, et al. (4), and Eastland and Gough (5) to several areas of industry using the large amounts of plasma energy in the form of high energy particles, neutrons and gamma rays, and electromagnetic radiation. Some of the industrial applications of these energy forms include: production of primary metals such as iron and aluminum; synthetic fuel production (that is, hydrogen and methanol); chemonuclear production of basic industrial chemical compounds such as carbon monoxide, hydrogen peroxide, ethylene, formaldahyde, and nitrogen dioxide; photochemical reactions in general; ozone production; desalination of H_2O; and element reprocessing and matter recycling. In addition, separation of basic atomic species from ores and other materials vaporized by direct plasma interactions by using rotating plasmas has been proposed.

From the research completed thus far it is clear that the advent of fusion reactors will open the door to the

Integrated Industrial Processing Complex

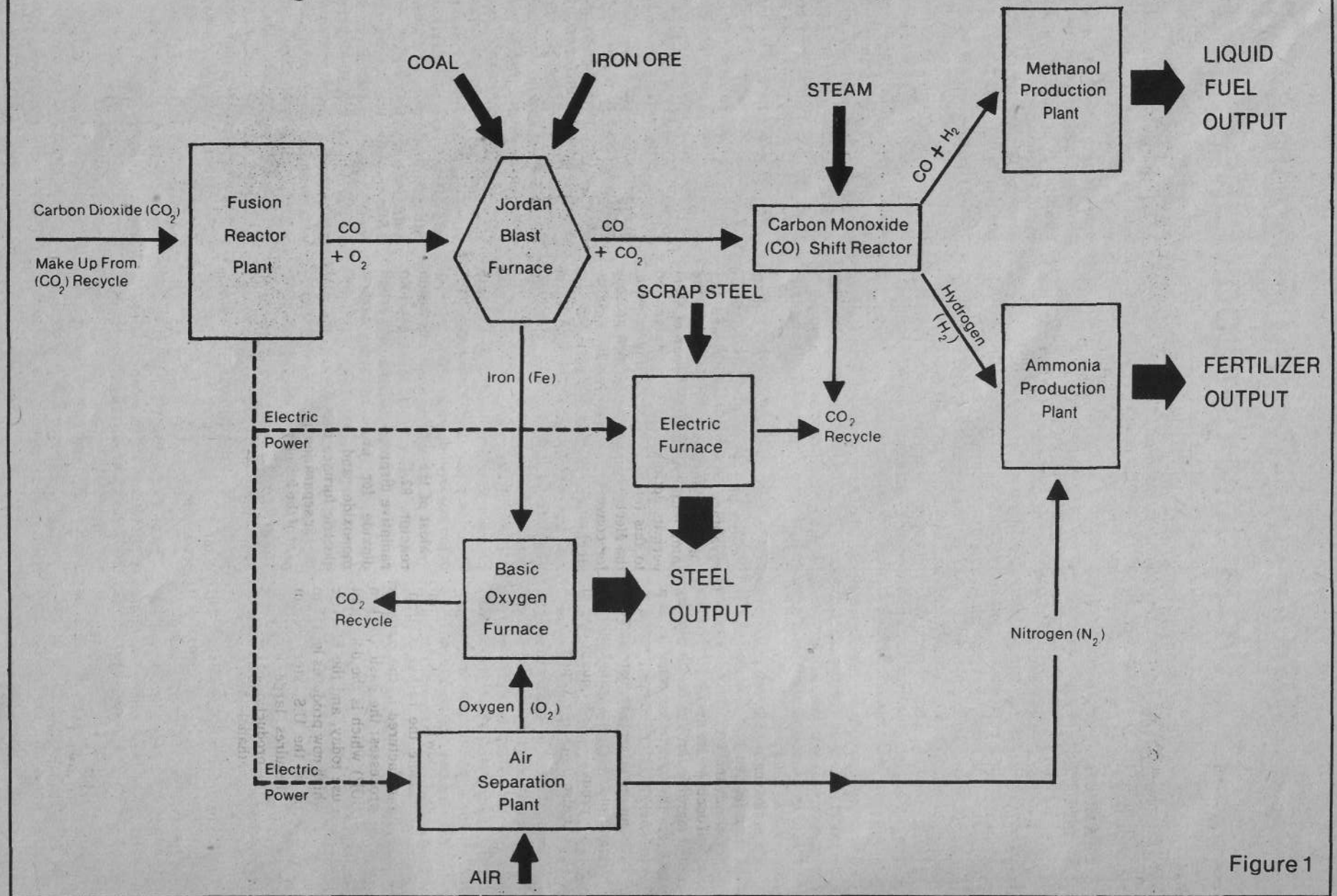


Figure 1

development of integrated, multi-component chemical and material complexes which were heretofore unknown and impossible. The following example of such an industrial complex was developed by Steinberg and Jordan (6) and would combine the production processes of steel, methanol, and ammonia as well as electrical power.

A MULTI- COMPONENT INDUSTRIAL COMPLEX

The first step toward economic recovery is to determine goals in the production of the most basic industrial commodity, steel. The current debt-imposed collapse of the steel industry in the advanced sector and particularly in the United States, is well recognized by the working class and a few enlightened industrialists as a result of the U.S. Labor Party organizing and publications. *(7)* Basic processes and technology within the U.S. steel industry have changed very little over the past century and are currently no more than a crude scale-up of the technology of at least 100 years ago. Therefore, the potential advances and breakthroughs that will occur in the steel industry once it is integrated within the technology available through fusion reactors is a particularly important focus.

Such an integrated industrial complex, shown schematically in Figure 1, not only produces large quantities of steel, but also processes large amounts of ammonia for the production of fertilizer, as well as methanol for use as liquid fuel. Production of iron is based on the "Jordan Blast Furnace Concept," an advanced process that could be incorporated into steel production today (see below) and would immediately double the output of iron. Steel is manufactured in the complex from two processes: the Basic Oxygen Process (BOP) which is the dominant method in use today, and the Electric Furnace, which now produces less than 20 per cent of the U.S. steel output because it requires large inputs of electricity. The production of ammonia fertilizer and methanol liquid fuel in the integrated industrial complex is also by currently used processes; however, the integration of these processes with a fusion reactor opens the door to their large-scale expansion and use. Overall, the integration of these multi-component industrial complexes with a fusion reactor allows production capacities that are not now possible.

The industrial complex shown in Figure 1 uses fusion energy in two forms, electricity through the conversion of heat via steam turbines, and radiation through the production of high energy gamma rays via neutrons produced in the fusion process. The fusion reactor is cooled by carbon dioxide (CO_2), which flows through the blanket regions of the reactor. Not only is the thermal energy removed by the CO_2, in addition, disproportionation of a portion of the CO_2 to carbon monoxide and oxygen by gamma radiation occurs; that is, $2CO_2 \longrightarrow O_2 + 2CO$. The oxygen and the carbon monoxide is then separated from the carbon dioxide and fed directly to the blast furnaces where iron is produced by the Jordan process. The carbon dioxide remaining, plus additional carbon dioxide make-up from the steel making process is cycled back into the fusion reactor as primary coolant.

Because of the large amounts of inexpensive electricity available from the fusion reactor, the steel making operation can incorporate two basic energy-intensive processes, the oxygen furnace and the electric furnace. Each of these processes has its own special advantage in steel making, and the capability to use both at roughly the same output in tons per year of steel permits optimal operation. As applied to this integrated processing scheme, the electric furnace is the best process for converting scrap steel to reusable steel, while the basic oxygen furnace best converts blast-furnace iron to steel. The air separation plant that produces the oxygen for the basic oxygen furnace also separates nitrogen from the air, which is then used in the production of fertilizer in another part of the production complex.

Most of the energy from the fusion reactor 92.7 per cent, goes into radiative disproportionation of carbon dioxide for production of carbon monoxide and oxygen, while the electric furnace uses 7.0 per cent and the air separation plant less than 0.3 per cent of the fusion reactor energy.

The balance of this integrated industrial complex consists of the production of liquid fuel (methanol) and fertilizer. Carbon monoxide which is produced in the fusion reactor is mixed with equal amount of carbon monoxide produced in the blast furnace operation itself and used as raw material feed to those industrial processes.

For the production of methanol, the carbon monoxide is mixed with steam in a shift converter, resulting in the production of hydrogen and carbon dioxide that is then carried by the unconverted carbon monoxide to the CO_2 solvent separator. This process removes the CO_2 from the mixture, where it is recycled back into the fusion reactor, while the hydrogen and carbon monoxide is channeled through a catalytic converter, producing methanol.

Ammonia is produced by a similar process, except that the carbon monoxide is completely converted to hydrogen and carbon dioxide via the steam shift converter. Therefore, removal of the CO_2 for recycle will leave only the hydrogen, which is subsequently mixed with nitrogen from the air separation plant, then passed through a catalytic converter to result in ammonia fertilizer.

This integrated processing complex clearly illustrates the relatively early industrial capabilities and breakthroughs possible during the transition to a fusion-based economy. Furthermore, this is only one example of the many possibilities for industrial integration that have already been identified by researchers in this area. It is clear, even from the industrial complex described here, that we need not worry about the necessity of rapidly using up all our current reserves of coal, oil, and natural gas in order to make the transition to fusion. Natural gas, which is now the primary raw material used in the produciton of ammonia fertilizers, can be fully committed immediately to large-scale fertilizer production based on world consumption requirements, since a future fusion economy will provide a means for even larger-scale fertilizer production through utilization of nitrogen and hydrogen, from air and water, respectively.

Similarly, oil and coal can be fully committed now as an energy resource to be exhausted during this transition period since the essentially infinite resources of fusion energy will completely replace future thermal and electrical power needs. Furthermore, the future requirements of liquid fuel for automobiles, diesels, and so forth, can easily be met by the production of methanol from hydrogen and carbon monoxide using several alternative forms of energy from the fusion reactor.

Other necessary heavy industrial materials and chemicals can be produced by similar methods based on future developments in fusion

technology and will be described in later articles.

THE JORDAN BLAST FURNACE CONCEPT

It is not necessary to wait until large fusion power plants are operating in order to greatly increase the industrial output of steel, fertilizer, liquid fuel, and other materials and chemicals. The process of beginning to create integrated multi-component complexes can begin immediately in combination with a commitment to developing fusion power.

The most obvious example of what could be done now in the steel industry is based on research that was completed ten years ago by Jordan. *(8)* He developed a relatively simple alternative to the age-old hot-air blast furnace currently used in producing iron. The concept involves altering slightly the operation of a conventional blast furnace to both double the liquid iron output and greatly increase the use value of the "top gas" exhaust from the furnace. Jordan replaced the hot-air blast to the furnace with a mixture of oxygen and carbon dioxide. This serves both to increase the heat of combustion in the furnace and to enrich the top gas, which could then be cleaned and converted to either ammonia fertilizer or methanol, — a first approximation to an integrated industrial complex. Part of this top gas would also be used to generate power to run the blast furnace.

