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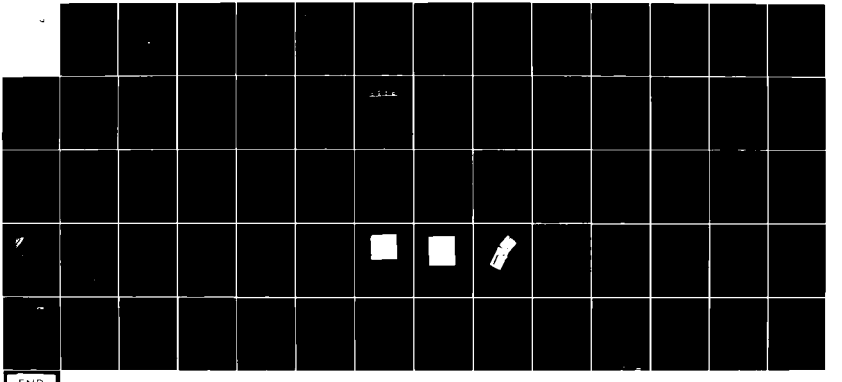

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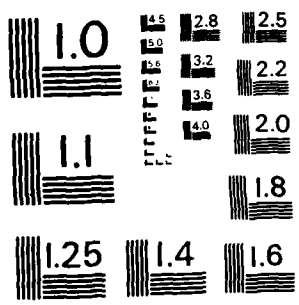

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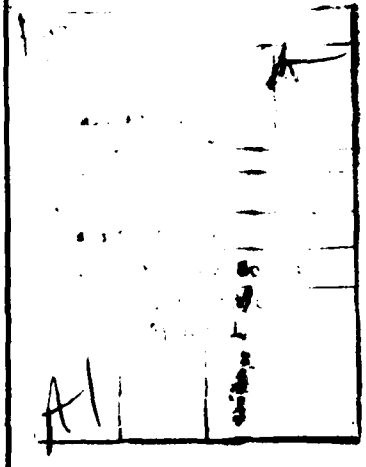

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BEHAVIORAL SCIENCES

SCANDINAVIAN RESEARCH ON OLD AND NEW QUESTIONS IN COGNITIVE DIFFERENTIAL PSYCHOLOGY

by Richard E. Snow. Dr. Snow is the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1985 from Stanford University, where he is Professor of Education and Psychology.

Poor Kinnebrook was fired from his job at the Greenwich Observatory in 1796 because his astronomical measurements did not agree with those of his superior. Only later was it recognized that individual differences in reaction time represent an important fact about human information processing rather than simply an annoying source of error or a sign of sloth.

Scientific interest in individual differences in ability can be traced from that event, although the programmatic research that built the discipline of differential psychology did not begin in earnest until the 1860s with Galton's studies in England, Wundt's experiments in Leipzig in the 1880s, J. McKeen Cattell's importation of this work to the US in the 1890's, Binet's invention of a practical intelligence scale in Paris at the turn of the century, and Terman's subsequent translation of that to US research. Galton's and Binet's lines of work persist today on both sides of the Atlantic (see *ESN* 38-2:63-66 [1984]; Eysenck, forthcoming). And both the basic and the applied science of mental testing are frequently in the courts and the news today, as well as in the journals. While it is recognized that mental testing technology is psychology's most important practical contribution to society to date, it is also clear that the substantive theory of differential psychology has lagged far behind the practice. A selection test used to accept or reject applicants for Kinnebrook's job can now be proved valid for that purpose in a technical sense, but the psychology of that validity is still not well understood, and the sociology of it is still well beyond the perception of many psychologists.

In this century, the basic research questions for cognitive differential psychology can be grouped into three sets:

1. How many distinguishable intellectual abilities must a theory of *intelligence* posit? How are these abilities to be interrelated, organized, and interpreted within some kind of general structure or taxonomy?
2. How can we understand intellectual abilities in transaction with the experiences of learning, problem solving, and performing in complex task environments over the course of educational and occupational development? What are the social, educational, and occupational implications of this transaction?
3. How can an integrated process theory of the human cognitive system be constructed that accounts for the details of ability differences and their development? How can training, instructional, and job performance tasks be designed to adapt, and to adapt to, this cognitive system?

Although the high points of interest for each set of questions correspond roughly to the first half, middle half, and last half of the present century, respectively, none of these questions has yet been fully answered by the research to date.

The bulk of the research on all these questions has come from the English-speaking parts of the world, with some notable work also from Dutch-, French-, and German-speaking investigators. But Scandinavian psychologists and educational researchers, though relatively few in number, have also made and continue to make signal contributions, though these are often not given wide or timely recognition, particularly in the US. One might say that the Scandinavians got into differential psychology on the late side. Though some important early contributions dealt with aspects of the first set of questions above (e.g., Ahmavaara, Werdelin), the bulk of the older important work concentrated on the second set (see, e.g., the studies of Härnqvist, Heinonen, Husén). But one must also say that, coming late, they have stuck close to the foundations of the discipline, particularly its mathematical-statistical foundations, and have made substantial improvements in it (e.g., the works of Jöreskog, Rasch, and Sörbom are especially notable).

The present article must leave aside the history of Scandinavian contributions to differential psychology, to concentrate instead on selections from important new work pertaining to questions in each of the three sets noted above. It is thus perhaps a representative review, but hardly a

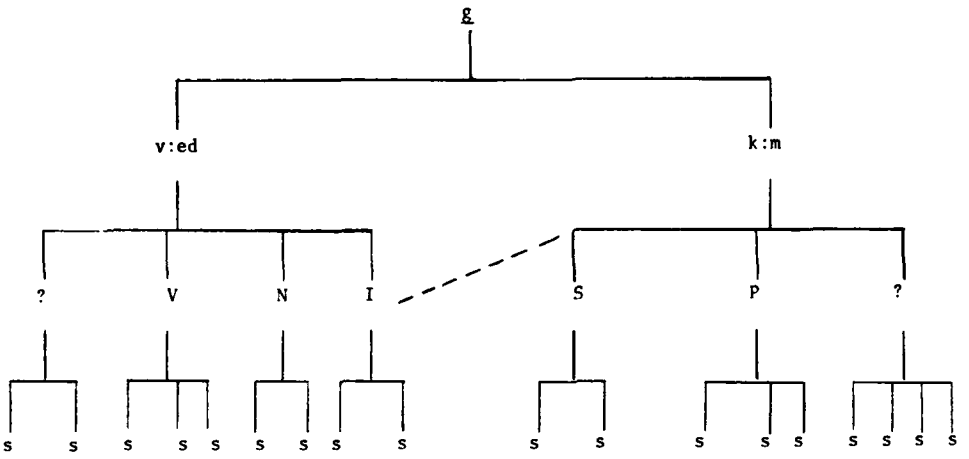

Figure 1. The Vernon hierarchy of ability organization.

comprehensive review, even of current work.

Distinguishable Abilities

The first set of questions remains important because structural models of ability organization and the identification within them of the abilities that deserve distinction provides the framework for research on questions in the other two sets, as well as a guide for the design of multiple aptitude batteries for practical purposes. Especially with the computerization of such batteries now under way, a solid justifiable framework is sorely needed. The problem has traditionally been addressed using the statistical methods referred to generically as factor analysis. Separable factors in the correlation matrices for mental tests identify separable underlying hypothetical ability constructs.

The British factor analytic tradition began with Spearman's g theory: a general intelligence factor can be found underlying all ability tests; any test performance is a function of g plus a specific factor, s_j, unique to each test. There are thus as many specific factors as there are tests; but g is seen as the essential, and largely inherited, ability--it is the mental "energy" of the cognitive system, while the specific factors are the myriad mental "engines" through which it operates. But the British tradition soon incorporated the Galton-Burt notions of a hierarchical structure, perhaps reflecting neural differentiation. It also heeded, without fully adopting, Thomson's looser and less physicalistic interpretation of test performances as mainly providing samples of the multitude of mental operations (then called "stimulus-response bonds") that are built up in the cognitive system through a person's learning history. Factors thus provide classification principles for grouping tests that draw similar samplings, but they do not necessarily identify distinguishable underlying unities or "vectors" of mind; g nonetheless is the general underlying cause of it all. The hierarchical model provided by Vernon is the most widely accepted version of the British hierarchy (see Figure 1). Spearman's g stands at the top, with major group factors representing the broad distinction between verbal-educational tests (v:ed) and spatial-mechanical tests (k:m) next; various minor group factors such as verbal comprehension (V), numerical ability (N), inductive reasoning (I), spatial orientation (S), and perceptual speed (P) next; and specific factors at the bottom.

The US tradition concentrated on the minor group level elaborating through the work of Thurstone, then Guilford, and many others, a long list of primary abilities which *were* interpreted as distinct underlying functional unities or dimensions of mind. The extreme of this position, Guilford's Structure of Intellect model, posits over 120 orthogonal abilities at the minor group level without hierarchical groupings. Although regarded as a good search model--that is, an aid in hypothesizing about ability distinctions that may turn out to be useful--as a theory it is now widely criticized as overly differentiated, subjective, and chancy. Among the more substantial empirical

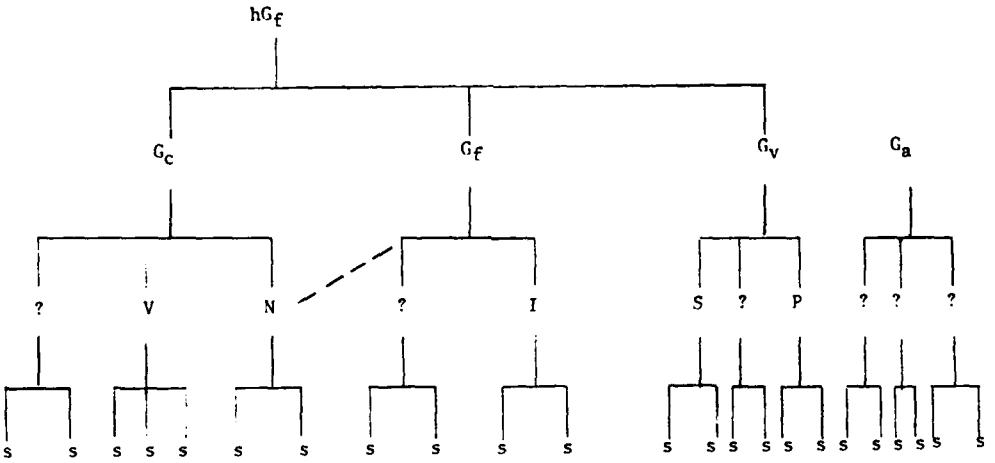

Figure 2. The Cattell-Horn hierarchy of ability organization.

criticisms of the Guilford model is the work of the Norwegian, Undheim (see Undheim and Horn, 1977; Undheim, 1979). He and others have shown convincingly that the Guilford model stands on a crumbly foundation.

It is now widely accepted that some form of hierarchical model works best for both theory and practice. But what hierarchy? R.B. Cattell, an Englishman turned American, contributed an attractive alternative to the British hierarchy now called the Cattell-Horn theory of fluid and crystallized intelligence (see Figure 2). It posits three major kinds of general intelligence: G_f, for fluid abstract-analytic reasoning ability; G_c, for crystallized intelligence derived from the investment of G_f in meaningful learning, particularly verbal and mathematical school learning; and G_v, for spatial visualization ability. Beneath these are the lower-order abilities of Thurstone and Guilford. Above them is what Cattell would prefer to call historical G_f, not Spearman's g, because the G_fG_c distinction is seen as a splitting of g. Provision is also made for the identification of some other general functions--G_a for general auditory perceptual ability, for example--as research continues. The Cattell-Horn hierarchy has lately come to the fore in US work, and it is increasingly used to guide current information processing research aimed at the questions of the third category.