Considering, for the moment, the steel-making industry alone, this would mean a doubling of the iron output from currently used blast furnaces with only the relatively simple modification in the plant of providing a source of oxygen via an oxygen-separation plant. Furthermore, the cost of providing this oxygen supply is reported to be less than the cost of the equipment required to heat and inject the hot-air blast in a conventional furnace. In order to accomodate the doubled iron output from this furnace in the steel-making end of the plant, the steel-producing furnaces and processing equipment would necessarily also have to be doubled.

Based on the Jordan process alone, vast increases in steel production can be implemented almost immediately. Such near-term advances will be necessary in order to provide the steel required to produce tractors and farm equipment for advanced-sector and Third World agricultural development.

(1) Meyer Steinberg, Morris Beller, and James R. Powell, "A Survey of Fusion Power Technology to the Chemical and Material Processing Industry," Brookhaven National Laboratories—18866, May 1974.

(2) B.J. Eastlund and W.C. Gough, "The Fusion Torch: Closing the Cycle from Use to Re-Use," U.S. Atomic Energy Commission Report WASH1132, May 1969.

(3) Z. Sabri, "A Study of the Feasibility of Fusion Torches," Ph.D. Dissertation, University of Wisconsin, 1972.

(4) Steinberg, et al., op. cit.

(5) B.J. Eastlund and W.C. Gough, "The Fusion Torch—A New Approach to Pollution and Energy Use," American Institute of Chemical Engineering, No. 104, 1970.

(6) R.K. Jordan and Meyer Steinberg, "Applications of Controlled Thermonuclear Reactor (CTR) Fusion Power in the Steel Industry," Brookhaven National Laboratories - 19885, March 1975.

(7) U.S. Labor Party Presidential Campaign White Paper on Steel Production, New York: New York: New Solidarity International Press Service, May 1975.

(8) Research completed at U.S. Steel in 1966 by R.K. Jordan, to be published by Pennsylvania State University.

Industrial Conversion: The Case for Tractor Production

The following article is based on an interview with engineer Jack Seiler several weeks before the Fusion Energy Foundation's Chicago conference. During his own conference presentation June 21, on "Industrial Conversion; the Case of Tractor Production," Seiler detailed the problems of designing and perfecting the transfer lines necessary for converting excess automobile capacity to tractor production. He then stressed the practicability of his own ideas: "It is quite possible to do such things on the enormous scale we are talking about —750,000 tractors in three months. We have seen industry in the last 40 years perform such tasks. We have forgotten in our day that these things have already been demonstrated by modern technology. We can, if we have to, organize the crash programs; it requires only motivation and cooperation."

In order to produce the additional 100 million tons of grain minimally needed between now and the 1977 harvests, the September planting in the southern hemisphere, especially the immensely rich and unused soils of the Argentine Rio de la Plata region, must be massively expanded. For this tractors, three quarters of a million of them, are required above all. With present U.S. and Western European tractor production operating at less than replacement rates for existing tractors, the necessary massive new production can come only from crash conversion of the auto industry. At the same time, the implementation of the agricultural development plans which are the core of any competent peace settlement in the Mideast similarly require hundreds of thousands of tractors from converted auto factories.

To stop the threats of thermonuclear war and ecological catastrophe, the auto plants must be converted. The prerequisites for their use — Third World debt moratoria and agricultural development agreements — must be set in motion.

Responding to to this urgent need, machine designer Jack Seiler, assisted by a small team of Midwest auto engineers has drawn up preliminary plans for the crash program of auto conversion. Seiler, who works for the Advanced Machinery and Engineering Company (a machine tool manufacturer) got help from other engineers by telling them, "These people in the Third

Jon Gilbertson is a nuclear engineer and one of the top nuclear plant safety analysts in the U.S. Mr. Gilbertson is now working on a long-range study for the Fusion Energy Foundation on retooling requirements of American industry in the transition to a fusion-based economy.

International Journal of Fusion Energy

The International Journal of Fusion Energy is sponsored by the Fusion Energy Foundation for the advancement of theoretical and experimental conceptions necessary for the realization of fusion power. The Journal aims to stimulate investigations of plasma dynamics from the standpoint of fundamental theoretical problems of physics, as well as to promote development of the revolutionary technologies and production techniques that are intrinsic to fusion processes.

Whatever the significant, hard-won progress and even breakthroughs in fusion to date, it can still all mean nothing — unless there is a political commitment to carry it through to fruition and a climate supportive of wide-ranging research.

The **IJFE** will be one of the few journals designed to be read from cover to cover because it provides what fusion scientists and non-specialists need in addition to updating on more technical developments: an ongoing **synthesis** of fusion research. To get efficient fusion reactors, there must be continuous mutual interaction of improvements of theory and devices — not simply improvements in the theory of existing devices. And there must be an understanding in Congress and elsewhere of the process of converging on various solutions that repay the original investments many times over to justify support for a growing research effort before payoff.

The **IJFE** will fulfill this vital function by publishing articles of three basic types:

* historical retrospectives on important lines of development.

* studies of the convergence (or divergence) and possible resynthesis of various approaches, and

* totally new conceptions.

The Journal will therefore be a focal point for stimulating the conceptual developments and pro-scientific climate without which fusion will not reach its goal.

Directly related to this function of the Journal are the more general activities of the FEF, which has been the most important institution — aside from the front line researchers — for the survival and development of fusion research. Subscribing to the Journal helps to finance and extend the influence of the FEF, which gives fusion scientists a social potency they are otherwise lacking individually.

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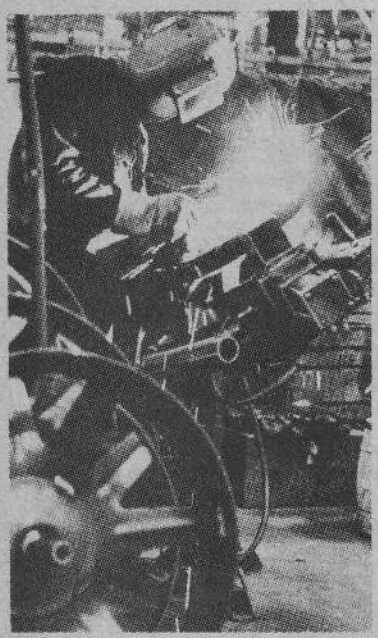
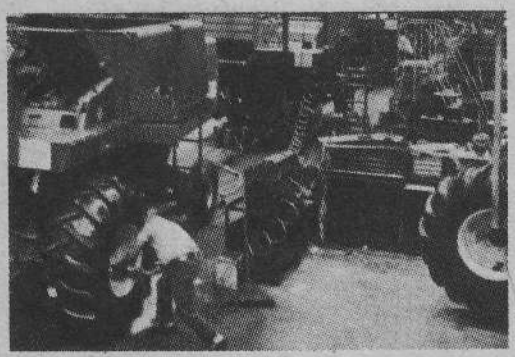
World can produce food, but they need our tractors — let's produce them!"

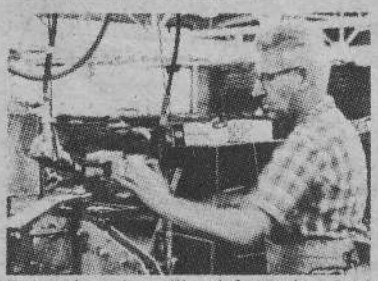
This is the first time that specialists outside the U.S. Labor Party have prepared programs to meet the requirements of the Labor Party's International Development Bank policy for world reconstruction.

THE CRASH PROGRAM

Seiler's plan outlines the precise steps for conversion and the time and manpower requirements involved. The first phase, occupying a small team of top agricultural and automotive engineers for about week, will be the selection of the existing tractor design most suitable for use in Third World countries and most readily produced — a "peasant-proof tractor."







With a war-time mobilization to convert idle and underutilized factories to tractor production, the U.S. alone could turn out 350,000 tractors a month — Each tractor would enable the production of some 150 tons of food on 75 hectares of land.

"What you want is a simple, rugged machine which can run on practically no maintenance," Seiler explained. He used as an example the Lantz Bulldog, a tractor designed by pro-communist engineers in pre-Nazi Germany for use in then dismally backward Eastern European agriculture. "This machine wasn't fancy, but if even one cylinder was still working, you could plow your field with it — it would run for years without major maintenance."

Simultaneously with this selection, the engineering cadre of the next phase must be organized in at most a couple of weeks. Three or four thousand competent engineers must be drawn off the unemployment lines and grouped into a concentric circle structure, beginning with a handful of top experienced engineers as organizers, who in turn will direct a hundred or so senior engineers and designers, themselves the heads of teams of less experienced but competent engineers and technicians.

In the second phase, a task force of 250 technicians and engineers will inspect and study the transfer lines, assembly lines, and foundries available for conversion. On the basis of this study, a decision will be made about which idle lines to use and which partially used lines to consolidate auto production on, to free the rest for tractors. Seiler estimates that today, even with the small increase in auto production, fully 40 per cent of all productive facilities remain idle. Ten transfer lines and the associated assembly lines and foundries for parts casting will be selected at this point for conversion. For all lines this phase will involve about 10,000 manhours, or about a week's work.

The third phase, the main design of conversion of the transfer lines and assembly lines, will then begin. Seiler's plan concentrates on describing in some detail the most difficult task, that of converting the complex automatic machine tools which machine the engine block, but simultaneous efforts will involve the simpler assembly lines where such changes are necessary, the foundries where the parts are cast, and so on. The selected tractor design will be used to decide how each part is to be machined and to select appropriate tools and automatic settings for machining them. Then transfer lines will be laid out and fixtures to hold the work and machining heads will be designed. Based on studies of the cycle time (repetition rate) of machine tools, all electrical schematics will be revised and existing controls rewired.

Finally the transfer line, made up of hundreds of machining stations, will be studied to alleviate bottlenecks by adding additional machines performing the same task, maximizing the ultimate production rate. For the transfer lines, this phase will mean about 100,000 manhours of work, and the job as a whole should take roughly two weeks for the total engineering manpower available.

At this point, the components for the redesigned transfer lines must be manufactured where they are not already available in the existent lines. This means a crash mobilization, prepared in the preceding month, of various specialized foundries and machine shops for rapid production of these key components. This phase, lasting a minimum of two weeks, will overlap with the final phase, that of actual conversion.

In this final phase, the previously organized engineers will become the supervisors of a larger workforce of 7,000 to 8,000 highly skilled machinists hired and organized during the preceding period. Working in shifts around the clock, this integrated task force will rework the machine tools' pneumatic, hydraulic, and electrical controls, rebuild the machining heads and holding fixtures, relocate the machining stations in the line, and install new motors where larger power is required. Simultaneously, other parts of the task force will be implementing the planned changes in assembly lines, foundries, axle and parts lines. For all lines some 500,000 hours of work, or another two weeks, will be required to finish the job.

WAR-TIME MOBILIZATION

Seiler emphasized that such an extreme crash program would be possible only with the highest degree of motivation, comparable to that of the war-time conversions at the start of World War II. "The leadership and team work of such a project must be absolutely top-notch — the task force must work like a well-oiled machine" if anything close to this timetable is to be realized, he said. If not, time is wasted in blunders and uncoordination.

Epidemiological and Ecological Consequences of Insufficient Rates of Development

In the closing session June 21, Eric Lerner of the FEF staff described in detail the threat of epidemics and ecological disaster if insufficient rates of development continue. Following Lerner, Gene Inch, M.D. discussed the straightforward, immediate measures that must be taken to stop this decay.

Inch, a New York City physician, stressed that we have the know-how and supplies to begin to deal with the crisis in three critical areas: (1) food stockpiles to begin immediate and remedial food aid, especially to the Third World; (2) vaccinations and personnel to vaccinate against the swine flu; and, (3) equipment and manpower to reverse the collapse of advanced sector cities, especially, their public health systems — hospitals, sewerage, water, and vaccination of children.

Without taking these simple measures in the next several months, Inch warned, "We are risking exactly the kind of disaster that Eric Lerner described."

A major part of Lerner's presentation, excerpted below, described the computer simulation of epidemic disease spread carried out by the FEF in collaboration with Robert Strom, a computer programmer at the Yale University computer center. The project is studying the development of epidemic disease under the conditions of increasing or decreasing economic variables, especially nutrition.

by ERIC LERNER

This is how we set up our computer simulation. We started with the assumption that the number of infected people in a general population who infect others with a given disease is dependent on the number of people who are, in fact, sick, and the number of people whom they can potentially infect. We assumed that in a major city, those people who are on the street — not homebound or in the hospital — mix fairly thoroughly. We also kept track of the people taken out of circulation, by being put into the home or the hospital, where they would have lesser degrees of infectivity.

Then we made the infectivity of each disease an empirical variable, dependent on the level of nutrition and the level of health of the population. If the level of nutrition goes down, the infectivity of the disease goes up. If you are already sick with some disease, you are weakened, and you are more likely to become infected. We based the quantities involved, as much as possible, on empirical data from previous studies of these phenomena.

We took into account the actual social setting in which epidemics occur. For instance, in a city there is not a homogenous population but generally a ghetto population with a lower standard of living and a non-ghetto population with a much higher standard of living. We took, as well, the potential societal disruptions that the epidemic would cause. For example, the hospitals becoming saturated, and losing the ability to depress infectivity. Also, the disruption of food supplies at the point that 50 per cent of the population is infected with a disease, and so on.

THE EPIDEMIC THRESHOLD

We have just begun these studies, but the computer runs completed this week demonstrate clearly, in a very graphic way, the nonlinear phenomena.

First, you have what we called the weak link phenomena. It is absolutely foolish to assume that if you depress the nutrition of one part of the population, any other part of the population will not be affected. This holds whether the part affected by the drop is the ghetto population, the unemployed, or, on a world scale, the Third World population.

Second you have what we called the threshold phenomena. If any part of the population falls below a threshold for disease spread, the entirety of the population is going to suffer.

Let me make this very clear. If you have an epidemic, people are being infected and infected persons are being removed from the population, either by hospitalization, isolation, death, or hopefully, recovery. You have two rates, recovery and infection. If the recovery rate is just slightly higher than the infection rate, no matter how close, an epidemic will not occur. Any accidental introduction of a disease into such a population will lead to a decrease in the disease from whatever level at which it was introduced. There will not be an epidemic.

In the opposite case, if you decrease the food supply and thus increase the infectivity by a very small amount, just enough to put it above the rate of recovery — 102 a day versus 100 a day — then the disease will have a tendency to expand. It will expand until the number of susceptibles in the population tends to become exhausted, the number of infected people again drops, and the epidemic dies out. In that circumstance, however, you very quickly get an epidemic that is very substantial.

Thus, you have an almost either-or situation, separated only by a fairly fine threshold.

We did several runs, assuming two highly infectious diseases - the swine flu and the pneumonic plague. We took a city that resembles New York or any other large city in a similar situation — such as London, Paris, or Chicago. We assumed a certain division between ghetto and non-ghetto population.

At the start of the run we introduced a single case of pneumonic plague and a few cases of the swine flu. This is a very reasonable assumption given the present situation. As I mentioned, as recently as three days ago there was a case of pneumonic plague in Vail, Colorado, a ski resort area just a few hours drive from Denver, and there is no question in the mind of almost every epidemiologist that swine flu exists in the population.

We started to look at how this epidemic would or would not develop according to different economic conditions. In the first run, we assumed a well-fed ghetto population, and a well-fed non-ghetto population, the sort of situation we hope to see very quickly in the transition to a fusion-based economy and in the process of eliminating ghettos entirely.

What happens is very interesting and the sort of thing we thought would happen. The plague and flu develop for a short period of time, until people begin to recover from the disease. After about a week the plague stabilizes at a very low level, two or three plague cases per week. In a totally realistic case, these plague cases would be very rigidly controlled by isolation and would die off very quickly. This occurred over a period of weeks in our model.

There were also several dozen flu cases per week, which died off again after a certain point, resulting in a couple of dozen deaths.

Exactly this pattern occurred in San Francisco in 1924, when plague was introduced in a period of general prosperity. There was no epidemic.

BELOW THE THRESHOLD: GRAVE EPIDEMICS

On the second run we lowered the level of nutritution in the ghetto areas alone, to about halfway between well fed and the current levels of nutritution among unemployed, semi-employed, and ghettoized populations, according to recent evidence. What happens is quite different from the first run. This graph (Figure 1) is based on the computer print out from the second run. The vertical line shows the number of people sick with the flu on a given day. The horizontal line at the bottom of the graph shows the days from the start of the epidemic, December 1. The vertical scale is thousands of people, so the total scale is two million, one-quarter of the size of the hypothetical city. Since we have crossed the threshold for flu, there is a massive flu epidemic. The flu develops in late January, peaking very rapidly by mid-February, and then dies away. We assumed that this was the 1918 flu, which has a mortality of 1 per 100 and which would result in the death of 35,000 people in this city alone. Obviously, such an epidemic would be occurring on a world scale and would result in millions of deaths.

"Without taking simple measures like vaccination against the swine flu, we are risking disaster."

The plague, doesn't show up on this scale, but in this model it developed rather slowly at the height of the flu. Conditions are sufficient for the plague to get up a considerable momentum, hundreds of cases a day. The result is a very grave epidemic, in which the number of dead reaches into the tens of thousands before the disease dies away. Plague dies away because, by coincidence (we didn't plan this in advance) we had selected for this specific model something very close to the threshold for the spread of plague. In these conditions, plague would create a very deadly epidemic, but certainly not one that would preclude the future survival of the city.

THE THIRD MODEL NEW YORK TODAY: DEVASTATING EPIDEMICS

The third run assumes living standards which are comparable to those existing today in a city like New York and which will probably exist in many other cities in the near future. What happens is devastating. The black curve on the second graph (Figure 2) is cumulative deaths up to that point, by both plague and flu, but overwhelmingly by plague. The dotted line is the number of flu cases. This scale indicates what would happen in a matter of one month, if such an epidemic were to develop. If the actions that I will describe are not taken at a very early point, this model situation would result in the destruction of approximately one-quarter of the population of New York City, in two weeks. Again, such an epidemic is inevitably global.

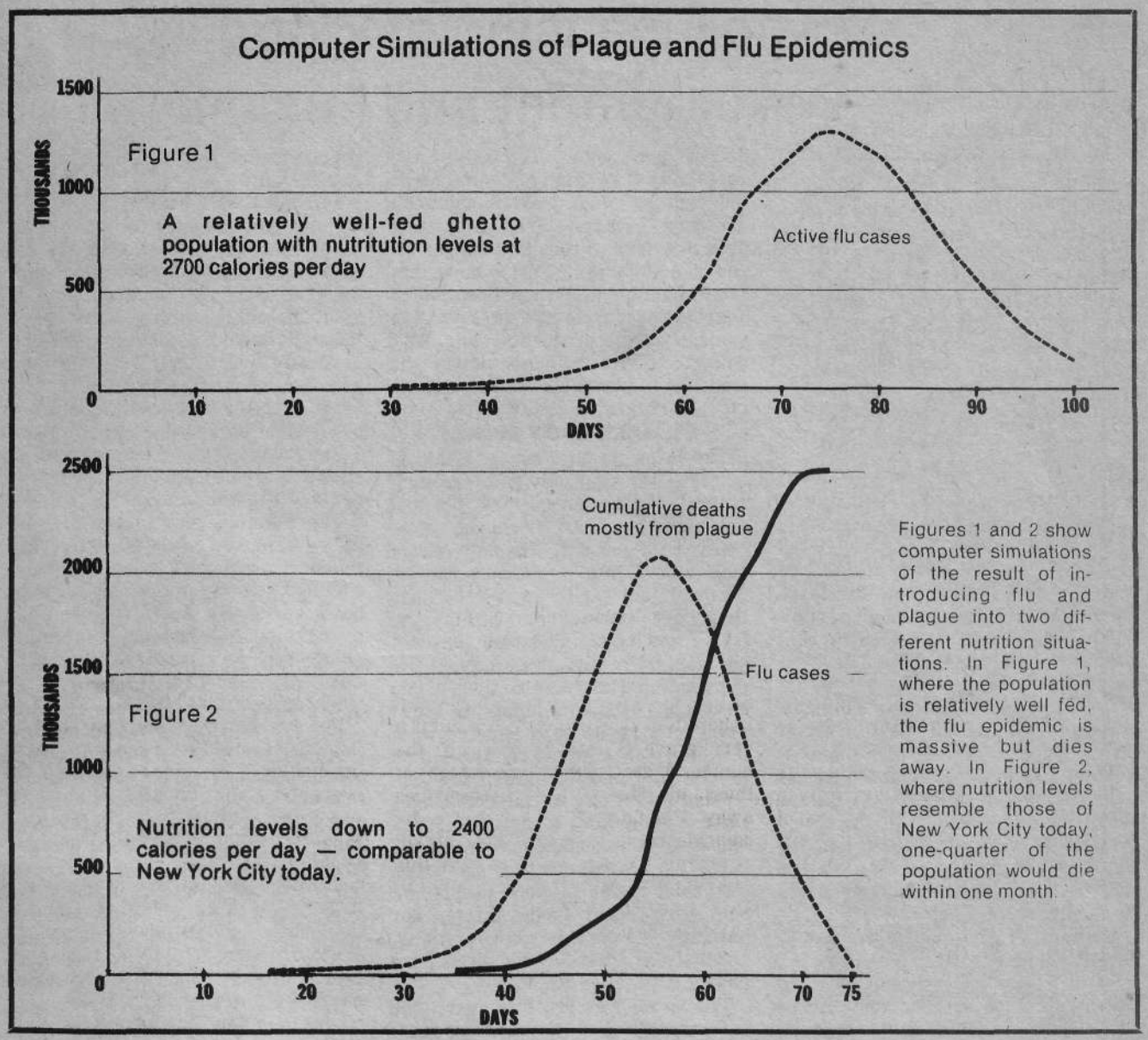
This situation is a potentiality for as early as the end of this year or early next year. In a period of about 30 days, around Christmas, one case of plague would rapidly develop into a substantial epidemic involving hundreds of dead. Because this situation would be substantially above the threshold for exponential growth, the plague grows at a rate that doubles the number of cases every three days. At this rate, by January 1 or slightly thereafter, the case rate would be up from hundreds a few weeks earlier, to tens of thousands every day. This would completely overwhelm the hospitals, reducing the level of hospital care basically back to the Middle Ages.

developing with much greater force and rapidity than in the previous model — begins to peak, large numbers of the population would be vulnerable to the plague, having just recovered from the flu. All sorts of disruptions would be going on and there would be a rise to a daily case rate of somewhere around 100,000. As the plague epidemic peaks, this would lead to the destruction of something like two million lives in a very short period.