Some recent Scandinavian studies by Undheim (1981a) and by Leino (1981) in Finland also show the Cattell-Horn framework, at least in broad outline. But Undheim (1981b, 1981d) has now advanced a reinterpretation of the G_fG_c theory he calls a neo-Spearman view; G_f = g and G_c should be more narrowly interpreted as the accumulation of verbal-education skills, strategies, and knowledge. He has reported his own data and reanalyses of Cattell-Horn data to support this view. He rejects, however, the Spearman and Cattell interpretations of g or G_f that posit some kind of neuropsychological or neogenetic energy, power, or capacity. Instead, the Thomson sampling theory (as currently interpreted in US research by Humphreys) is used by Undheim to argue that intelligence is achievement, not definable apart from its acquisition in a surrounding social-cultural context.

Meanwhile in Sweden, Gustafsson (1982a, 1983; Gustafsson, Lindström, and Björck-Åkesson, 1981) has come independently to the view that g = G_f and has taken the important further step of demonstrating this with the most general and powerful statistical method now available for the purpose--the LISREL method developed by his countrymen, Jöreskog and Sörbom (1978, 1981). Unlike the many earlier factor-analytic methods--which were good only for exploratory, hypothesis-generating purposes and involved many method-specific complications--LISREL provides a confirmatory method of estimating and testing alternative factor models, using maximum likelihood procedures. It allows hierarchical models and combines factor analysis with path-analytic techniques. Applying the method both to Undheim's data and to a large data set of his own, Gustafsson shows clearly that g is the same as G_f, which in turn is also essentially the same as I (the Thurstone inductive reasoning ability at the minor

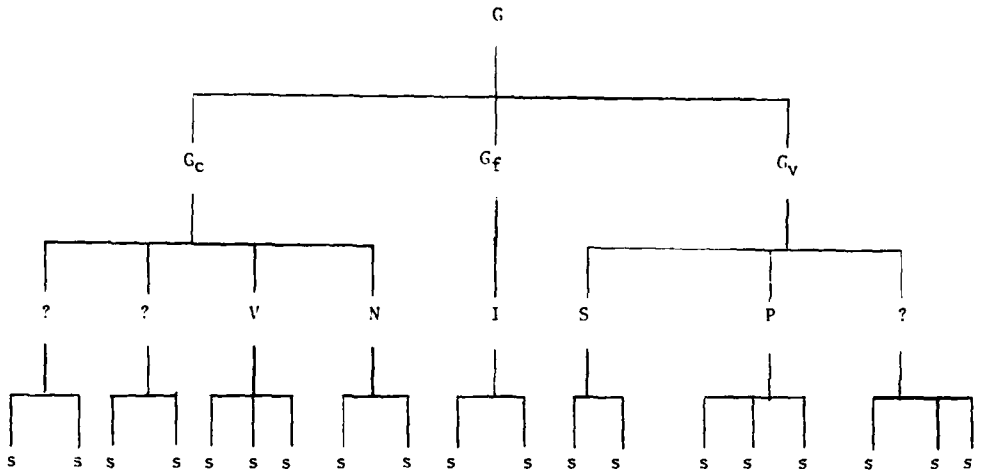

Figure 3. The Gustafsson-Undheim hierarchy of ability organization.

group level). He thus reaches a unique kind of parsimony and undercuts some US attempts to interpret the three as different in process terms.

Figure 3 shows Gustafsson's result, which is essentially the same as Vernon's hierarchy of Figure 1. Note that the interpretation of the major factors in the two cases may be slightly different because the methods used by the British and by Gustafsson distribute variance a bit differently. The most compelling conclusion for the present, however, is that Vernon was essentially correct.

There is a methodological message also in adopting the Vernon-Gustafsson hierarchical model. For several years, some US investigators have recommended simplifying and orthogonalizing aptitude dimensions for various research purposes by taking a G principal component and then a bipolar G_c-G_v factor to contrast the two main classes of special abilities. The Gustafsson results now justify this practice on new substantive as well as methodological grounds, and a good example of the value of this practice in further research is given in the next section. The results argue against using other kinds of contrasts, such as G_c-G_f, except for the rather special purpose of examining the specific verbal knowledge component of G_c that is left over when G variance is extracted from it; G_c-G_f is clearly not the same contrast as G_c-G_v.

Intellectual Development

A vast literature demonstrates that intelligence measures administered at one point in time predict educational and occupational achievements at later points in time. Causal networks for these relationships have also been developed and substantiated. But those supporting the Cattell-Horn theory of G_f as prior to G_c in cognitive development have now been questioned by other Undheim studies (1981c). He argues from these data that G precedes both and that the evidence supporting the hypothesis of G_f investment in G_c is due to the verbal knowledge component of G_c only, and to the interest and motivational aspects of G that are involved in acquiring it.

The research on intellectual development in hand, including the Undheim work just cited, has mostly been conducted on children and high school students. The transactive relationship of educational and occupational experiences through young adulthood has long been a matter of doubt and dispute, enlightened by rather little data. Early Swedish studies by Husén (1948, 1950) and Härnqvist (1959, 1968) suggested that the longer the educational experience, or the higher the level of educational experience reached, the more positive change in G measures could be observed. Higher social class and certain regional factors contributed to intellectual development, too--probably by influencing the quantity and quality of educational experience gained both at school and outside it. But the methods used were open to some criticisms, and occupational effects on intelligence could not be investigated in the early Swedish work in any event, nor anywhere else for the most part.

However, Härnqvist's research was conducted within a longitudinal project, following a 10-percent sample of all

Swedish males born in 1948 and 1953. Test, questionnaire, and performance data were collected when the samples reached 13 and 18 years of age, but also when they entered military service and again in 1980. During the period of study also, the Swedish schools were reorganized, changing from a more selective, streamed system to a comprehensive system with delayed selection. This afforded educational-experience comparisons reflecting both level of education and type of educational emphasis--verbal-theoretical versus spatial-technical.

A report by Balke-Aurell (1982) now summarizes the past research on these samples and provides new analyses with several important implications regarding cognitive development. Consistent with the Vernon hierarchy (of Figure 1) and thus with the Gustafsson-Undheim hierarchy (of Figure 3), Balke-Aurell first formed two factors--one for G and the other for the bipolar contrast G_c-G_v. She then was able to demonstrate, using a combination of multiple regression techniques and the path-analytic features of LISREL that the higher the educational level the more positive the change in G. In addition, Balke-Aurell found that, especially among the sample remaining in school to age 18, those pursuing lines of education with a predominantly verbal emphasis show more change toward the G_c end of the bipolar factor, whereas those pursuing more technical lines of education show more change toward the G_v end of the bipolar factor.

The results with respect to the relative verbal versus technical emphasis of occupational experience were less clear but ran in a similar direction: occupational work demanding verbal functioning results in verbal development; work demanding spatial-technical functioning results in spatial-technical development. It is difficult to separate in these patterns, however, differences in occupational experiences and differences in the educational experiences that preceded them. There are also indications in the data that spatial-technical experience is more concentrated and thus provides more specialized change in ability, whereas verbal experience is more pervasive, affecting persons in both lines of educational and occupational emphasis, which results in less verbal difference between persons pursuing either line. Finally, evidence was presented to suggest that social class differences act indirectly by influencing educational level rather than directly on G development.

The Swedish longitudinal study continues to support other important studies relating intellectual development and higher educational attainment to social and economic as well as educational and occupational variables. Only a few such studies are added in here to show the potential of the project. Readers interested in this line of work can expect much more to come.

One analysis, by Gustafsson and Svensson (1982), both clarifies and complicates the Confluence Model of family size and birth order influences on intellectual development that has been of great interest in the US in recent years (Zajonc, Markus, and Markus, 1979). In brief, that theory states that, within a family, the intellectual growth of offspring will be a function of the average of parents', siblings', and their own intelligence (represented on an absolute scale). As persons enter and leave the family intellectual environment, the average intellectual level of that environment changes--increases as there are fewer or more spaced offspring, and decreasing as adults or mature offspring depart or new offspring are added, particularly if these new arrivals are closely spaced in age. The model thus predicts lower intellectual performance for offspring in larger families--especially for those standing lower in the birth order. Special positive effects are also predicted when older siblings teach younger siblings; thus only-children and twins are predicted to show lower intelligence, on average, than the oldest of two siblings or the first two nontwin siblings, respectively. The model has been shown to fit many large data sets now in hand.

The Gustafsson-Svensson study also uses a large data set. Furthermore, it includes a family socioeconomic status index, a multivarate conception of intelligence reflecting the major group distinctions of Figure 3 (although tests rather than factors were analyzed), and uses more sophisticated analytic techniques than has previous work. It also offers, incidentally, an excellent technical comparison of alternative methods for studying the complex interactions--including curvilinear and higher order interactions--often expected in behavioral science but rarely tested. Even with the birth-order aspect of the model disregarded, several results are striking.

First, socioeconomic status (SES) had a strong effect on G_c abilities but not on nonverbal abilities, and the trend was curvilinear--i.e., higher socioeconomic levels showed even more

advantage over lower socioeconomic levels than would be predicted by a linear relation between SES and ability. The SES index used here reflected both educational level and occupational status of the family. Second, the relation between number of siblings in a family and G_c variables was linear and negative; for nonverbal abilities it was curvilinear such that higher ability scores were obtained for intermediate size families. The Confluence Model's indication of special handicaps for only-children and last-born children may thus apply to nonverbal abilities, because the special-teacher function hypothesized in the model may operate especially between older and younger siblings in two- or three-sib families in the spatial manipulatory and mechanical domain rather than in the verbal domain. In the latter, parents may be the primary teachers so there is no handicap for only children here. Third, there was consistent interaction between SES and family size in predicting ability scores, and this is not a prediction of the theory. It is a reasonable effect, however, since large family size could be expected to have less negative effect in high-SES than in low-SES families, especially if higher SES brings a higher quality of intellectual interaction between children and parents or other adults--such as teachers, service people, and representatives of other socializing agencies. The conclusion, at any rate, is that the Confluence Model applies well to lower SES families but less well to higher SES families. Fourth, data on entrance into and graduation from higher education were also analyzed; family size related positively to these variables among higher SES families (a finding inconsistent with the Confluence Model) but negatively to these variables (as expected) among lower SES families. The interaction can perhaps be accounted for, however, if the economic environment of the family can be brought into the model. Finally, when the data were analyzed with respect to higher-order interactions involving sibling gender, it was found that males showed a particularly strong advantage in spatial ability if they came from a high SES, low-sib-size family. Perhaps a larger number of siblings in a family reduces the effect of differential socialization practices related to the development of spatial ability.

Some other related studies based on the longitudinal project have also been able to show that access to and accomplishment in higher education can be a function of personal, social, and institutional factors. Svensson (1979) divided the project sample into 10 intelligence levels and five socioeconomic levels within each of these. It was clear that, within intelligence levels, college attendance and completion still depended heavily on social class. The data suggested that social class and intelligence interact to predict college starts, and do so somewhat differently to predict college completions. But the analyses were not geared, in this report at least, to test such interactions. Ambition, or motivation to achieve, was also estimated by comparing intelligence and achievement scores; the implication was that students of all social groups who completed a higher education degree were especially those whose educational achievement by age 13 exceeded what would have been predicted on the basis of their intelligence scores at that age. Reuterberg and Svensson (1983) have shown further that the social class bias in higher education attendance and completion is substantially reduced by the existence of the national financial aid system now operating in Sweden.

Process Analyses of Ability Differences

The hottest topic in recent years in US differential psychology has been the construction of cognitive process models of ability differences. The US Office of Naval Research has supported some of the best of this work; there have been several productive lines of study and many interesting findings. The questions in this set have been opened up by this effort, but hardly answered at this early date. The Scandinavians have also now contributed.