HOW TO PREVENT EPIDEMICS

What immediately comes to mind is how would this devastating situation be allowed to develop. To take the swine flu and pneumonic plague — and we can be quite specific on this since the flu is well known — there is no question that if vaccination of almost the entire population, or at least 50 to 60 per cent of the population had not occurred by

Eric Lerner is a long-time member of the science staff of the U.S. Labor Party. Mr. Lerner has recently begun a computer simulation of the spread of epidemics, continuing the ground-breaking work that he did in 1975 to develop the concept of an "ecological holocaust."



Figures 1 and 2 show computer simulations of the result of introducing flu and plague into two different nutrition situations. In Figure 1, where the population is relatively well fed, the flu epidemic is massive but dies away. In Figure 2, where nutrition levels resemble those of New York City today, one-quarter of the population would die within one month.

mid-December, there would be no way of stopping such an epidemic.

A vaccination takes about two weeks to take effect. Recommendations like those of the New York Times to "let's wait and see whether we have an epidemic," are absolutely prescriptions for suicide. After you have an epidemic there is no cure for the flu — you have to wade through it. And this sort of pattern would inevitably develop. In the Victoria A flu last year, the number of cases in New York City in February 1976 at the peak of the epidemic was estimated at two to three million cases.

In the case of the pneumonic plague, there is one thing that can be done — a mass prophylaxis with antibiotics, expecially with tetracyclin, of the entire population in whatever city plague occurs. This is a very serious political decision, since it would involve about 50 per cent of the entire stockpile of such an antibiotic in the United States for a single large city. It is not something you could do two or three times in a row.

There are also other problems. If you had a large number of plague cases at the time you carried out the antibiotic prophylaxis, it is virtually certain that you would provoke the development of antibiotic resistant strains. This means that antibiotics on this scale would actually be self defeating.

If the plague had already spread to other cities — and in any advanced country this would happen very rapidly — the situation would again become impossible.

If you look at how rapidly such an epidemic would develop in the real world, within something like four weeks of the first case, it would be too late for antibiotic prophylaxis. And if you consider the amount of time reasonably necessary to mobilize such a massive use of antibiotics, the decision to do so would have to be made about two weeks into the epidemic, at a time when the number of dead would be perhaps a dozen.

In other words, there is such an unstable situation in the world today, that if it is allowed to continue, your only protection from holocaust would be a reaction system so rapid that on the detection of what at that point would be a small epidemic, 18 to 20 cases, a very massive counterreaction could be mounted.

The Financing of World Development and Fusion

These are excerpts from the presentation given by Uwe Parpart of the U.S. Labor Party on "Financing World Development," in which Parpart described the Labor Party's proposal for debt moratoria and an International Development Bank to create the new, production-based credit for development.

by UWE PARPART

There are some hard facts that have to be faced if we want to speak seriously about the transition to a fusion-based economy. What we and most financial and monetary experts consider to be the major fact that actually prevents significant investment programs both for agricultural and industrial development in the Third World and for infrastructural development of a broader sort is the massive indebtedness of Third World countries and the concomitant major internal indebtedness of municipalities in the United States. While the exact amount of this Third World debt is something that I think no one has a complete reading of, the latest estimate we have is in the neighborhood of $800 billion.

The most urgent problem we have to face is **not** how to repay past debt, but how to assure a reasonable level of operations of the world economy and of world trade financing. Unless we make a definite commitment to assuring levels of operations at least of those of the early 1960s, and create an international banking institution to bring about the investment projects and financing that will assure 1960 levels of trade, everything else will be merely illusory.

But where's the money for such investment going to come from? At this moment there does not exist a single credit facility on a world scale that would be able to provide credit for such investment proposals.

The hard fact of a situation such as that in which the world finds itself, in which debt is rising considerably faster than is surplus product, is very well known to most corporations and banks. Under those circumstances you have to declare bankruptcy. You assure the operability of your major operations at the expense of at least temporarily declaring a moratorium on existing debt payments. From that standpoint you can then say: "Let's make absolutely sure that every red cent we're going to spend from now on is going to go into actual production, and isn't going to be invested in a situation that feeds the very process of debt development that brought us into this fix."

THE ZERO-GROWTH TRAP

The principle question is: Can you increase the productivity of existing natural wealth? Can you make the land more productive? Of course you can — everyone knows that. The only reason why zero-growth arguments to the contrary gain any currency is because they are considered **within** the framework of the financial and debt situation we're discussing here. If you put your mind into this straitjacket, you have to end up believing that everything has to be considered from the standpoint of repaying $800 billion in debt first and foremost, "and then we'll see what else we can do." Under those assumptions, then, some quack like Barry Commoner can come up and say, "Well, there's only so much available; there's all these people; we can grow some fancy things, but basically we have to reduce everything, and there is only so far you can go ... we have to have fewer people."

But as soon as you free your mind from that straitjacket — and this is not merely a psychologically relevant act but the most important political act for us to consider now — the solution becomes obvious.

Deurbanize, deindustrialize, get back to the land, grow turnips, make sandals — these are all very nice if you want to do them in your backyard. If this is what you are proposing for the the world economy, however, then you are fooling no one: what you are proposing, simply, is to kill people. If you are proposing to not merely maintain but actually reduce current energy throughput levels, the result is simple and calculable. We know that even the already existing energy throughput level is not sufficient to feed the world population; if you reduce that any further, for each percentage reduction you can estimate just how many people you will kill.

FUNDING THE FUSION EFFORT

From the standpoint of the current problems of the world economy, fusion power is not just a good idea, something that can be slowly phased in as an additional energy source comparable to the way fission reactors are now being gradually introduced. Over the next decade the world's population will certainly grow by a few billion. If we phase in fusion we will be much too late — unless we make a commitment to simply starve a few billion people to death, which is the alternative.

The current funding of the fusion effort is in the neighborhood of $250 million a year, which is amazingly low. Equally amazing is the fact that at those very, very low levels we have over the past six months reached the point where we can see the light at the end of the tunnel (as is said in a different context).

Despite this dismally low level of funding, several fusion energy projects are coming to the stage at which we can probably begin thinking about test reactors. The Soviet Union has proposed to build a test reactor by 1982. I think that that is a relatively pessimistic proposal, but only because it is based upon levels of funding, manpower, and so on which can be drawn from the Soviet Union alone. In the context of a much broader international effort we could actually speed up this timetable considerably.

We are immediately proposing

Uwe Parpart is a National Executive Committee member of the National Caucus of Labor Committees. Mr. Parpart recently published the first English translation of leading 19th century mathematician Georg Cantor's "Foundations of a General Theory of Manifolds." Released by Campaigner Publications, the translation included a lengthy introduction by Mr. Parpart of the major currents of mathematical thought through the 20th century.

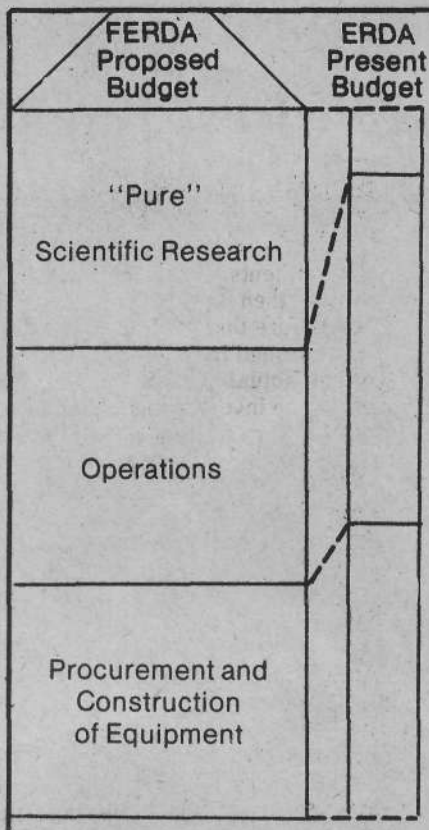
overall funding of the fusion program at something like the magnitude established for the Apollo project. We are proposing, for the immediate period ahead, funding in the $5 billion range for the fusion effort alone, with which three different things could be done.

Most crucial is the establishment of research and development centers which would focus on the fusion effort. Associated with existing fusion projects and academic facilities, we propose that ten such research centers be created in appropriate locations throughout the country, for example, at the Alcator project at the Bitter Magnet Laboratory in the Boston area, in California, in Chicago — $1.6 billion for ten research centers. The purpose of these centers would be not simply to fund and further develop **existing** fusion projects, but to create the theoretical side of the process — the necessary facilities, the stipends for the students and graduates that would have to be trained in the principles of plasma physics, one of the least funded efforts at this point. (How many physics graduate students are currently supported or funded into their work by the National Science Foundation or other organizations? I would suspect virtually none ... a scandal, to say the least.)

We'd want to set up the relevant research centers in which to bring scientists together. Not in the style of the Manhattan project, because there are various reasons why that form would not be the most desirable at this point. Nor is it comparable to the type of facilities put together for the space effort, because that was a purely engineering effort in most respects. This is not the case here because it is absolutely clear that at this point we have a long way to go. We may be able to build the first test reactors before we fully understand theoretically all aspects of plasma behavior. In fact, I'm certain that will occur. It wouldn't be anything new; we built steam engines before we really understood thermodynamics.

BUILDING THE FUTURE

The second aspect of this proposed funding would involve not just existing projects but getting perhaps 30 machines funded on such a scale that we would no longer need to worry about building something on a diameter of 5 meters instead of 15 simply because we can't afford enough wire. While we don't want to recommend that someone try to build a fusion machine by pid-



FUNDING FUSION

This bar diagram and table show both proportionally and in absolute figures the necessary budget for fusion research compared with the actual 1977 budget for the U.S. Energy Research and Development Administration's fusion program. The necessary budget, as discussed in the Parpart presentation, was submitted to Congress by the U.S. Labor Party in 1976 as the Fusion Energy Research and Development Act (FERDA).

FERDA's total for fusion research is more than ten times that of the present ERDA budget. The budget structure is different in other critical ways. More than 30 per cent of the FERDA budget goes for pure research. In general, the FERDA budget composition is similar to the organic composition of capital required for continued development in an advanced, high technology economy: the high ratio of pure research ("s") to operating costs ("v") and capital costs ("c") resembles the ratio of surplus (s) to constant (c) and variable capital (v) $s/c+v$

In Billions	FERDA	ERDA
"Pure" Scientific Research	1.60	0.028
Operations	3.10	0.227
Procurement and Construction of Equipment	1.40	0.147
Total	5.10	0.392

dling around in his garage, one thing is very clear: this sort of broad-based effort, if accompanied by a theoretical commitment that makes sense, has, in uniform experience in the development of technologies, yielded the most marvellous results. On the other hand, sometimes projects that have been pushed as crash projects have then crashed. You want to have the necessary breadth so that you don't put all your money into one line and then find that you bet on the wrong horse.