Leino's (1981) work has sought to identify processing activities and strategies in mathematics problem solving, using think-aloud methods, with Finnish school students. Included in the study were several minor group-ability factors previously found related to mathematics achievement, and also attitude and achievement measures. The process measures reflected differences in *obtaining information* from the problems (e.g., perceiving given facts and figures, seeing embedded geometric cues, grasping the formal structure of the problem); *processing information* (e.g., using trial-and-error methods, using particular notation and forming equations, drawing inferences, changing direction or curtailing reasoning, making figures as an aid); and *retaining and recalling information* (e.g., recalling terminology, formulas, and problem types).

Correlational and path analyses showed substantial relationships among ability, process, and achievement variables. Of particular interest were the ability-process results which Leino interpreted as corresponding to some of Carroll's (1976) hypotheses. He was able to show that some ability distinctions seem to reflect process differences. Measures of deductive reasoning ability related to processing time and curtailing reasoning in the think-aloud protocols, for example; whereas inductive reasoning ability related more to drawing inferences, forming generalizations, and changing direction in problem solving. Fast perceiving of embedded geometric information was related more to spatial visualization ability than to spatial relations ability. The correlations for verbal ability were low, with no relation to processing time, in contradiction to some previous results.

Comparisons between good, average, and poor achievers suggested that good achievers on average show higher ability in general but particularly in deductive reasoning and numerical ability; they work rapidly, seldom using trial-and-error or drawing methods. The profiles of these students, however, indicated two different types of mathematically capable individuals, characterized as geometric versus analytic types, and this distinction has also appeared in Russian research on mathematical abilities. In contrast, poor achievers--though not low in all abilities--did show notable deficiencies in inductive reasoning and visual-spatial abilities; their think-aloud protocols suggested particular inability to discover the macrostructure of problems or to analyze problems by forming equations or drawing figures. Although the sample used here was small, Leino's research is continuing to follow these leads in further studies designed also to investigate ways to help students monitor their own cognitive operations in problem solving.

Following several earlier studies, Gustafsson (1982b) has also conducted new work that contributes to process analyses, particularly of the distinction between verbal and visualization abilities in reading and listening. He also provides an excellent demonstration of how to use LISREL methods to study aptitude-instructional treatment interactions.

His instructional treatments contrasted reading versus listening to material on heart function and blood circulation, crossed with illustrated versus nonillustrated presentation. Learning-outcome measures also distinguished verbal versus pictorial performance, and separated out for special attention verbal performance on material thought to be particularly spatially demanding. The theoretical framework available from previous research would predict that the processes involved in reading and in visualization should be incompatible, either because both are visual processes competing for the same information processing resources and so cannot be performed simultaneously, or because reading forces automatic verbal processing that interferes with the organization of internal spatial representations. Listening to instructions rather than reading them should avoid this incompatibility or reduce the interference, though it may introduce other demands.

The results were partly consistent with the initial framework; reading was found superior to listening for verbal learning, but it adversely affected performance requiring pictorial interpretation. Also, high G_v ability was required in illustrated treatments if the learning of illustrations was important for criterion performance. However, the relation of G ability differences to learning was stronger with listening than with reading, particularly on pictorial outcome measures. This was interpreted to mean that the sequencing and interrelating of processes required in instruction that combines auditory-verbal and visual-pictorial information places a processing burden on learners that only the higher G students can meet.

Interpretation was further complicated because results were dramatically different for males and females. And it was the females that produced most of the complex interactions. Using previous research on cerebral hemispheric lateralization in males and females as well as the performance results here, Gustafsson proposes a formulation that deserves further research in its own right, as well as attention by other researchers who tend to mix genders indiscriminately in cognitive process analyses of individual differences.

It is usually assumed that for most persons (at least, right-handed persons) verbal-logical processes are localized in the left cerebral hemisphere, whereas holistic-spatial processes are localized in the right cerebral hemisphere. Some studies also suggest that females may be less lateralized with respect to these functions than males. Gustafsson's hypothesis (and it is consistent with some other work) is that females are more heterogeneous than males with respect to lateralization; some females

are as completely lateralized as males are usually shown to be, whereas others are much less lateralized and thus tend to perform both visual and verbal tasks using the verbal-logical processes of the left hemisphere. Also, degree of lateralization among females is positively associated with performance on G and G_v ability measures. Thus, learning that requires audio-visual processing requires both efficient lateralized processing and coordination of the two types of processing. G and G_v ability measures will thus predict achievement especially for females. Pure reading treatments, or other tasks that can be approached with purely verbal processing, may show stronger ability-learning relations for males; they should show less ability-learning relation for females.

Summary and Implications

What messages are there for US research, and particularly for Navy-related research, in all this? I draw 10 such messages; these are admittedly shaped and embroidered by my own theoretical preferences and speculations, and by the results of other recent research, including my own, not explicated here.

1. Cognitive differential psychology still has a lot of work to do. Work in this field progresses in Scandinavia, and US investigators should pay attention to it.

2. LISREL programs and the literature pertaining to them should be obtained, studied, and applied widely in US research. LISREL provides the power to find convergence in the diverse findings that have plagued us.

3. The implications of the Vernon-Gustafsson-Undheim hierarchical model of ability organization should be carefully considered in process-analytic research; in the conduct of data analyses for a variety of instructional, developmental, and training evaluation studies; and in the design of aptitude assessment batteries for use in practice. In particular, analytic experiments, data analyses, and computerized adaptive test batteries now under construction should be focused primarily on distinguishing and explaining the $G \times (G_c - G_v)$ aptitude space.

4. Process-analytic research, in particular, should be addressed to the hypothesis that $G \equiv G_f \equiv I$, and to the explanation of how G interacts with special abilities to produce any kind of test performance. An adequate theory of intelligence is unlikely without this.

5. In this connection, the sampling theory of intellectual task performance deserves much more attention. In US research, it is apparent only in Humphrey's work (see, e.g., 1981) and in my own (see, e.g., Snow, Kyllonen, and Marshalek, in press). Yet it should ultimately prove more adaptable than other views to both the theoretical and the practical needs of aptitude theory (see Snow, 1983). Certainly in applied work it is the case that, given a reasonable job analysis and criterion measure, one samples from the commonwealth of knowledge about individual differences to identify tasks that one thinks sample skills close to those critical for job success; predictive validity proves the success of this sampling. The theory should follow and explain this tried and true practice.

6. Cognitive developmental research among children and adolescents had better consider both the Cattell-Horn and Vernon-Gustafsson-Undheim models in collecting and analyzing data. Some significant distinctions between these models may well be found here. The Confluence Model also deserves study in the same context; G_c and G_v development may be differentiated in part by sibling experiences. And indices of family organization may be predictive of performances in early adulthood.

7. Cognitive developmental research among late adolescents and young adults had better be ignored no longer. For military, educational, and industrial purposes, it is important that we understand the extent to which educational and occupational experiences shape and develop ability organization. The evidence in hand suggests that it does so by specializing abilities already manifest; abilities long unused in a specialty, however, may atrophy. On the other hand, too rapid a shift from one specialty to another may produce development in no abilities. There seems to be no research on military specialization from this point of view.

8. Neither has there been research on the social effects of selection on ability or of the effects of educational and occupational choices on differential ability development. There is a talent pool--a collective intellect--in a society that is influenced by all this. There are social class and economic effects that may interact to produce different ability organizations at different educational levels and thus at different social-class levels. When one selects military officers at a particular level, what other average strengths

and weaknesses is one selecting? Career choice and career development at and from different age, ability, and socio-economic levels is not well understood at present.

9. Gender differences are not just group differences on average; there are individual differences within groups, and these may relate to family configuration, such as number of siblings or birth order; neuropsychological organizational variables, such as degree of hemispheric lateralization; and many other variables. Simple average comparisons of males and females are short-sighted, but so are routine analyses that ignore gender differences; there may be fundamental differences in ability organization among significant subgroups of each gender group.

10. Instructional and problem-solving research benefits from description of the processes, activities, and strategies used by learners during learning and problem solving. These may reflect the manifestations of ability differences rather than a distinct category of underlying variables.

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2/23/84

TOWARD A *PSYCHOLINGUISTICS OF* ORAL DISCOURSE: COMPREHENSION AND MEMORY IN CONVERSATIONS

by Richard E. Snow.

In the military world, as well as the worlds of business, government, education, and everyday life, oral discourse between humans remains a central communications medium. Even with the rapid advances in communications technology and artificial intelligence, it will likely always remain the medium of last resort. Detailed comprehension of and memory for what is said in conversations is often important; sometimes it is absolutely crucial.

It is therefore disquieting to think that relatively little research in *modern* cognitive psychology and psycholinguistics concerns this medium, and that we know relatively little about it as a result. Consulting recent discussions of issues in contemporary psycholinguistics research, such as the excellent chapter by Flores D'Arcais and Schreuder (1983), confirms the suspicion; Flores D'Arcais is an Italian psycholinguist now Professor of Psychology at the University of Leiden, The Netherlands, and an associate of the Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands (see *ESN* 84-1:1-3 [1984])--he is not only a leading scientist in this field but also well connected with both US and European research.

That review characterizes research on language *processing and understanding* on three levels. The vast quantity of research has focused on the levels of *word recognition and sentence* understanding. The level of discourse processing has only recently received attention, and most of the attention has concerned processing text, not oral discourse. When oral discourse is studied, it is usually in the form of well-constructed verbal messages or stories--not naturally produced, extemporaneous discourse. Furthermore, the theories of text processing, text comprehension, story grammars, and the like, all make roughly the same assumptions: the structure is assumed to be hierarchical; the text is represented as an organization of propositions and inferences in this structure; propositions high in the hierarchy are predicted to be more central to the conceptual meaning of the text and more likely to be recalled. The emphasis of these theories tends to be on representing the main meaning or gist of the discourse--the deep structure, not the surface structure; the theoretical notions of "semantic network" and "schema" are often used. Underlying all of this seems to be the assumption that there is no such thing as a stable verbatim memory for verbal discourse; literal recall is unimportant (e.g., Anderson, 1980; Bartlett, 1932).

One contemporary researcher who *has* studied naturally produced oral discourse argues strongly that these assumptions should not be carried over from research on text processing, and that they may be wrong even in that context. The intentions of the participants, the use of partial or ill-formed statements, and various contextual factors make natural oral discourse quite different from written text. The researcher is Erland Hjelmquist of the

University of Göteborg, Sweden, whose experiments show, among other things, the importance of verbatim memory in oral communications.

In one Hjelmquist experiment, 24 college students were paired to form 12 dyadic conversations; they were asked to discuss recent political events in Sweden (*Discourse Processes*, in press). The conversations were tape-recorded and interrupted after 5 minutes. Later, for each subject, paraphrases of five utterances were constructed, five actual utterances were selected, and five new utterances not included in the conversation but on the same general theme were created. These were then inserted into typescripts of the dialogues and presented to the subjects 4 days later. They were asked to judge for each utterance whether it had occurred in the earlier conversation and how sure they were of their judgment; they also indicated whether their decision was based on form, content, or both. Each subject thus judged 30 utterances, 15 purported to be their own and 15 their partner's.

Results clearly showed verbatim memory for surface form and content; ratings for paraphrases were lower than ratings for actual utterances, and both were higher than ratings for new utterances that had not occurred before. Subjects gave lower ratings for new utterances purported to be their own than they did for those purported to be their partner's utterances, but higher ratings to their own actual utterances than to their partner's. Control studies verified that the paraphrases and actual utterances expressed the same content and assured that the paraphrases and new utterances did not contain cues that would have made them appear unlikely to have occurred in the dialogues.

A second experiment followed the same procedure but presented only the 30 utterances of interest in a list, not in the context of the whole dialogue transcript as before. Essentially the same results were obtained; there was clear evidence for memory for content and for surface structure. When the two experiments were compared it was seen that the reduction of context (i.e., retrieval cues) resulted in lower ratings on average.

The two experiments thus show that people exhibit considerable recognition memory for surface structure as well as content used spontaneously in conversation, even though the conversation lasted only 5 minutes and took place 4 days earlier. The subjects had not known their memory would be tested. Some other experiments (Hjelmquist and Gidlund, 1983) have shown the same phenomena using recall techniques. This sort of memory is not considered in the abstract conceptual theories of memory or language processing that are currently popular.

Memory for surface form and content is one thing, but the argument goes further. The large differences in speaker versus listener conditions reflect the speaker's own knowledge of what might have been said and also the way it might have been said. Speakers may know what their intentions were, and their own styles and language habits, but they may also be able to reconstruct these aspects of conversations through verbatim recall. Also, much research in psycholinguistics, cognitive psychology, and artificial intelligence seems to require that people have already internalized conventional schemata for stories, narratives, and a variety of other kinds of discourse, so that a conception of the message when received can be constructed using these structures. But extemporaneous conversations seem not to have such conventional schemata, except in a very abstract sense; they may have only a beginning, middle, end, and some sense of turn-taking. In many, even a conventional ending may not be orally expressed. It seems that memorization of oral discourse cannot rely on conventions, but must be flexible enough to allow construction of meaning during the course of conversation without previously set schemata or networks. Hjelmquist (*Studies*, in press) thus seems to argue that a mental model of a conversation must be built *on line* and likens such models to the theoretical notions of Johnson-Laird (1983) in England. Johnson-Laird's mental models mimic reality and can include verbatim memory and surface structure as well as deeper abstractions. They need not be bound, however, by the structures of schema theory or semantic network theory. The mental model concept thus provides a more adaptive, flexible structure for mental representation than cognitive science has assumed heretofore.

Flores D'Arcais and Schreuder (1983) note that research in psycholinguistics has lately been moving away from linguistically based theories and toward psychological theories, away from algorithmic theories toward those characterized by the use of heuristic strategies, toward theories that include the perception of background knowledge and context, and toward the study of *on-line* rather than *off-line* cognitive processes. All these movements suggest

that new research will soon be grappling with the complexities of natural oral discourse and its processing. The sooner the better.

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BIOLOGICAL SCIENCES

GERMAN RESEARCH CENTER LEADING CELL-ELECTROFUSION RESEARCH

by Thomas C. Rozzell. Dr. Rozzell is the Liaison Scientist for Biological Sciences in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until August 1985 from the Office of Naval Research, Arlington, VA, where he is Program Manager for Cellular Biosystems.

The fusion of animal and plant cells has been shown in recent years to have great potential in a number of areas, such as membrane structure research, membrane reconstitution, and genetic mapping. Indeed, cellular fusion is the fundamental process of the new science of biotechnology in which lymphocyte (or other) cells are fused with a permanent cell line to form hybridoma cells capable of producing monoclonal antibodies of predetermined architecture. These hybridoma cells are considered important tools in future clinical diagnosis and therapy as well as in the purification and enrichment of a number of compounds of biological and medical interest.

Cell-to-cell fusion is generally achieved *in vitro* by chemicals (such as poly(ethylene glycol)), by inactivated virus, by freezing and thawing, or by other drastic physical methods. In each case, the membrane is disrupted. Even though promising results have been obtained with these methods, science is still a long way from understanding the underlying molecular mechanisms of the fusion process. The current fusion techniques have a number of drawbacks that make it desirable to find a better way to achieve the same result.

It appears that a better way may have been found by Prof. Ulrich Zimmermann and his Membrane Research Group of the Institute for Medicine at the Nuclear Research Center (Kernforschungsanlage) in Jülich, Federal Republic of Germany. Zimmermann's group has patented a method that uses pulsed electric fields to rapidly and gently fuse like cells to form giant cells, and unlike cells to form hybrids. Further, they have been able, using electric fields, to open cell membranes and encapsulate substances such as drugs within the cytoplasm and have the cells reseal themselves with no apparent detrimental effect on the cell membrane.

Most cells in suspension, being electrically neutral, will not tend to come into close membrane contact with other cells. More than 25 years ago, a US Office of Naval Research contractor, Herman P. Schwan, noticed that individual cells in a nonuniform field form chain-like aggregates and align themselves adjacent to each other along the direction of the field--much in the manner of pearls on a string (Schwan, 1957). This was called the "pearl chain" effect and has been much observed and reported in many bioelectromagnetics studies.

In the presence of a nonuniform electric field of the proper frequency, cells not only become polarized and form pearl chains, but also rotate in response to the field. This overall behavior of cells to a nonuniform electric field has come to be called dielectrophoresis (Pethig, 1979; Pohl, 1978).

The term dielectrophoresis should not be confused with electrophoresis.

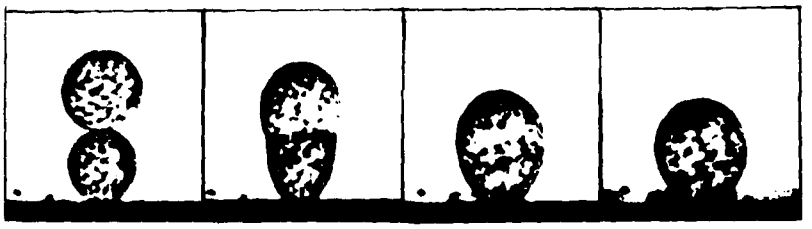

Figure 1. Cell-fusion stages as viewed under the microscope, from initial contact through complete fusion.

While both imply the study of motion, dielectrophoresis is concerned with the motion of neutral (rather than charged) particles in a nonuniform field. Further, in contrast to electrophoresis, dielectrophoresis occurs in an alternating-current field. As in all polarization processes, the force is proportional to the square of the field strength (Pethig, 1979; Schwan and Sher, 1969). Dielectrophoresis (particularly of small cells) usually requires quite divergent fields for a strong effect. While electrophoresis is independent of particle size, from atoms up to macromolecules, dielectrophoresis gives rise to a force that is proportional to the particle volume.

Another fundamental difference between electrophoresis and dielectrophoresis is that the latter phenomenon requires a substantial difference in the relative permittivities of the particle and the surrounding medium (Pethig, 1979; Pohl, 1978). The dielectric properties of living cells are a function of frequency, and there are three distinct regions--termed α-, β- and γ-dispersion--in the frequency ranges between 1 and 100 MHz (Schwan, 1957). Also, the conductivity increases with increasing frequency. The dielectrophoresis force is thus a function of frequency.

One of the most interesting aspects of the movement of polarizable cells toward the region of high field intensity is that the cells will tend to contact each other as they form the pearl chains. The forces of attraction arising from the dipole generation in each cell overcome the electrostatic repulsion between the apposed membrane surfaces bearing net charges and the repulsive hydration force. It is this critical contact between the membranes of cells under the influence of dielectrophoresis that has led to an innovative application of electric fields--that of fusing of cells without changing their overall function or without irreversibly degrading the membrane.

The Zimmermann electrofusion technique requires, first of all, very close membrane contact between cells. Thus, in the first stage of the process, a low-intensity, alternating-current field (e.g., 10 to 100 V/cm, depending on cell size) is applied to the cell suspension until the pearl chain aggregates are formed. Point-to-point contact is achieved between adjacent cells in a pearl chain, as shown in Figure 1a. As a general rule, sufficient membrane contact for subsequent fusion is achieved when one can observe a flattening of the membrane contact zones under a microscope, as in Figure 1b.

Once the cells are in close contact, the actual fusion process is triggered by one or more high-intensity, direct-current field pulses of 3- to 50-μs duration (depending on the cell types). This type of pulse causes a temporary breakdown in the membrane of the cells. The field strength required for breakdown is about 0.5 to 10 kV/cm, depending on cell size. The actual breakdown voltage at the level of the cell membrane for living cells is on the order of 1 V. The electrical breakdown of a viable cell membrane causes no irreversible changes in the cell membrane or the cell itself, if the pulse length is less than about 100 μs (Zimmermann et al., 1980 and 1981).

Electric breakdown opens pores in the membrane which, in free cells, soon close after a certain, experimentally adjustable time period, so that the original impermeability and high electrical resistance of the cell membrane are restored. The pores are formed in membrane sites oriented in the direction of the field, i.e., at the "poles" of the cells. When a critical field pulse is applied to cells in a pearl chain,

pores are induced in the membrane at the contact zones since these are oriented in the field direction. The pores in the two membranes are apposed so that there is cytoplasmic continuity between the two adjacent cells. In contrast to the situation in a single cell, the randomly distributed lipid molecules in the pores of the adjacent cells do not return to their original bilayer structure. Instead, the process of bilayer-bridge formation between the apposed membranes seems to be favored so that membrane continuity is maintained between the cells in the contact zone. As a rule, more than one pore is formed in the membrane contact zone, because it has been empirically found that the field strength for fusion must be a factor of 1.5 to 2 higher than the corresponding critical field strength. If this mechanism is correct, as Zimmermann believes it is, there should be formation not only of a membrane continuity but also of vesicles within the contact zone. Vesicle formation may be an important process for the removal of extraneous and superfluous membrane material (Vienken et al., 1983). The fused product of two cells has a volume whose sum is the sum of the individual cells and a smaller surface area than the parent cells (Zimmermann and Vienken, 1984).

The formation of membrane continuity is the decisive step in the process of electrofusion. In the subsequent stages, the spherical shape of the fused cell is restored without further input of energy. These final stages can be seen in Figures 1c and 1d. The proposed mechanism of electrofusion suggests that the loss of intracellular material from the cell during fusion should be minimal. The higher the number of cells fusing in a pearl chain, the smaller the loss--since mass exchange between the cell and the external medium through the breakdown pore can only occur in cells at the ends of the pearl chains. In addition, the external presence of isotonic nonelectrolyte solutions prevents the loss of intracellular substances during electrofusion, in contrast to chemically and virally induced fusion techniques. In experiments with electric breakdown of human erythrocytes suspended in nonelectrolytes such as sucrose or insulin, Zimmermann has shown that there is considerable delay in the loss of hemoglobin at a given field strength. In this case, higher field strengths are necessary to induce a rapid loss of hemoglobin because nonelectrolyte solutions prevent the osmotic processes that would occur from the increase in membrane permeability.

Nonelectrolyte solutions are also used because of their low conductivity. If alternating current is applied to conductive solutions in which cells are suspended, heating problems and their resultant turbulences would severely disrupt the pearl chains and the membrane contact between the cells.

On the other hand, Zimmermann and his coworkers have carried out the electrofusion of cells of a permanent cell line in the presence of an electrolyte solution by applying a sequence of direct-current pulses in the dielectrophoresis step instead of an alternating-current field. It was necessary to alternate the polarity of the pulses, however, to avoid electrolysis and electrophoresis. Heat production is considerably reduced in pulsed fields. Since there is practically no current flow in an nonelectrolyte solution, electrofusion is clearly attributable to electric field effects.

The electrofusion technique can also be used for producing heterokaryotic hybrids. High yields are best achieved by using low suspension densities to enhance the formation of two-cell aggregates. If the two parent cells, A and B, are mixed in a 1:1 ratio, the probability of A-B combinations theoretically should be 50 percent. In some cases the yield is much higher. In an experiment in which a mixture of human myeloma cells and lymphocytes were fused, there was practically no fusion of lymphocytes to each other, and the final products contained a high proportion of hybridoma cells.