The remainder of the funding would be for the building of new facilities, yielding about $1.5 billion in necessary new investments in contracts to industry. We could then reach a point in 1978-79 at which we could consider test reactors, which would mean doubling or tripling funding to something like $10 or $20 billion. Under those circumstances, test reactors could be in operation in the early 1980s, possibly before the 1980s.

Beyond that, the sky's the limit — we can begin to consider an actual fusion-based economy.

About that I can say very little, but we would be talking on the order of $10 billion for the first two and a half years and another $20 billion over roughly five years. And that is not exorbitant, not at all.

It is the major thing that, in the very near future, will be the motor behind world development, the effort that will increase the self-productivity of nature. For that, $50 billion over five years is, I think, a very modest proposal indeed, considering what we are spending money for now.

Technological Developments Necessary for Fusion

Following the review of current fusion research programs presented June 22 by Prof. George Miley, director of the Fusion Studies Laboratory at the University of Illinois' Nuclear Engineering Department, conference participants joined in a discussion of the relationship between basic research and the "mission orientation" stressed by Prof. Miley. The following are excerpts from that discussion.

(The "Logic 3" referred to denotes one of several possible funding and research plans calculated to reach fusion breakeven and develop a demonstration fusion power plant, specifically, the "systems" strategy favored by the U.S. Energy Research and Development Administration.)

Professor Winston Bostick, Stevens Institute of Technology: ...I think that scientists become culpable (in the stifling of science — Ed.) as they assume more of a bureaucratic attitude, that is, a strictly mission-oriented attitude, rather than looking at things patiently and carefully, bringing in all the little data fragments that might otherwise be overlooked, looking in all the nooks and crannies. I'm afraid that especially for young scientists, this idea that a computer-age scientist is mission-oriented and has got to go in there with terrific impetuousity and meet certain deadlines — I'm afraid that this is improper and will turn out to be counterproductive, from a historical point of view. We've got to get back to the more old-fashioned idea of what a scientist is and how he looks at things.

Prof. Miley: If we go to what the Fusion Energy Foundation proposes, programs of I don't know how many billions of dollars, then I don't think society will permit such a program without a mission orientation. We've got to pay our money and take our choice. I think that one good thing that has happened to the fusion program is that it has moved on to realize that it is aimed at producing **power**, fusion power; it isn't aimed at all plasma physics.

"This is an exciting time — it's enough to keep you young forever." — Prof. Robert Moon at the closing conference session.

Uwe Parpart: I want to argue against the idea of a "mission orientation." The problem is that we are on a very limited track. As the examples of the mirror machine, the Alcator, and so on show, you can get very excellent results out of very unexpected corners. We could elevate that to a principle, which, however, would not fit into any constricted logic. When you actually try to make projects of the sort that these different ERDA "Logics" imply, the difficulty is that in those Logics you essentially assure scaling and so on **dependent** on what is **presently understood.**

But this has never been the norm in scientific development, especially not in periods of rapid development. On the contrary, the norm has always been what would from the standpoint of these "Logics" necessarily have to be regarded as accidental. Here is the problem. The human mind does not in fact work the way these "Logics" imply, and scientific results are after all achieved not by a computer, but by a human mind.

Perhaps I should counterpose two things: a mission orientation, which I argued for very strongly in my own presentation, but also the necessary breadth for the program, which I also argued for.

As to the problem you started your talk with, Prof. Miley, certainly we are asked to make a commitment of large sums of money at this point for a future return which is at least ten years away, in anybody's book I think, in terms of actual, real returns. But that is nothing extraordinary; I don't think that anyone in 1957 would have argued with it. But in 1977 it seems impossible. I agree with you that it is problematical for any scientist to simultaneously handle those public relations or political aspects and the actual technology, but our assumption at this point in time is that you will have great trouble separating them. And as for the question of mission orientation, it would be wrong to counterpose that to fundamental research as began to develop here. We have to have both, and the mission will be accomplished to the extent that we have the necessary breadth and depth in background.

Prof. Miley: I'd like to respond to that.

Dr. George Miley is the Director of the Fusion Studies Laboratory of the Nuclear Engineering Department at the University of Illinois. Dr. Miley is a leading researcher in advanced fuel systems in fusion and has just published a book on fusion, **Fusion Energy Conversion**.

Certainly, when funds are tight the things that get cut out are the alternatives, and I agree that it would be nice if we had a broader base, more alternatives, and so on. However, much of this, I'm afraid, gets too idealistic. I just don't think that society is ever going to fund a program of that sort, and so one has to work with what one has. I'm not sure that on that basis what's been done is so far off base.

Prof. Bostick: I want to illustrate the point that Uwe is making with one historical incident. Robert Hirsch, then the director of ERDA's Controlled Thermonuclear Reactions division, last fall made an address to several scientists out at the Los Alamos Laboratory. He announced that the research phase of the CTR program was over; from now on, it would all be technological development, and "irrational" criticism of the Tokamak program would not be tolerated. Now apparently there were all sorts of pressures on him — he had only so much money, he had to deliver results to the Joint Congressional Committee on Atomic Energy — and so he felt obliged to make a statement like that. But in the Los Alamos audience there were many seasoned workers who have worked in the fusion field much longer than Robert Hirsch has, and they knew that he was dead wrong in saying that the research phase could be considered to be over.

Dr. Morris Levitt, Director of the Fusion Energy Foundation: ..I'll just add one more anecdote that comes a little more recently. At the most recent meeting of the ERDA CTR division at Germantown, Maryland two weeks ago, the "Logic 3" was presented. Bruno Coppi — who works on the Alcator, which has so far achieved some of the most striking results in the Tokamak field — after all possible contortions had been exerted to make the case that Logic 3 was, all things considered, the best thing going, turned to Steve Dean, the director of the Fusion Planning Committee, and said, "Listen, there are a heck of a lot of us who think that no matter how many times you go over this 'logic', the thing isn't **ever** going to converge on breakeven." In other words, I think there is another problem about the five branches (five different "Logics" — Ed.) which you showed, Prof. Miley, all five going up to the nice breakeven surface. There is still no guarantee that we know exactly which one of those branches is in fact going to intersect the breakeven line.

Scientific Problems of Fusion Development:

Fusion Plasma An Overview of the Research

by DR. STEVEN BARDWELL

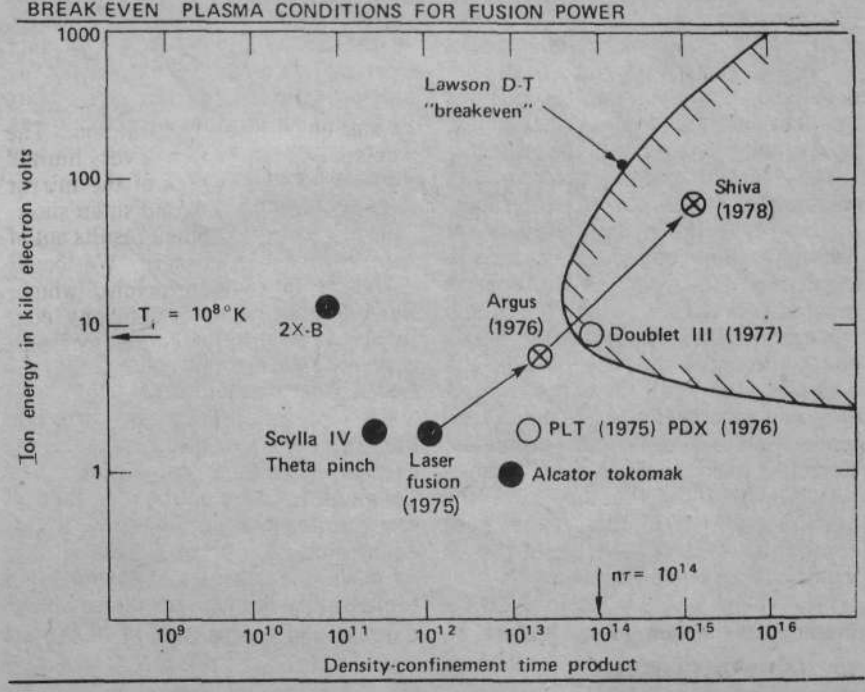
In the fifth Conference session June 22, Dr. Bardwell presented an overview of the problems of fusion research and the direction fusion plasma research must take in the future.

To a large extent, what I have to say this afternoon on scientific questions relating to the development of fusion power is a negative statement of the problem. Therefore, I begin with a disclaimer: I want to make it absolutely clear — and to my mind this cannot be questioned at any point in the ensuing discussion — that whatever scientific problems exist, whatever difficulties we run into from a theoretical or basic science standpoint, the invariant has to be a commitment in terms of time, money, and scientific manpower to the development of fusion **machines** as rapidly as possible. A commitment to the development of test reactors in the next 10 or 15 years.

Since I am going to recount the deficiencies of the ongoing scientific research and criticize many aspects of the fusion program, the basic issue must not be confused: As quickly as possible these machines have to be put together. This is going to take engineering, hard work, some magic, fine.... Whatever it takes, it has to be done. We have to supply the manpower and the money to make sure it happens.

THE PROBLEM WITH FUSION RESEARCH

The graph here(below)represents the problem of achieving the Lawson criterion (the breakeven point in terms of temperature, pressure, and time). On the graph is the most important of the present fusion machines, the 2X—IIB; one of the theta pinch machines; the progression of laser machines; the Alcator; and the Tokamaks. The parabolic curve in the upper right is the criterion for achieving fusion on the basis of the simplest considerations. What bothers me about the way the scientific research relating to fusion is conducted, is that almost all scientific research is done exactly along the line



of the handful of experiments shown on this graph.

By far the largest part of the so-called pure research in plasma physics, is in relation to the Tokamaks, the Princeton Large Torus, the Alcator, and so on. Most of the manpower and about half of the money spent on "pure" scientific research in plasma right now goes into this scientific research. If we look at the 15 or 20-year time scale for the development of fusion, however, it is obvious — and this is certainly true also for anyone with experience in technologically innovative industry — that developments that were originally strange, marginal, or even marvelous, in the research and development program, very quickly developed into the guts of the program. If you want to save money, in a certain sense, you have got to waste money in the beginning developing the ideas and the furthest implications of those ideas, that go into production only later on in the project.

The scientific research program that the United States government funds, the Energy Research and Development Administration budget, has essentially overlooked this point. As Dr. Bostick mentioned earlier Robert Hirsch (former ERDA fusion division head) has commented that the bulk of the necessary scientific research is now over and we can devote our time to engineering and technical problems. Even if it were true — in some strange sense — that all the theory of the machines shown in this graph were known and mastered, we would still be foolish to stop scientific research.