The production of mouse and human hybridoma cells by electrofusion is particularly notable because of the wide range of possible applications. The yield of viable products is very high with the electrofusion method, especially in the production of hybridoma cells. It is not certain yet, but this procedure could be well suited for large-scale production of monoclonal antibodies. To obtain large-scale production of hybridoma cells, Zimmermann recommends the use of the flow system shown in Figure 2.

Electrofusion has also been used successfully for the fusion of animal cells and of sea urchin eggs. Zimmermann and his group showed that the latter undergo fertilization after fusion and subsequently divide (Richter et al., 1981). Studies of fused protoplasts of *Petunia inflata* have shown that the fused cells can regenerate their cell wall and divide. Thus, the electrofusion technique offers the possibility of producing plants with new properties.

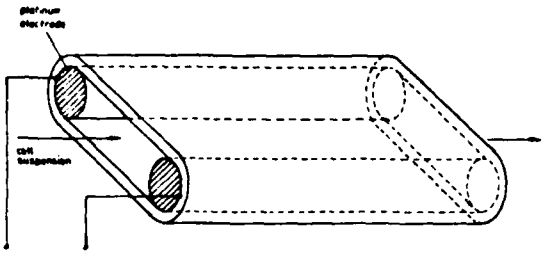

Figure 2. Fusion chamber to achieve large-scale production of heterokaryotic cells by means of a flow system. The chamber consists of a capillary with a bicillary cross section. Two platinum electrodes, whose diameters fit to the minor internal diameter of the capillary, have been pulled through the capillary. The diluted cell suspension is discontinuously pumped into the lumen of the capillary and exposed to the current-bearing wires. In this way, cells may undergo electrofusion.

Electrofusion has also been used with heterozygotic dipliods of the yeast, *Saccharomyces cerevisiae*, in which one of the constituent strains exhibits a mitochondrial respiratory defect and the other has an auxotrophic marker (requiring a special growth factor) in the nuclear DNA. The fusion produced a high yield of viable and reproductive hybrids.

Electric-field-induced inter-kingdom fusion of plant protoplasts with erythrocytes has also been recently carried out in Zimmermann's laboratory. This could lead to the fusion of antibody-producing lymphocytes with plant or bacterial protoplasts which are able to regenerate their cell walls and are much easier to grow than mammalian cells.

In contrast to conventional methods, electrofusion can be used to produce giant cells by the controlled fusion of thousands of cells. The fusion of such large numbers of cells is achieved by using high suspension densities which favor the formation of many pearl chains arranged in parallel and in close contact with one another. With the application of a field having an intensity high enough to cause the breakdown of large membrane areas (up to 80 percent of the total membrane surface), one obtains not only fusion of all the cells within a chain, but also fusion of cells from parallel chains. The latter phenomenon is called lateral fusion. The giant cells appear to be mechanically stable, and it is possible to transfer them to other solutions. Electrophysiological studies of giant cells should help elucidate the electrical properties of many cells or vesicular systems which previously could not be investigated. This technique should also make possible completely new approaches to cancer research and clinical diagnostics (e.g., studies of fused giant cells of sickled red blood cells).

In May, Zimmermann and his entire group, complete with laboratory instruments, are moving to the University of Würzburg in Bavaria, where the electrofusion research will continue, and new applications will be sought for this technique.

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2/10/84

THE BIOZENTRUM AT THE UNIVERSITY OF BASEL

by Thomas C. Rozzell.

The University of Basel, Switzerland, has a research center for biological sciences called the Biozentrum.

The Biozentrum is a teaching and research center training young research workers in several disciplines of biology. This article highlights some recent changes in the administration of the center and summarizes the major research being conducted in the various departments.

The Biozentrum is divided into six departments: Biochemistry, Biophysical Chemistry, Microbiology, Pharmacology, Structural Biology, and Cell Biology. These departments are autonomously administered university institutes, but a committee of all the leaders of research groups in the Biozentrum deals with policy and questions of interdepartmental research, teaching, and administration.

In the beginning of 1982, a policy established a scientific board to provide guidance on research and new projects, and to review the overall programs of the Biozentrum. The board consists of six internationally known scientists; only one--the chairman, Prof. Ch. Tamm--is from Basel. The remaining five members are: Profs. R. Dulbecco (San Diego), E.H. Fisher (Seattle), B. Hirt (Lausanne), D.C. Phillips (Oxford), and P. Starlinger (Cologne).

Eighty to 90 percent of the personnel and operating costs for the Biozentrum come from the Canton of Basel-Stadt and, through an intercantonal agreement, from the Canton of Basel-Land. Most of the remaining funds are derived from grants from the Swiss National Foundation and a few other agencies. Fellowship holders and guest scientists usually bring their own salary support with them when they join the Biozentrum.

The members of the Biozentrum teach at all levels in the University of Basel--not only in strictly biological fields but also in other areas. There are close ties with several other research institutes in Basel, in particular the Basel Institute of Immunology and the Freidrich Miescher Institute. Within the University of Basel, the main teaching emphasis is on the undergraduate curriculum leading to the diploma in biology II and on postgraduate courses leading to the doctoral degree. The diploma in biology II is essentially equivalent to a master's degree in the US. Students may choose from any one of the following discliplines for independent research work during the last two semesters of the eight-semester course of study: biochemistry, biophysics, biophysical chemistry, cell biology, developmental biology, genetics, immunology, microbiology, neurobiology, pharmacology, structural analysis of biopolymers, or virology.

Overview of the Research Programs

Department of Biochemistry. There are three research groups in this department, and most of the work is concerned with the function, biogenesis, and structure of biological membranes. One group, concentrating mainly on several functions of the cellular plasma membrane, addresses questions such as: How can a surface membrane influence a tumor cell to invade healthy tissue and metastasize? How does the cytoskeleton, which is responsible for shape and movement, interact with the plasma membrane? How do cells recognize each other at their surface and thereby form organs?

The second group is studying the transport of proteins into mitochondria. The goal of these studies is to learn how a protein recognizes a particular intracellular target and then penetrates across one or even two membranes. The third group is mainly interested in the mechanism and regulation of eukaryotic protein synthesis initiation. They study the structure and function of individual initiation factors and are currently cloning genes coding for these factors.

Department of Biophysical Chemistry. This department has five groups, primarily focusing on structure-function relationships in biological membranes. One group works on the interactions between active sites in multienzyme complexes and multifunctional proteins. A second group is concerned with ion transport in membranes, while a third has several projects dealing with the physical chemistry of protein-DNA interactions. The structure, function, and assembly of the extracellular matrix of basement membranes and components of the complement system are the main concerns of the fourth group. The final group seems to be primarily interested in the dynamics of the binding of various ions and complexes in the membrane and, lately, in medical applications of nuclear magnetic resonance.

Department of Cell Biology This department claims that their favorite research creatures are frogs and flies. Actually, the researchers dealing with frogs are interested only in the frog's immature ovum, the oocyte, with its giant nucleus and surplus of cellular material. It is with this cell that studies are conducted to attempt to answer such fundamental questions as: How do macromolecules accumulate selectively in the nucleus? How do nuclear and cyctoplasmic components differentiate and get put into the correct place? One approach to some of these questions uses as tools cloned genes

coded for small nuclear RNAs, antibodies from patients with autoimmune disease against these RNAs, and the proteins binding to these RNAs.

The group dealing with flies is concerned with the genetic control of development in *Drosophila*. The researchers have cloned homeotic mutants that transform one part of the body into another part and affect the segmentation of the embryo. Analysis is by a new sensitive method for localizing transcripts in tissue sections.

Department of Microbiology. This is the largest department in terms of research groups, with a total of seven. Such a large department naturally has many research interests. There appears to be a lot of concern with the bacterial cell membrane--its structure, function, and transmembrane proteins. Two of the groups focus a great deal of their energy on analytical methods for biological applications; most of the attention is on development of improved techniques in scanning transmission electron microscopy and on attempts to increase the analytical power of biological electron microscopy. The electron microscopy groups also work closely with other departments, lending their expertise in sample preparation and interpretation.

Department of Pharmacology. There are three major areas of research in this department, but they do not appear to be as sharply divided into groups as the others, primarily due to a recent high turnover and reorganization. The research activities appear to be focused on: (1) molecular mechanisms by which genetic and environmental factors control the biotransformation of drugs and toxic and carcinogenic substances, (2) mechanisms of biosynthesis of digestive enzymes and other components of cells in the intestine, and (3) studies of the molecular defects and clinical implications of certain pharmacogenetic diseases.

Department of Structure Biology. In this department there are two groups, one concerned with animal virology and immunopathology and the other studying structure and function of proteins. Some members of the department have recently begun work on a special cell, the Mott cell. This is a plasma cell with included immunoglobulin and is found in large numbers in the lymphoid organs of animals suffering from autoimmune diseases. The researchers hope that this cell will serve as a model for the transport of secretory proteins in eukaryotic cells.

Research on the structure and function of enzymes is carried out by the protein crystallography group. There is also emphasis on structural studies of membrane-bound proteins. A new computer-controlled graphics display system using a VAX-730 computer was just installed and should greatly enhance studies of the structure of macromolecules.

2/22/84

COMPUTER SCIENCES

COMPUTER SCIENCE AT THE UNIVERSITY OF LIEGE

by J.F. Blackburn. Dr. Blackburn is the Liaison Scientist for Computer Science in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1984 from the National Academy of Sciences, where he is Executive Director, Computer Science Board.

The principal areas of research in computer science at Liège University are computer networks, modeling, and simulation of computer systems, medical diagnosis, cryptography, artificial intelligence and expert systems, and image processing and robotics. The work on computer networks, modeling, and simulation represents a useful extension of work done at the University of Hawaii, allowing the load potential of communication channels to be maximized. The work on automatic processing of written French language and the use of the system for encoding medical diagnoses is unique insofar as I know. Also, the development of a knowledge-based system to assist molecular biologists is different in approach from similar systems. Finally the scientists at Liège have devised a new approach to proving the correctness of parallel programs.

Computer Networks, Modeling, and Simulation

Banh Tri An (1978) has been working on packet switching in computer networks. This investigation began with a study of certain specific aspects of a network of lines, with special attention to the problem of routing. Certain inherent deficiencies in a network of lines were examined for comparison with data communications using a diffusion channel.

After demonstrating the instability of a discrete network, Aloha (a system at the University of Hawaii for use of radio channels in data communication), Banh Tri An proposed several practical control techniques with improved schemes offering quite satisfactory performance.

The replacing of circuit switching with packet switching was motivated by the law of large numbers. The same logic favors replacing conventional networks of lines with diffusion networks. The main motivation is that of accommodating the largest possible number of users and thus increasing the use of the system. At the heart of the group of diffusion networks is the principle of minimizing to the extent possible the probability of collision of packets. Thus we pass from the pure scheme Aloha to the discrete scheme Aloha, reducing by half the duration of vulnerability (propagation time) of a packet and thus doubling the potential use of the channel. The system of explicit reservation replaces the collision of packets by the briefer and less costly (in time) recovery of reservation messages. The monitoring of the carrier avoids all conflict after a minimum time of successful transmission. Finally, the implicit reservation exploits the group nature of the arrivals in certain contexts in order to eliminate all risk of collision when the first packet of a block is correctly received.

The study appears to show that regulation of the volume of the mean traffic around the time to transmit a packet must lead to optimal performance of the channel. This was the chosen scheme of control. This criterion of "traffic unit" allows us each time to maximize the load potential. This maximum load amounts to: $\frac{1}{e} \approx 37$ percent in the completely uncertain scheme of discrete Aloha; 100 percent in the case of completely controlled entries. Between the two extremes, a large variety of control schemes can be elaborated to make use of certain particularities of each case.