Two weeks ago, I went to ERDA's meeting on the new fusion budget. It was a very sad affair. There was a group of about 50 scientists there, from different fusion laboratories around the country, trying to have some input into the ERDA budget proposal. The atmosphere was one of tremendous resignation and bitterness. These were the guys who, in the last 10 or 15 years, had been trying to hammer together the kind of innovative scientific and technological development required.

It was very moving when a member of the MIT Alcator project said: "The budget, as ERDA has conceived it now, is not so much insufficient — that is something we have all lived with for a long time — but, damn it, that budget is not going to get fusion." The scientist was very straightforward: "If you expect to get fusion by 1990," he said, — the ERDA projection — "to get a working fusion reactor, you are not just being optimistic, you are being Pollyannaish. It is not going to happen. There is no way we can spend that little amount for money year after year and ever get fusion."

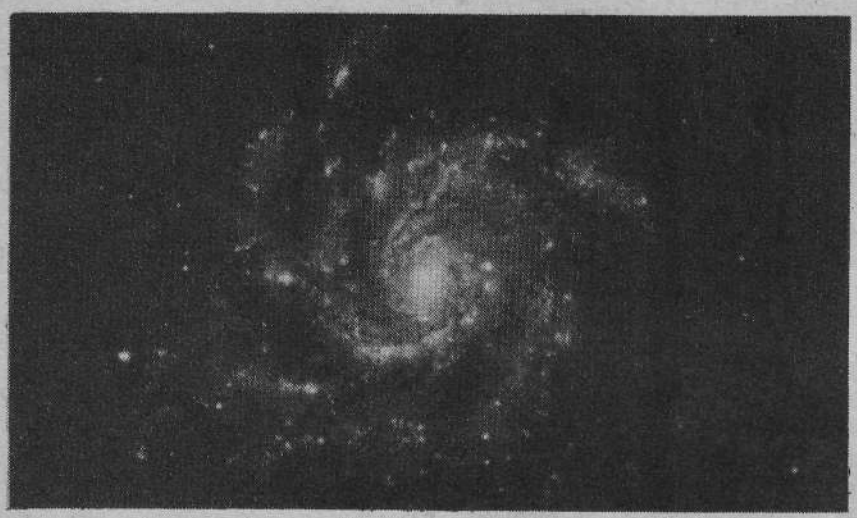


Figure 1 Plasma turbulence: The disordered state of the elliptical nebulae progresses to a highly ordered spiral galaxy.

MAKING IT HAPPEN

This is the scope of the problem. Without more money, and more money funneled very quickly into scientific research, we are not going to have a fusion program that works.

The present Tokamak program illustrates a major insufficiency in the current approach to fusion. The Tokamak is based on the idea that we can put together a long-time, stable equilibrium of a plasma. That is, that we can put together a plasma that has a temperature of hundreds of millions of degrees and a density of 10 We are trying to build a machine that can force that plasma into a stable configuration with a long lifetime — for plasma processes — of between one and ten seconds. This is explicitly premised on the hope that the most important and appropriate way to describe a plasma is how you describe things in every day life, in terms of their equilibrium states. You define a temperature for it; you define a thermal equilibrium that exists; and, given your knowledge of the kind of forces that exist in that collection of matter, you try and set up a situation in which the matter can stay in that configuration essentially indefinitely. My sense of the situation — and I think this is borne out in more detail by a look at the forefronts of plasma physics research — is that this approach is barking up the wrong tree.

In the June issue of the FEF newsletter (Vol. I, No. 6) there is a reprint of a very provocative article by the Soviet physicist V. N. Tsytovich. Tsytovich looks at some of the recent experimental results from non-magnetically confined plasmas that point to nonlinear and essentially non-equilibrium behavior. This behavior is not just accidental or peripheral; it strikes at the heart of the physical theory underlying plasma physics. This is the most important problem that scientific research must address.

COMMON SENSE VERSUS PLASMA

Certainly the common-sense overview of any situation is that things go from an ordered configuration to a relatively disordered one. According to the conceptual basis of thermodynamics and statistical mechanics, we choose the most normal state and the way it naturally exists. This common-sense perception of the world — which I would criticize on a number of other bases — is simply not borne out in a plasma. Plasma behavior very immediately demands that a scientist come to grips with highly non-equilibrium and non-linear situations, and very ordered situations — not as something unusual or as something derived. A scientist can no longer say: "Well, a plasma naturally wants to be disordered, just like everything else. There was something here preventing it from being disordered and thus it ended up in an ordered state." On the contrary, the tendency toward ordered states is much more the direction that processes in a plasma naturally take.

The first pictures are of the

plasma generated in the plasma focus machine. They depict the natural shapes that plasma takes as you dump a tremendous amount of unordered energy into it. Think of that in more day-to-day terms. You know what happens when you put a lot of energy into something; the thing burns up, it explodes, it falls apart. Common-sense experience says that putting a lot of undirected energy into a system is a prescription for destroying it. In a plasma, however, very specifically and profoundly, the opposite happens.

Dumping a lot of energy into a plasma, frequently and "normally" results in generating ordered situations out of disordered. These pictures of the discharge depicting the current sheath in this plasma focus, as it comes off the end of the electrode, show that in addition to being nicely shaped with a kind of waterfall effect, it is very clearly divided into threads, plasma filaments. Figure 2 shows this even more clearly. You can see a radiating pattern; the plasma is highly concentrated into these filaments. To give you some idea of the concentration, the energy density in those threads is on the order of a million times greater than the energy density of the plasma immediately surrounding them.

Figure 1 shows (the last stage of an) abbreviated evolution of a galactic structure from diffuse and relatively unorganized nebulae to a spiral galaxy, and then to a more advanced spiral, which has developed into an obviously very highly structured state. If you compare these two sets of figures, you get a striking phenomenon. In Figure 2, you see plasma filaments, phenomena that exist for microseconds, with a dimension of, say, a sixteenth of an inch. In Figure 1, you see plasmas that exist for billions of years and on linear dimensions of thousands of light years. Both figures, however, exhibit one very fundamental common property — the natural tendency in both situations is toward order rather than to develop disorder.

Dr. Steven Bardwell is a plasma physicist with the Fusion Energy Foundation. Dr. Bardwell is currently doing research on the broader implications of ordered phenomena in plasmas.

FUSION: WHAT PLASMA DOES NATURALLY

The last aspect of this I will mention is sort of the payoff. The research carried out on the filaments provides good evidence that fusion goes on in these devices (in fact they provide the most conclusive evidence yet of fusion in the laboratory) and that the bulk of the fusion goes on in the filaments. The neutrons produced are not **thermonuclear** neutrons but fusion neutrons. It is very tempting to speculate that the most fruitful lines of future research will develop by taking advantage of the natural tendencies of the plasma to organize itself, to form high density and temperature, very ordered structures.

If we want to develop in a thoroughgoing and rigorous way, we have to take advantage of what the plasma does "naturally" and there is good evidence — the billions of years of existence of stars for example — that what a plasma does naturally is fusion. We must rigorously reorient plasma physics so that it takes the fact into account. Plasma physics must not impose on scientific research the prejudices of our daily experiences; instead it must take full account of the plasmas' highly nonlinear and non-equilibrium processes in order to develop fusion.

At The Threshold Of The Pasteur Era

by DR. WINSTON BOSTICK

The mainstream of the financed Controlled Thermonuclear Reaction movement in the USA and in the Soviet Union has not paid a great deal of attention to the existence of plasma filaments. I claim that these structures, these vortices shown in the pictures (Figures not shown) show that the Pasteur era of plasma physics is really at hand. Pasteur showed the importance of microbes and bacteria in contagious and infectious diseases which had spread in animals and humans since time immemorial. He showed the importance of these very small structures; the fine structure was the essence of understanding the disease. If you did not consider the fact that microbes were there, you would never understand the disease.

Now, plasma physics is in that same pre-Pasteur era. Physicists, with statistical mechanics, with the Vlasov equation, with the Boltzmann equation, with the MHD equation, with a knowledge of atomic physics, are trying to understand plasma physics. But the real complexities, which are going to come from the fine structure, are these entities that are whipped up out of this otherwise amorphous plasma soup. Those entities were not predicted by the theorists, but they have come forward as experimental entities.

Just recently, at the Institute of Electronic and Electrical Engineering plasma physics meeting in Houston last month, researchers on relativistic electron beams at both the Naval Research Laboratory and Sandia enthusiastically reported evidence of "filaments" in their relativistic pinches. At the 1971 American Physics Society Plasma Physics Division Meeting in Madison, Wis., I remember sitting through an immense rash of Sandia papers on relativistic electron beams, and one paper showed clear evidence of pairs of plasma vortex filaments. I pointed those out to the Sandia physicist, but apparently my remark at that time had no effect. I also listened to an invited paper by a Sandia physicist on certain aspects of their electron beam program in October 1975. When asked whether they had observed evidence of filaments, the reply was negative.

Now at last, years and millions of dollars later, it is gratifying to see that people from the large, financially favored laboratories have decided to join the club and recognize that, after all, there may be something to this Pasteur era of plasma physics, even in the field of relativistic beams. However, they are a bit too late to qualify for charter membership.

THE CLASSIC AUTO RACE

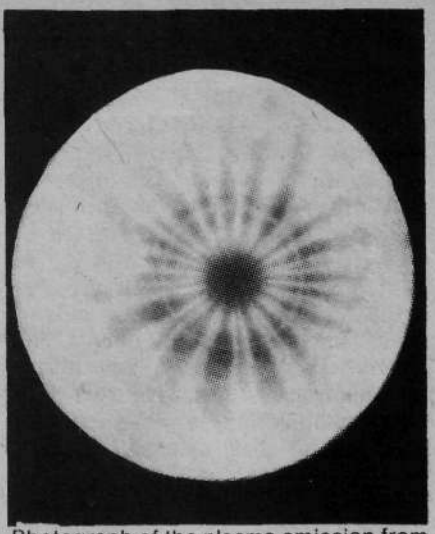
In the matter of large plasma focus machines which produce large numbers of neutrons, the drama has been something like a great classic automobile race: Joe Mather, a winner of many races, driving the most powerful

machine to date (his 700 kilojoule machine, is retiring early in the race at a pit stop because his government sponsoring agency declined to fill his gas tanks). The most powerful machine built thus far, the Frascati one megajoule, is still in the shop. Filippov, who hails from Tokamak country, is obliged to visit the Frascati shop frequently in order to be near a powerful machine. John Luce, operating the LLL one megajoule machine, on only one-quarter of its cylinders, is turning in some fine laps, where he extracts 75 per cent of the machine's energy into the pinch. The officials are repeatedly trying to flag him down and retire him from the race because of age, but he keeps on, lap after lap. He does most of the work in the pit by himself.

It is somewhat doubtful that these Moseses of the plasma focus world will live to set foot on the promised land of a "breakeven" machine.

A ROMANCE WITH PLASMA VORTEX FILAMENTS

Since the Energy Research and Development Administration has declined to sponsor plasma focus research for the last 15 years, and since the plasma focus has no friend in court in Washington, it is perhaps an idle dream to think of building a breakeven plasma focus machine. Though I have envied the plush funding and resources enjoyed by our Tokamak, stellarator, and mirror brothers, I would never for a minute give up the once-in-a-lifetime exhilaration of discovering and studying the plasma vortex filament. Even if the Soviet Union had provided for Lev Arzimovich, the super-salesman for the Tokomak, the ultimate sanctification of laying him out alongside of Lenin in the tomb at Red Square, I never for a moment would have traded my romance with the plasma vortex filament for all the prestigious flush and financial salvation of Tokamak fever.



Photograph of the plasma emission from an axial view of the discharge in a theta pinch machine. Note the occurrence of the radial filaments in pairs (paramagnetic vortex filaments) and the single concentric filament (a diamagnetic filament). Figure 2

Indeed, if the right physicist with the right attitude and the proper instrumentation takes a really careful look at the Tokamak, he will probably find plasma vortex filaments there, where they may be playing a significant role in neutron production. It took 14 years before the vortex filaments were discovered to be significant in the pinch effect, and now 24 years before the profession at large takes them seriously in the pinch effect. The Tokamak is not yet 24 years old!

In fall 1975, Robert B. Hirsch, then the director of ERDA's Controlled Thermonuclear Reaction Division, addressed scientists and engineers at Los Alamos, declaring that the research phase of the U.S. CTR program was over, that from then on it would all be technological development, and that irrational criticism of the Tokamak program would not be tolerated. These remarks bring to mind the answer given by an elderly, laurel-rich, A.A. Michelson to the question "Where lies the future of physics?" Michelson replied, "In the last decimal place." Although Michelson had lived and worked at the threshold of the greatest era in physics, his imagination was unable to project itself into this era which would witness the developments of quantum mechanics, nuclear physics, high energy physics, solid state, general relativity, etc.

If Robert Hirsh really and permanently means what he said at Los Alamos, he is choosing to ignore the fact that plasma physics is at the threshold of the Pasteur era. But, history perhaps will not permit him entirely to escape that fact.

PATIENT RESEARCH

The history of the pinch effect has demonstrated some of the great complexities inherent in plasma physics. These complexities represent potential hidden navigational hazards, or possibly favorable currents, for all CTR craft and sailors, including the bureaucrats on the bridge. These complexities could delay a voyage, damage a craft, sink a ship, or make an otherwise impossible voyage possible. The understanding of these complexities of nature will come primarily through patient research, not through technological development.

Dr. Winston Bostick has been a leading fusion physicist for more than 20 years. Dr. Bostick has been especially important in the development and perfection of experimental techniques for the study of short-lived plasma phenomena. His publications have appeared in every major physics journal over the last two decades.

IN THE NEXT ISSUE OF THE FEF NEWSLETTER

* A Primer on Fusion Energy From an Advanced Standpoint

Compiled by the FEF staff, this handbook is especially written for the election year. It lays out the necessity and promise of fusion energy, both as an energy source, and the technological foundation of a fusion economy.

*Frontiers of Science in Plasma Physics

This provocative article by Dr. Steven Bardwell includes a major historical survey of the observation and attempts at theoretical description, of ordered phenomena in plasmas. As it becomes clearer that plasma physics demands a conceptual leap in our scientific understanding, a historical accounting of previous attempts to deal with globally coherent phenomena in plasmas is essential.

*Progress in Fusion Research

This regular FEF Newsletter feature includes a report on Academician Rudakov's recent visit to the United States with details of the Soviet Union's electron beam research.

Rockefeller Opens Total War Against Fusion

The overt as well as the hidden attacks against fusion development all can be traced to the Rockefeller faction. The key figures in the agencies and institutions involved — Attorney General Edward Levi who controls the FBI, Dr. Robert Seamans who heads ERDA, Guyford Stever who heads the National Science Foundation, and Margaret Mead and Kenneth Clark of Science Magazine — are all close associates of the Rockefeller family political-economic faction.

by THE FEF STAFF

The release of significant portions of the FBI dossier on the Fusion Energy Foundation combined with the recent publication of two articles in Science Magazine panning the prospects for fusion indicate that the Rockefeller faction is going for total war against fusion. The first casualty of this war, as the Science article makes clear, is the fusion effort of the Energy Research and Development Administration. ERDA's fusion program is now set to self destruct.

U.S. Energy Research

ERDA'S FOLLY

Circles within ERDA have willingly collaborated with the FBI in labeling the FEF a potentially subversive "front group" of the National Caucus of Labor Committees, attacking scientists who work with the Foundation, and laying the ground for 1950 s-style "Soviet spy" frameups. These circles will be shocked to learn that the position they thought the safest—"fusion development presents no more major unsolved scientific problems"—functions not only as the basis for slanders against the FEF, but also as the ammunition for Rockefeller's attacks on the ERDA program itself!

On June 25 the FBI released to the FEF two reports previously prepared for ERDA that reveal the grotesque reaction-formation against scientific theory and the self-delusory reliance on engineering know-how endemic to security-intelligence circles.

The core of self-delusion is contained in the views of the FBI's unnamed "expert" consultant on fusion: "All the theoretical problems of nuclear fusion have been resolved . . . The FEF is attempting to recruit scientists to its ranks to solve the details of theoretical research when most of the problems that remain are of transferring knowledge already gained in the laboratory into a workable economical power plant."

Precisely the view that "fusion's just an engineering problem now" — universally denied by the fusion community itself but programmed onto ERDA — is what set ERDA up for the well-calculated attack in the June 25 and July 2 issues of Science Magazine. The Science attack informs the ERDA "engineers" that their "engineering" of fusion is useless — the problems are just too mind-boggling.

THE WITCHHUNT

The Rockefeller faction attack on fusion from contradictory positions is a result of the growing influence of the FEF and the U.S. Labor Party's development programs among leading scientific and industrial strata. Like previous political witchhunts, the war against fusion includes harassment and strongarming specifically directed at individuals or laboratories to bend their minds or silence their opinions.

A scientist close to the fusion

research effort disclosed to the FEF that the source of post-Chicago harassment against Conference Advisor Benjamin Lax, Director of the Bitter Magnet Lab at MIT which houses the innovative Alcator Tokamak Project, was none other than Dr. Robert Hirsch, former director of the ERDA fusion research division. Hirsch, instrumental in keeping fusion research on a narrow "science-free" track, is now head of ERDA's "advanced systems" division, which lumps fusion together with technologies patently incapable of powering an advanced industrial society: solar, geothermal, and wind.

The harassment of Lax follows the threatened cut-off of funding to FEF International Journal Advisor Dan Wells of the University of Miami, Florida, by the Rockefeller-controlled National Science Foundation.

Meanwhile, the October League, a crew of illiterate Maoist thugs from the Rockefeller-funded Institute for Policy Studies stable, has been directed to sell its rag "The Call" at the Lawrence Livermore Laboratory in California. Livermore is one of the top three ERDA national labs working on fusion and the site of the very successful 2XII-B Mirror Machine.

BACKGROUND TO THE ANTI-FUSION STRATEGY

The background and recent relevant facts of the fusion set-up are as follows:

In the fall of 1975 the FEF publicly invited a number of leading fusion scientists to participate in a seminar in New York to delineate the frontier areas of plasma physics which demanded research efforts far beyond the restrictive scope of research conducted by ERDA. The seminar produced two significant results.

First, none of the several scheduled non-FEF speakers appeared. In at least one case, that of Prof. Dan Wells, a leading theoretical and experimental investigator of "dynamic stabilization" at the University of Miami, Fla., the FEF was directly informed that the reason for Wells' withdrawal was fear a cut-off of research funding — even though Wells was funded by the National Science Foundation, not ERDA.

Second, analysis by the FEF of fusion research results and ERDA policy responses provided clear evidence that ERDA was about to expand its **development** programs, centering on the Princeton Tokamak project, at the expense of other main lines of inquiry and basic research. U.S. Labor Party Presidential candidate Lyndon LaRouche, Jr., a leading participant in the FEF seminar, immediately issued a statement, widely circulated in government and scientific circles, exposing the fact that ERDA was being manipulated into adopting a program that was bound to run itself into the ground because of its total dependence on the ultimate viability to the low-efficiency Tokamak as a reactor device.

The FEF subsequently learned that then Division of Controlled Thermonuclear Reactions (DCTR) director, Dr. Robert Hirsch of ERDA, had told the assembled scientists of Los Alamos Scientific Laboratory that the scientific research phase of the fusion program was over and there was to be no "irrational" criticism of the Tokamak project.

FBI Releases Censored Document on FEF

The following are excerpts from censored documents concerning the Fusion Energy Foundation (FEF), released under the Freedom of Information Act. On file with the FBI and compiled, in part, by the Energy Research and Development Administration (ERDA), the documents contain personal history as well as the recent activities of FEF director Dr. Morris Levitt, in addition to an analysis of the Foundation's role in organizing for world development and fusion-based economies.

During December, 1975, *(Deleted)* furnished the following information concerning the Fusion Energy Foundation (FEF) ...

According to its original brochure, the FEF may be reached at General Post Office 1901, New York (NY). The real address of the FEF is the fifteenth floor of 231 West 29th Street, New York, NY, the headquarters of the National Caucus of Labor Committees (NCLC), a characterization of which is attached to the Appendix hereto.

A prospectus distributed by FEF claims that "the FEF was founded in November, 1974, at a meeting attended by representatives of the United Nations, the International Atomic Energy Commission, and scientists who have made significant contributions to fusion research and interested laymen." This report continues, "The purpose of the FEF is to provide a forum of independent, high-level scientific discussion of fusion from the standpoint of comprehensive policy-making. This will be accomplished in several ways:

By educating the general public through various publications and through the holding of public forums.

Through publication of a theoretical scientific journal which will examine fusion research from the standpoint of developing alternative research policy.

By providing our findings to appropriate government agencies and laboratories so as to facilitate creation of a crash program for fusion power developments."

The prospectus further claims that "policy for the organization" is set by the Board of Directors in association with the Scientific Advisory Committee. This is fantasy. The FEF is a tightly run front group for the NCLC. The FEF has used NCLC manpower and technical equipment to produce two hour long videotapes entitled "FEF Founding Meeting" and "Ecological Holocaust."

The concept of fusion power is seen as one of the NCLC's major tactics in its effort to gain political leverage on the international scene. Since the FEF is, in effect, a section of the NCLC, it can be and is used to recruit persons of influence in various scientific institutions and technical organizations to the NCLC viewpoint. Generated by fanatic fervor, the real zeal of the FEF — NCLC organizers is reflected in their extreme activity as they attempt to penetrate target groups. With the FEF as the spearhead of this drive, these organizers are making strong inroads into the left-liberal scientific field,

whose members have little or no experience in handling Marxist indoctrination sessions and some are brought into the fold.

The structure of the NCLC and its attitude towards other radical organizations preclude any toleration of independent groups within their orbit and the FEF can be seen as merely revolving around the mother group. Unlike such organizations as the Communist Party, USA (CPUSA), a characterization of which is attached to the Appendix hereto, who operate covert fronts to entice the unwary political worker, the NCLC manipulates the FEF in a semi-covert manner. The FEF remains an important part of the NCLC agitation pattern.