However, as long as there is no supplementary channel available upon which the stations can make known their needs and reach a concerted action through negotiation, the principle of random access will always apply somewhere. At this level we reencounter the factor $\frac{1}{e}$, the theoretical limit of the load under optimal control of a random access system and an infinite source.

Banh Tri An notes some advantages of a diffusion network compared with a conventional network of lines:

1. The sharing of the same apparatus of communication by a greater number of users increases the rate of utilization.

2. The characteristics of diffusion and multiple access are highly valued in all applications where one wishes to send the same information to many places or receive on the same channel signals coming from different sources.

3. The absence of material connections is very convenient where access to sites is difficult. The installation of the first network of this type in Hawaii is a specific example. This same characteristic gives substantial mobility to users within the radius of action of the system as well as a greater versatility of the system where it is necessary to connect a new user or drop an old one.

Automatic Processing of Written French Language

D. Ribbens and his colleagues have developed an automatic processor of French language. This processor uses syntactic and semantic information about words in order to construct a semantic net representing the meaning of the sentences. I'll discuss the structure of the network and the principles of the parser and then examine an application to the processing of medical records.

The parser--"Semantic Analyser, Backward Approach" (SABA)--is essentially semantically oriented. The goal is to determine the possible semantic relations between the terms of the sentences. The system tries to characterize the semantic dependence between the complements and the terms which are completed by them (called "completee"). The syntactic subject of a verb is treated as a complement of this verb. The system uses a set of relationships like agent, object, instrument, and locus. The system is similar to the family of case systems using the principle of case grammars (Fillmore, 1968). However, no effort is made to find a complete and minimal set of universal relationships. About 20 relationships with practical usefulness are used by the system.

The grammar of the system has two components, syntactic and semantic, which are used interactively. The system uses a simplified version of a semantic net, which is a set of nodes that may represent the different significant terms of a text or a domain of knowledge. The nodes are interconnected by labeled arcs that represent the semantic relationships established between them.

Four kinds of syntactic units are defined: words, groups, clauses, and sentences. The parsing strategy is defined recursively as follows: for each syntactic unit (except words) execute the following steps:

1. Segmentation of the unit into its own internal syntactic units,
2. Parsing of these internal units according to a definite order,
3. Determination of the semantic relationship between the internal units,
4. Substitution of the given unit, at the next higher level, by a special symbol, which represents the analyzed unit.

A natural language processing system called Diagnoses Semantic Coder (DISC) is used to perform automatically the encoding of medical diagnoses expressed in French. DISC performs a full semantic parsing of the input diagnoses. Its main feature is to integrate morphologic, syntactic, semantic, and pragmatic techniques to produce a "natural language processing expert" in the medical domain. It has been fully implemented in MACLISP, a version of the LISP language, and has been tested on a number of examples. DISC is built around SABA, the general parser of French sentences.

Knowledge-Based Systems in Genetics

A research program is under way as a joint project between the university's genetics laboratory and the computer science department and is intended to produce a new kind of knowledge-based system to assist molecular biologists. The system will be based on advanced artificial intelligence technology.

The analysis work consists of determining the base sequence of some gene and structuring all the information gathered from it. In the synthesis problem the goal is to design a method for the production of some kind of hormone or protein which fulfills some given constraints. This could be called sequence engineering. The two subproblems are: (1) determining what should be the sequence of the gene of the hormone or protein fulfilling the constraints, and (2) designing some process to produce such a hormone or protein.

The plan is to develop an integrated knowledge-based environment for genetics. The system is partitioned into five classes of subsystems called utilities. The central utility is the manager (M), the real kernel of the system as it centralizes all communication between the other modules. The other utilities are dialogue utilities (D), expert utilities (E), computational utilities (C), and ancillary utilities (A).

The dialogue utilities are responsible for the interface with the user. The three main dialogue techniques are natural language, menus, and graphical output. Natural language is the standard input/output language. The expert utilities are the high-level utilities given to help the user. The kind of utility is concerned with knowledge management and use. The computational facilities integrate some of the programs needed for data management and computation. The ancillary facilities deal with low level data-management problems such as access to local or remote databases.

Proving Parallel Programs in an Incremental Way

Most proof methods for parallel programs are derived from the method of inductive assertions used in sequential programming. For various reasons those adaptations were not fully satisfactory. Other techniques, such as temporal logic, were explored by many researchers. The classical nondeterministic model for parallel programming is not always adequate.

At Liège, researchers have investigated the reasons for the evaluation of approaches. They have also shown that the major drawback of classical methods is not their use of a nondeterministic model or inductive assertions, but rather the inadequacy of the translation of these concepts to parallel programs.

A new adaptation of the inductive assertions method was suggested, and its efficiency was illustrated by examples.

The major point of the Liège method is as follows. They start with a condensed version of the program for which the proof is fairly easy to discover (due to the low level of concurrency allowed); then each process is refined--breaking useless critical sections, and increasing the level of concurrency, while maintaining the invariant. The process terminates when no useless critical section is left.

Mutual Exclusion in a Computer Network

A formal proof of the correctness of an algorithm that creates mutual exclusion in a computer network has been developed at Liège. The program designed by G. Ricart and A.K. Agrawala (1981) was rewritten in the formalism of Hoare's communicating sequential processes (1978). The method relies on inductive assertions. Such approaches are now challenged because: (1) in the general case, the invariant

grows exponentially with the size of the program, and (2) there is a lack of suitable methodology for invariant design.

The researchers at Liège do not think the first objection is valid. The size of the invariant reflects the complexity of the program, and the complexity of a parallel program grows very quickly with its size. Moreover, the length of a parallel program proof is far less critical than the time needed to design it; therefore the main goal is design time reduction. Concerning the second objection, a suitable methodology is needed to transform the craft of proving parallel programs into a reliable technique.

The basic idea for the verification and the design of programs consists of considering successively a sequence of programs of increasing complexity, the last one being the actual program. The design of the invariant will be incremental and structured--and much easier if the elaboration method fulfills the following two conditions. First, refining one version of the program into the next one is methodical and easy; second, the invariant of one version of the program becomes--without alteration--the main part of the invariant of the next version.

The invariants are designed using the concepts of weakest precondition and strongest postcondition (de Bakker, 1975)

Processing of Radiographic Images Obtained by Tomography

Various hypotheses on the use of acquisition systems using tomography have been studied at Liège. This has led the researchers to develop a particular mode of optimization of the disposition of sources relative to the body studied and the system of acquisition.

Several problems arise in the processing of radiographic images. A reduction in the time to acquire information for processing normally leads to an increase in processing time. These conflicting characteristics have to be revealed in an optimum way. Also, a method needs to be used which eliminates as much background noise as possible. The approach to handling the problems depends on the expected use of the acquired information--for example, whether it will be used to study a particular feature or to serve a more global use.

The researchers were not able to study all imaginable uses for the tomographic information. However, a number of problems of acquisition and processing were solved. In all cases, the optimization issue proved to be dependent on the planned use of the information.

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2/14/84

ESPRIT UPDATE

by J.F. Blackburn.

The primary goal of the European Strategic Program for Research and Development in Information Technology (ESPRIT) is to encourage the cooperation necessary to make the EEC countries as a

group competitive in the world market in information technology. In *ESN* 38-2:69-71 (1984), I described the goals and progress of ESPRIT. This update is based on a 23 January 1984 meeting with Richard Nobbs (External Relations Manager, Information Technology Task Force, European Economic Community [EEC]).

The pilot phase of ESPRIT is now under way; funding for the first of two 5-year phases was approved in late February. The two phases are to cost 1.5 billion ECUs (1 European Currency Unit equals approximately $0.80). The table in *ESN* 38-2:70 (1984) lists the areas to be funded for research and development.

The pilot phase of 36 projects (selected from over 200 submissions) will cost 23 million ECUs. The EEC will pay half of this cost, with the remainder being paid in the country where the research is done. Table 1 lists the 36 projects in the pilot phase and the responsible countries (all are EEC members).

When the first 5-year phase starts, it will operate on an annual cycle based

Table 1

ESPRIT Pilot Phase Projects

Proposer	Country	Title
Nat. Microelec. Res. Cntr.	IRL*	*Interconnection of High Pincount*
Stability Electr. Comp.	IRL	Integrated Circuits
Brit. Aerospace Dynamics	UK	
BPA Ltd.	UK	
Plessey, GEC	UK	Advanced Interconnect for VLSI
Thomson-CSF	F	
Telefunken Elek.	D	
Newcastle Uni.	UK	
Southampton Uni.	UK	
Montpellier Uni.	F	
GEC, Plessey	UK	High Level CAD Design System for
CII-HB	F	Interactive Layout and Design
AEG, Uni. Berlin	D	
Philips	N	Description Language for VLSI
Siemens	D	
BTMC	B	A Compiler for Advanced Parallel
EFCIS	F	Signal Processor
Kath. Uni. Leuven	B	
Kath. Uni. Leuven, BTMC	B	Advanced Algorithms Architecture
Silvar-Lisco	B	and Layout Techniques for VLSI
Philips	N	Dedicated Signal Processing
Siemens, Ruhr Uni.	D	
CII-HB	F	A Basis for a Portable Common Tool
Siemens, Nixdorf	D	Environment
ICL, Marconi	UK	
Olivetti	I	
Philips	N	Formal Specification & Systematic
Sticht Math. Cntr.	N	Program Development
Lab. Marcoussis	F	
CGPS	IRL	

*B=Belgium, D=Federal Republic of Germany, DK=Denmark, F=France, GR=Greece, I=Italy, IRL=Ireland, N=The Netherlands, UK=United Kingdom.

Table 1 (Cont'd)

Proposer	Country	Title
GMD Olivetti Italsiel Uni. Patras Siemens	D I I UK D	Personal Workstation for Incremental Graphical Specif. and Formal Implementation Of Non-Seq. System
Siemens SDL CIT-Alcatel Philips	D UK F N	Software Production and Maintenance Management Systems
STC Consuldata Cerci Data Mngmt.	UK N F I	Software Production and Maintenance Management System
CSELT AEG-Telefunken GEC, Plessey Thomson-CSF	I D UK F	Advanced Algorithms and Architecture for Signal Processing
Knowledge-Based System Uni. Amsterdam	UK N	Design of Techniques and Tools To Aid in the Analysis and Design of Knowledge Based Systems
Plessey, Uni. Sussex CIMSA CSELT, ITALSIEL S.T. Lungso, Riso Uni. Dublin	UK F I DK IRL	Knowledge Information Management Systems
Siemens CII-HB Lab. Marcoussis	D F F	Knowledge Information Management System
Belgian Inst. Mngmt. SCS Fraunhofer Gesel. Uni. Hamburg Scicon Uni. Crete Cranfield Inst.	B D D UK GR UK	A Logic Oriented Approach to Knowledge and Databases Supporting Natural User Interaction
Plessey DDC GMD STL	UK DK D UK	Functional Analysis of Office Requirements
Lab. Marcoussis CSELT	F I	Document Storage and Interchange Standards
Correlative Syst. CII-HB Softlab	B F D	Multimedia User Interface at the Office Workstation
INRIA, CII-HB Uni. Libre Bruxelles Uni. Nijmegen Inst. Comp. Science Crete	F B N GR	Multimedia Office Workstation
Siemens Queen Mary Coll. Thomson Titn.	D UK F	Handling of Mixed Text/Image/ Voice Documents Based on a Stand. Office Document Architect.