The NCLC sees the FEF as their alternative to the National Science Foundation and National Academy of Sciences, as well as the left-leaning Foundation of American Scientists.

The general line of the FEF is that the capitalist United States refuses to allocate enough funds to basic scientific research. This line of argument naturally has appeal to "pure" scientific researchers who are searching for government grants. Further, there is an appeal toward fusion research because if it could be developed and energy were made nearly free, the consequences for the human race would be staggering, but as Doctor Edward Teller said in Stuttgartt, West Germany, early in July, 1975, "Fusion won't work until after the year 2000." He added that "While it is quite possible that the Soviet Union will have an experimental fusion power reactor by 1980, it is only communist propaganda that fusion power can actually be used economically by the year 1985...a dangerous idea that several well-meaning, but naive, scientists in the West have given credence."

The NCLC, through the FEF, also claims that American scientists do not study the way knowledge is correctly gained. That is, they make "epistemological" errors which mainly consist of failing to see science as a part of the development of the human race which is the negentropic factor in the universe.

The FEF is trying to publicize what the NCLC has previously characterized as a "fusion gap" between American and Soviet researchers directly traceable to sabotage of required fusion programs by the Energy Resources Development Agency (ERDA) and Rockefeller stooges.

This supposed "fusion gap" exists, but not in the way the NCLC claims. In a hearing on June 3, 1975, of a subcommittee of the Committee on Government Operations, the development of fusion power is examined in detail. The Committee reports on November, 1974, International Atomic Energy Agency's fifth meeting on plasma physics in Tokyo, Japan. Plasma physics is the key area of science considering fusion power. At that time, a Tokyo newspaper, "Mainichi Shimbun," quoted the Russian Scientific Secretary to the meeting, Mr. Belazerov, admitting, "that this data was a better record than the USSR's." The report makes clear that all the theoretical problems of nuclear fusion have all basically been resolved. The problem is technological — how to build an economical power producing plants outside the laboratory.

As the FEF prospectus admits, "The USSR lacks the vitally important high-technological competence in which the United States excels." The FEF is attempting to recruit scientists to its ranks to solve the details of theoretical research when most of the problems that remain are of transferring knowledge already gained in the laboratory into a workable economical power plant.

The NCLC produces a massive amount of frantic pro-USSR propaganda in the context of its imagined roll (sic) of a worldwide catalyst of political agitation. Once strongly Anti-Soviet, the NCLC has shifted 180 degrees from this position and presently seldom mentions this tool of Russian subversion and internal control (**apparently KGB—ed.**). Despite this propaganda wave, the isolation of the NCLC within the United States and international left elements nullifies any effect, so that the FEF remains in potential the most important reason for possible Soviet support.

A real possibility exists of infiltration of the FEF by foreign intelligence services in general and Soviet intelligence in particular. It is known that Soviet intelligence considers scientific institutions as an important target for intelligence penetration and control. The FEF can serve as a vital organization to meet and recruit as sources technical people, many of whom will have high level connections to provide information from governmental centers of research. Left-liberal individuals who are naive enough to be included in the circles of the FEF members and supporters would be valuable targets for such operations and the strong pro-Soviet line of the FEF-NCLC provides excellent political foundation.

OFFICE OF THE DIRECTOR

UNITED STATES DEPARTMENT OF JUSTICE

FEDERAL BUREAU OF INVESTIGATION

WASHINGTON, D.C. 20535

June 25, 1976

Mr. Morris Levitt
Director
Fusion Energy Foundation
General Post Office Box 1901
New York, New York 10001

Dear Mr. Levitt:

This is in further response to my letter to you dated May 27, 1976.

Enclosed are copies of two FBI documents which were located by the United States Energy Research and Development Administration in connection with that agency's processing of your Freedom of Information Act request and referred to us for handling.

Excisions have been made from these documents in order to protect materials which are exempted from disclosure by the following subsections of Title 5, United States Code, Section 552:

Science Magazine Attacks the Development of Fusion Power

by JON GILBERTSON

Precisely at the time that the Fusion Energy Foundation held its precedent-setting conference in Chicago on "World Development and the Transition to a Fusion-Based Economy," *Science* Magazine published a two-part article featuring the "tremendous" difficulties of developing fusion power. Entitled "Fusion Research: What is the Program Buying the Country," and "Detailed Reactor Studies Identify More Problems," and appearing June 25 and July 2, the slanted article alleged the near-impossibility of this alternative energy source for at least the foreseeable future. The *Science* polemic against fusion research went so far as to suggest that to continue such research one had to be loony: "It sometimes seems necessary to suspend one's normal critical faculties not to find the problems of fusion overwhelming," the author concludes.

The article, written by William D. Metz, focuses on the University of Wisconsin's Tokamak design, UWMAK-I, a very conservative first-cut at what such a fusion power plant would look like.

A SCIENCE SMEAR JOB

The negative tenor of the article is best illustrated by the disparaging and sometimes just plain lying statements that Metz intersperses among his carefully selected technical facts:

"Fusion power would not be infinitely abundant, because the present reactors rely on a fuel cycle that must have lithium, and lithium is not particularly more abundant than the U-238 that would fuel the breeder reactor."

". . . the realities of fusion are governed by the laws of physics, which are turning out to be more favorable to the technically less attractive options."

"Many observers think that the Soviet Union has given up on the prospect of an economically viable pure fusion reactor."

"The conceptual reactor studies have uncovered a number of crucial problems for which it is uncertain whether a solution exists—such as impurity control, refueling, extending the life of the first wall, and effective maintenance."

As one of the leaders of the University of Wisconsin's team described Metz' unscientific technique: "It is obvious that the author had already decided how he was going to write the article before he examined the information we provided him, and then he simply filled in the information that he needed to back up his case."

Once the cardinal point about Metz' and *Science's* intentions is understood, it is useful to comment on some internal features of the article. Much of the article's analysis and discussion is based on the UWMAK-I study which is a very conservative, first-of-a-kind conceptual design that admittedly represents a reactor that would never be built. Other more recent designs were available to *Science* Magazine to review, including the latest U. of Wisconsin design, UWMAK-III, which would have at least provided them with the most current technical information.

One of the leaders of the University of Wisconsin Fusion Reactor Project, Prof. G. Kulcinski, met with author Metz several weeks prior to publication of the article and stressed to Metz that from his standpoint as a nuclear engineering professor with broad experience in all facets of power production from nuclear reactors, the general findings of the UWMAK-III study certainly indicated a favorable situation for fusion reactors in costs per kilowatt terms.

Representatives at the Princeton TFTR Project, the Electric Power Research Institute, as well as at the University of Wisconsin, pointed out that in fact there is a wide range of parameters including size, cost, and complexity, to be selected from, even at this early stage. All of these groups contacted were disturbed by the twisted presentation of their results and will respond to the *Science* Magazine article.

Even the Bechtel Corporation, which has been heavily involved in the "Project Independence" boondoggle and is no promoter of fusion power, has come up with information that contradicts Metz's conclusions. Bechtel concluded that the estimated fusion reactor costs compared well to those for other advanced energy sources. Based on consistent and comparable assumptions, the costs range approximately as follows:

	mills per kwhr.
UWMAK-III	30 - 60
LMFBR Fast Breeder	35 - 55
Geothermal	40 - 60
Solar	70 -200

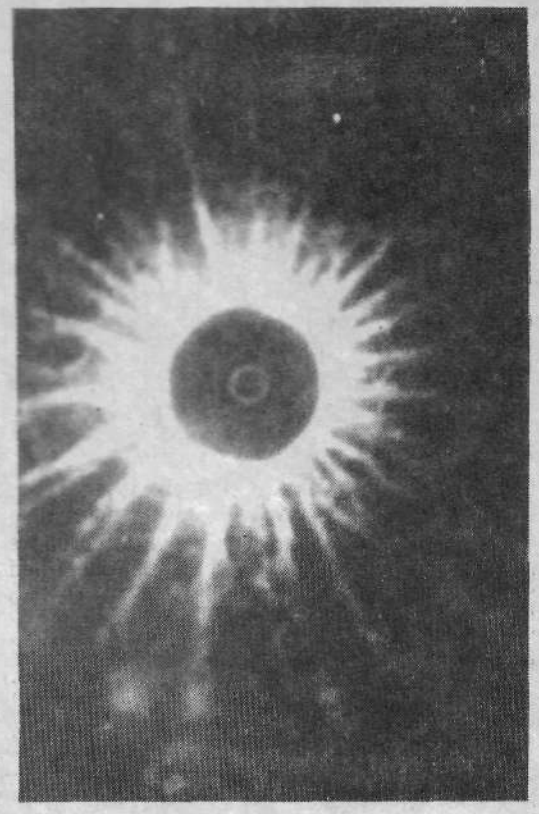
OVERALL PRODUCTIVITY IS KEY

As the U.S. Labor Party's White Paper on Energy Policy points out, the key criterion in these comparisons is not the cost per kilowatt but the alteration of the overall productivity of industry. By this criterion, solar and geothermal power are not even worth mentioning, and fission breeders are not competitive. Measured on this basis, therefore, Metz's entire article is pure bunk. As we get beyond these preliminary studies we will be able to construct more optimal designs and establish more concretely their applications in transforming basic industrial processing. In short, it can be said even now that fusion will provide an open-ended development of technology and industry that no other energy source does.

Metz's purpose is to tighten the controlled environment around ERDA by giving it the "choice" between a do-or-die gamble on a quick payoff from large experiments or spending the same limited funds on "long-range" research. As the presentations at the FEF conference made clear, if the same levels of funding are maintained, there may not be a payoff at all. Only by increasing the levels of funding to provide parallel efforts of several promising concepts, including basic theoretical development, can we guarantee energy at costs similar to or less than other advanced systems. In addition, the kind of program the FEF has proposed will provide the basis, through the plasma medium, for the transformation of industrial processing to new advanced levels of output currently not possible, yet necessary for the continued development of human society.

Science Magazine is one of the leading exponents of the zero-growth, who-will-fit-in-the-lifeboat view of human activity in the biosphere. It commonly features such outspoken advocates of genocide as Lester Brown of the World Watch Institute. As an obedient conduit for the programs of this faction, *Science* could not be expected to recognize or promote those aspects of fusion development which would revolutionize man's role in improving and maintaining the biosphere. Its smear job on fusion is fully consistent with its record.

Fusion Energy Foundation



Vortex Filaments from the current sheath in the plasma discharge from a Theta Pinch Machine. Photo courtesy of Dr. Winston Bostick.

The Fusion Energy Foundation was founded in November 1974 at a meeting attended by representatives of the U.S. Labor Party, the United Nations and the International Atomic Energy Agency, scientists who have made significant contributions to fusion research, and interested laymen.

The purpose of the FEF is to provide a forum of independent, high-level scientific discussion of fusion from the standpoint of comprehensive policy making.

The FEF publishes a bimonthly newsletter summarizing and analyzing all major developments in the fusion field and is cosponsoring, with the Baywood Publishing Company, the International Journal of Fusion Energy, which will stimulate and synthesize conceptual advances in the fusion-plasma field.

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