Table 1 (Cont'd)

Proposer	Country	Title
Philips Plessey, GEC CII-HB, CGE, Thomson Siemens, Nixdorf STET	N UK F D I	Standardization of Integrated LAN Services and Service Access Protocols
Uni. Liege ACEC, BTMC Stollman & Co. SG2	B B D F	Broad Site Local Wideband Communication System
Olivetti Nixdorf	I D	Local Wideband Communication System; Broadband Docum. Communic.
Thomson Uni. Toulouse CSELT, Politec. Milano	F F I	Local Wideband Communication System
Syntax, CNR Pisa Uni. Crete, Mnemonica	I GR	Development for an Experimental Mixed-Mode Message Filing System
Plessey DDC Uni. Coll. Dublin	UK DK IRL	Office Filing and Retrieval of Unstructured Information
CIT-ALCATEL? CII-HB AEG, Siemens Olivetti, Selenia GEC Philips	F D I UK N	Design Rules for CIM
British Leyland Sys. British Leyland Tech. Sticht Math. Cntr. Uni. Amsterdam Trinity College	UK UK N N IRL	Design Rules for CIM Systems
Fraunhofer Gesell. Uni. Karlsruhe Uni. Galway Renault	D D IRL F	Design Rules for the Integration Of Industrial Robots into CIM Systems
Logica Ltd. IFAO	UK D	Computer Integrated Production Insula, Design Rules & Standards
AEG-Telefunken GEC	D UK	Integrated Electronic Sub-Systems For Plant Automation
Welding Inst. Babcock Power RWTH, Oerlikon	UK UK D	Exploitation of Real-Time Imaging for Arc Welding
Siemens Olivetti Fraunhofer Gesell. Comau, Sincon	D I D I	General Purpose Sensory Controlled System for Parts Production
Fraunhofer Gesell. Peripherie CS Digital Equip. Aut. Thomson	D D I F	Integrated Sensor-Based Robot System
Uni. Strathclyde Barr & Stroud IROE	UK UK I	Computer Aided Thermal Image Technique for Real-Time Inspection of Composite Material

on the progress of the work, which will be reviewed by the EEC's Council of Ministers. Each year the Council will decide whether to continue the program.

Projects are expected to be of two types: a type A project will be intended to develop a system; a type B project will pursue an idea. All projects must incorporate partnerships of at least two EEC countries.

Even though ESPRIT will represent only 6 percent of EEC R&D spending on information technology, the program will account for about 50 percent of spending on precompetitive research.

The Community has about 15 percent of the $500 billion world market in information technology. The aim is to substantially increase this percentage as a result of the ESPRIT R&D program and the complementary research programs in the member countries.

2/3/84

SERC SPONSORS MEETING ON ROBOTICS RESEARCH IN THE UK

by J.F. Blackburn.

A review of robotics research sponsored by the UK's Science and Engineering Research Council (SERC) was held on 5 and 6 December 1983. The sessions covered dynamics and control, robot design, optical sensing, manufacturing and assembly, offline programming, and robot applications. The foremost issues involved in further application of robots in industry are those of kinematic and dynamic control and the associated problem of sensing. The papers presented by J.R. Hewit (Newcastle-upon-Tyne) and R. Featherstone (Edinburgh) provided new information on the control problem. A paper by C.J. Page (Coventry Polytechnic) discussed an intensity-sensing capability as well as range finding in the development of a three-dimensional robot vision system. The intensity sensing is novel in this context.

Dynamics and Control

The control of articulated machinery includes, but is not exclusively devoted to, the control of robotic manipulators. Such control requires computational power to enable the real-time transformation between coordinate systems.

One must specify, for example, reach, load capacity, and operating speed so that an articulated machine will meet the requirements of the task to be performed. Satisfying these specifications will result in a geometric configuration described by a set of machine coordinates. However, it is convenient to describe the operation of the machine and to plan its control in terms of the task itself or in terms of the environment in which the task will be done.

A controlled articulated machine needs to be able to use the machine coordinates, the task coordinates, or the environmental or "world" coordinates as required to do the task. The control of articulated machinery also requires accommodation, at high operational speeds, for dynamical effects. At low speeds, coordinate transformations are the main computational task, but at high speeds the effects of friction, link inertia, and flexibility become major factors. The dynamic interaction between the arm links requires solving differential as well as algebraic equations.

J.R. Hewit (Department of Mechanical Engineering, University of Newcastle-upon-Tyne) described a slow kinematic control application and one fast dynamic control method. He first described the decoupling of the control of a fork lift. Its extending boom design, which gives it long reach, means that the natural machine coordinates are "reach" and "tilt," r and θ. However, for stacking and unstacking pallets, a more natural set of coordinates would be "horizontal extend" and "vertical lift"--x, y. At Newcastle the robotic control method of resolved motion rate control is used to convert the machine to world coordinates. The manually operated control valves were replaced by servovalves controlled by a microprocessor which also performs the coordinate transformation.

Hewit then described a fast dynamic-control method. The equations of motion of a rigid robotic manipulator moving at high speed can be put in the form

$$M(\theta)\ddot{\theta} = B(\theta,\dot{\theta},t) + DT,$$

where θ is the machine coordinate vector, M is the inertia matrix, T is the applied torque, and B is a vector of Coriolis, centrifugal, gravitational, and frictional torques and forces. In most cases the calculation of B causes the most difficulty. According to Hewit, measurement is substituted for computation to overcome the problems associated with the real-time implementation of the movement control.

Figure 1 shows the method, including provision for the kinematic relationship $X = X(\theta)$ between X, the

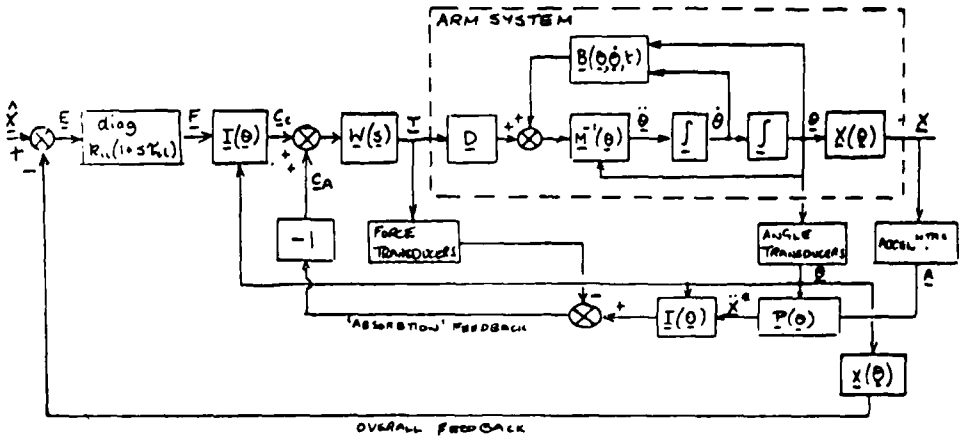

Figure 1. Fast dynamic-control method.

"world" coordinate vector, and θ, the machine coordinate vector. Hewit's group is building an active force controller for a three-link experimental arm (Hewit, 1981).

R. Featherstone (University of Edinburgh) reported on a model of the dynamic behavior of industrial robots and the interaction between them and their workpieces. He and his colleagues have written a robot dynamics simulator program which can simulate a wide range of robots and their interactions with a rigid, inpenetrable surface. The simulator is an interactive computer program running under the UNIX operating system. It can simulate the dynamics of an arbitrary, unbranched, kinematic chain, where each joint is either resolute or prismatic, and the base is fixed, or at least has known motion which is independent of the motion of the rest of the robot. The links are modeled as rigid bodies having arbitrary inertia properties, and an inertial load may be placed at the end effector. Forces at the joints can be provided manually but are normally provided by actuators, which may be ideal or simple models of electric motors. Friction in the joints can be modeled, as can elastic drive trains between the actuators and the joints.

To check the accuracy of the simulator in modeling a real robot, a PUMA 560 robot has been modified and instrumented so that recordings of actual motions and the forces that produced them can be made. These data will be compared with the simulator's predictions.

Robot Design

Many robot manipulators are of the anthropomorphic "arm" type, with their actuated joints arranged in series. They usually have special geometry with adjacent joint axes parallel or intersecting in groups of two or three, and there are few offsets between adjacent links in the system. These systems impose many restrictions on the range and complexity of tasks that can be performed. For example, the dexterity of a manipulator is largely dependent on the arrangement of links and joint axes.

J. Rooney (Open University, Milton Keynes) reported on a project to investigate the structure and organization in robot manipulator, gripper, and pedipulator designs. The project objectives were: to explore the structure and organization required of manipulator components and subsystems; to develop classification schemes for describing existing designs and comparing them with novel designs; and to develop techniques and procedures for the design and evaluation of new, or existing, designs.

The research generalized anthropomorphic designs in which the links are interconnected in serial chains by independently actuated joints, and in which the adjacent joint axes are usually parallel or intersect orthogonally.

The kinematic structure was generalized by examining multiloop kinematic chains, in which the joints are not all actuated independently, and in which the links are arranged in parallel, or in branched tree-like configurations.

The geometric structure was generalized by examining systems in which adjacent joint axes are skew lines, and offset distances are allowed between links at each joint axis.

Two main types of module were developed for the kinematic structure: actuation components and distribution components. Both have a tree-like topological structure. The actuation modules have at most six drives (allowing up to six degrees of freedom). The distribution modules have at most six inputs.

For the geometric structure the modularity was achieved by choosing components with special geometry, such as $\pi/2$ twist angles or equal link lengths and offset distances. Thus a two-joint link can be represented by a tetrahedron with right-angled-triangular faces, for example.

D.T. Pham (University of Birmingham) gave a paper on progress on the design and development of versatile grippers for industrial robots, a project carried out in collaboration with Unimation. The objective is to reduce the need to custom-design grippers by having a small range of general-purpose or versatile grippers, each capable of handling a family of parts. Tests were made on jaw-type toggle grippers, jaw-type cam-driven grippers, a jaw-type gripper made up of flexible, inflatable rubber fingers, and vacuum grippers.

Since cylindrical components form the largest group of workpieces in Unimation's applications, the initial investigations were directed toward developing good generic grippers to handle these. To grip an object concentrically a cam-type scissor-action jaw using compensating cams on the pads to achieve concentric gripping was developed. Also, a gripper was designed to hold rotating workpieces. Recent work has been on parallel-jaw grippers which do not rely on cam actuation. Rack and pinion grippers have been built for handling small parts.

Optical Sensing

A major problem with robot vision systems is their inability to cope with depth or range to any significant degree. Because of the simple silhouette images employed, binary vision cannot reliably detect three-dimensional structures using standard lighting arrangements. More sophisticated gray-scale vision can overcome this limitation to some extent. However, some ambiguity arises from inferring geometric structure from a two-dimensional intensity image. The use of range information, either alone or with conventional intensity imagery, can simplify subsequent image processing.

C.J. Page (Coventry Polytechnic) reported on a project to develop a prototype three-dimensional robot vision system based on rangefinding and incorporating an intensity-sensing capability. The single-sensor, single-view system was chosen because it will be the most common, and cheapest, in practice.

Time-of-flight range finding using laser light is the technique being applied to measure sensor-to-workpiece distance. The basic requirements for the sensor being developed are that it must be small and robust; in addition, it must be capable of measuring range with a resolution of better than 0.5 mm over a range span of 1 m at an image acquisition rate of less than 0.5 ms per point, allowing for averaging of 100 or more successive samples of the same point.

Manufacturing and Assembly

A. Pugh (University of Hull) spoke on vision-guided assembly applied to batch manufacture. He concentrated on the Hotpoint Compressor assembly, which has been partitioned into several discrete tasks; a multiprocessor system has been developed to facilitate the application of the various sensors. A high degree of flexibility is obtained by giving each sensor its own slave processor. Work is also under way on the supervising language required for the master processor within the system.

The 14 components in the assembly range from a large casting to floppy valves and small valve parts. The orientation problem was overcome by preloading the compressor casting into a primary jig which incorporates an air cushion to alleviate the weight problem. To handle the compressor a special gripper structure has been devised. It is based on a triangular set of inflatable rubber fingers, which allow the robot to grip the rotor and move the assembly; the fingers provide the necessary degree of conformance to pressure between the robot and the compressor.

A gauging device based on a standard dial gauge movement is used to measure the top dead center of the piston face relative to the cylinder head in order to select the correct thickness of the compensation gasket. This device is microprocessor driven and has an accuracy of 0.00001 inches.

All the components are built up on a secondary assembly jig equipped with optical sensors for reliable acquisition and placement of gaskets. A vacuum

gripper has been developed to enable the robot to pick up all the gaskets, and sensors are incorporated in the gripper to indicate successful gasket acquisition and to detect force overload.

Offline Programming

R.J. Popplestone (University of Edinburgh) gave a paper on spatial relationships derived from a RAPT program for describing assembly by robot (Popplestone et al., 1978, 1980). The RAPT language was developed at the University of Edinburgh to use in programming robots offline. This is particularly important for small batch assembly. The language allows the user to describe the task in a natural way, in terms of surface features being in contact and motions of objects relative to each other. The gripping parts of manipulators can be included as objects used in the task. Popplestone described the system for transforming the relational information into the positional information necessary to drive a manipulator.

Robot Applications

P.M. Taylor (University of Hull) reported on the use of robots in the garment industry. The particular task chosen for study was what he called the motif-application process. Fabric is supplied from the cutting rooms in stacks. The first part of the task is to separate the top ply of fabric from the rest of the stack. This top ply is then picked up and put in a known location. Onto this separated piece of fabric a small motif must be placed within a positional accuracy of ±1 mm and ±1 degree. The motifs are picked from a bin and oriented under a low-resolution vision system. The robot can then pick up the motif and place it on the fabric. The motif is then joined to the fabric under high temperature and pressure for about 10 seconds in a special bonding machine (Kemp and Taylor, 1983).

For the most part the research presented was not exceptional. However, several papers presented new information on slightly novel approaches to some common problems.

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1/26/84

EDUCATION

PHYSICISTS VISIT RUSSIA AND CHINA

by R.L. Carovillano. Dr. Carovillano is the Liaison Scientist for Space Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until June 1984 from Boston College, where he is Professor of Physics.

As a member of a delegation of university physics educators affiliated with the American Association of Physics Teachers (AAPT), I participated in a 3-week visit to Russian and Chinese cities. The visit took place under the People to People program that was founded by President Dwight D. Eisenhower. People to People International is a nonpolitical, nonprofit organization working to establish greater understanding between Americans and people of other nations.

This article contains only a few general comments and observations about the journey. In subsequent articles, I will provide more focused and detailed descriptions of meetings and exchanges that took place at particular institutes, schools, or universities in the two countries.

The official mission of our delegation was to visit schools, universities, and physics teachers in designated cities of the USSR and the People's Republic of China (PRC). The expectation was that our itinerary would include village communes, schools, universities, museums, research institutes, industrial laboratories, and factories. In the USSR these expectations were seldom realized, and there was much disappointment with the lack of business

meetings. In the PRC, there were more professional exchanges, most dealing with university physics programs. In both countries we sampled the culture generously, were treated kindly, and spent long hours touring and traveling.

Perhaps because of the heightened political tensions between the US and the USSR following last year's Korean airline disaster, many government-related visits to the USSR were canceled at the time of our journey (16 to 24 October 1983 in the USSR, and 25 October to 5 November 1983 in the PRC). The journey was not threatened with cancellation, and the nonpolitical nature of People to People International apparently was an important factor. Nevertheless, our visits to Leningrad and Moscow were largely professionally sterile and unrewarding. Meetings related to our mission were restricted to a visit and discussion at the so-called Friendship Society in Leningrad, and a visit to a high school in Moscow (see next article). For various reasons--and with the Soviets expressing profound regrets--planned visits to universities and institutes were canceled or somehow never materialized. In contrast, our journey in the PRC included four cities; Beijing, Shijiazhuang, Xian, and Shanghai, with useful professional and cultural visits in each.

Russia

Space science was prominent in the radio and TV news, and the coverage was more extensive and sophisticated than is typical in the US. Features treated the manned Soyuz-T9 spacecraft that was on an extended mission at the Salyut space station, and Venera 15 and 16, the two satellites that had just been injected into orbit about Venus. The Soviet newscasts emphasized the cooperative role of Communist bloc countries in their space program. For example, the infrared spectrometers on Venera were made in East Germany; the optical platform on which the Vega cameras and instruments will be mounted was being built by Czechoslovakia.

On the afternoon of our final day in Moscow, a last-minute cancellation to a university caused much grumbling and was replaced with a brief, escorted visit to the large industrial and technical exhibit in a vast park across from our hotel. The visit consisted mainly of walking outdoors past buildings. It was finally arranged for us to go into a building which had a computer exhibit that consisted mostly of printed signs about equipment, or equipment on display but not capable of live operation or demonstration. Many requests and a search by the exhibit director produced a simple flyer describing a computer.

Moscow News, a semiweekly tabloid printed in English at the Izvestia Press, was available at Intourist hotels. The paper has a modest price (5 kopeks or about 6 cents) but was usually provided free of charge. Much of the international news was slanted--pro-Soviet and anti-US--and even mundane news notes were biased or opinionated. The paper is available in the US; inquiries can be directed to Total Circulation Services, Inc., 111 8th Avenue, New York, NY 10011.

PRC

A different guide was provided in each city in China. The guides were well trained and gave prepared statements in good English, but their problems in grasping and responding to questions indicated a more limited knowledge of the language. The Chinese guides were as highly competent as their Russian counterparts, but their presentations and comments were free of political nuances and refreshingly simple and direct. Another striking contrast was how much more the Chinese smile, laugh, and enjoy interacting with people.

News of the West was more available in the PRC than in the Soviet Union. Our primary source of such news was the *China Daily*, a newspaper published in English in Beijing and provided to us free of charge. Newspaper coverage included domestic news, international events, culture, economics and finance (including a summary of trends on the New York and other stock exchanges), education, science and medicine, editorials, and sports. A North American edition of the newspaper is available; inquiries may be directed to China Daily Distribution Corporation, 15 Mercer Street, New York, NY 10013.

A second publication in English available in hotel lobbies was the *Beijing Review*, a Chinese weekly of news and views. I found this publication, essentially a small magazine, to be less interesting than the *China Daily* but especially informative on government programs in areas such as agriculture, science, culture, medicine, and education. The *Beijing Review* is available in the US at the annual subscription price of $13; write to the Beijing Review, Beijing (37), The People's Republic of China.

Reports and articles on science and technology in these publications included the use of microsurgery in Chinese clinics since 1978; the awards to the US, the UK, and Japan to explore for

offshore oil in Chinese waters; an international symposium on geological dating held in Nanjing, PRC; research in radio communications to satellites; cancer research; research on the use of laser acupuncture to cure baldness; the establishment of a computer service center in Beijing to train Chinese users and provide maintenance for a Japanese branch of IBM; oil exploration in China by a French company; the discovery of new fossils in the region of Zigong in the Szechuan Province, known as the home of dinosaurs; transfer of technology between Chinese provinces (a major task); the spacewalk of Soviet cosmonauts Lyakhov and Alexandrov; the establishment of science clubs and societies in high schools and communes; the use of solar energy in China; and the successful August launch by the PRC of a low altitude satellite that reentered the atmosphere after 5 days.

2/3/84

PHYSICS AND MATHEMATICS EDUCATION IN THE USSR

by R.L. Carovillano.

As a member of the US physics teachers' People to People delegation, I met with Soviet educators in Leningrad and Moscow and discussed their educational system.

In Leningrad, the delegation spoke with Dr. F. Kupsov, an assistant professor in the nuclear physics department at the Leningrad Polytechnic Institute; Kupsov had spent a postdoctoral year at Connecticut University. We also met with two high school teachers: Ms. V. Drosdova, a physics teacher, and Ms. L. Matseva, a mathematics teacher.

In Moscow, I participated in a discussion with a university professor and visited a high school.

Primary and Secondary School Education

High school teachers are very well trained in their disciplines, typically far more so than their American counterparts. The college curriculum for a physics or mathematics teacher (or specialist) is 5 years and essentially the same as that for a regular major in the field. About 50 percent of the curriculum is math for a math teacher and physics for a physics teacher. Females dominate high school faculty positions, while most university faculty members are male.

Table 1

Student Class Hours in Physics and Mathematics

	Year				
	6	7	8	9	10
Hrs/wk, physics	2	2	3	4	6
Hrs/wk, math	6	6	6	5	5

All children are required to go to school for 10 years. The program amounts to 3 years of elementary school, 5 years of junior high, and 2 years of senior high school. Children begin school at age 7. Most of the curriculum is the same for all students, but advanced classes attempt to accommodate gifted students. The study of Russian is compulsory for all students, separate from the local language of each region. Since the USSR consists of about 27 nations and many more dialects, this is an important requirement. In higher education, classes are taught in Russian.

Students begin studying mathematics in their 1st year of school and physics in the 6th year. All students study both subjects. Once begun, the subjects are studied each year at a more advanced level and a more intensive pace. In both math and physics, one teacher takes the same class of 30 students from the 6th through the 10th years. One teacher handles three or four such groups, or 90 to 120 students per week. The contact hours per week vary with level, as indicated in Table 1. Teaching loads are heavy. If a teacher carries an extra class or assignment, extra pay is provided.

In mathematics, the curriculum is designed to develop mathematical skills and to bring out the student's natural ability at analysis. There is no exposure to the computer before the 6th year, and computer usage is not emphasized. Trigonometry is studied in the 8th year, and students are exposed to calculus for the first time. Differential and integral calculus are the main topics of the 9th and 10th years.

Gifted students are permitted to go to special schools for their 9th and 10th years. Selection of such students

is by course grades, the results of a test, and an oral examination. About two to three students per class are selected in this way. The standard high school curriculum is the same (i.e., fully prescribed with no electives) for all students. About 20 to 30 percent of the high school graduates nationally go on to higher education. For many reasons, far greater percentages of the high school graduates from Leningrad and other cultural centers continue into higher education.

Of the top university students in physics, many are not graduates of the special schools. High school students emerge from the regular programs in large numbers to excel in physics at the university.

High School 444

In Moscow our delegation visited a technical high school simply named School 444. We were welcomed by Ms. I. Iryuchkova, the principal, who described the school curriculum and arranged for our group to attend a physics or mathematics class.

School 444 has about 40 teachers, mostly female, and an enrollment of about 700 boys and 260 girls. All 10 grades are taught at School 444, with typically two classes at each grade. The special programs for gifted students begin in the 7th grade. Specializations include mathematics, physics, foreign language, literature, and other subjects. The top two-thirds of the 6th year class at School 444 continue into the special programs, and the others are transferred to regular schools.

In the special programs, optional lessons or electives are available in all subjects--a feature not available in regular schools. Mathematics is a major program at School 444. In offering only one extra hour of physics, the physics program is not elaborate, although it is intensive and of high quality.

The mathematics program is geared fully to prepare the students for computer work. School 444 has its own computer center (which we did not visit) and has the oldest program in the country to train computer operators. Computer training begins in the 7th grade. In the 9th grade, theoretical computing problems are solved. All students learn FORTRAN; other computer languages are optional. Each 10th grade student completes a special computer project in an interdisciplinary, practical area such as farming, aviation, or marketing. These are significant projects and can involve background in several sciences and a great deal of research. The projects are commonly supervised jointly by a teacher and an outside expert, who may be from industry, government, or the university.

I visited a 10th grade mathematics class with a male teacher and 14 females among the 29 students. The class was conducted in an unusual fashion with regard to method and pace--there were bursts of brief instruction, problem solving, and recitation. (The physics class attended by others in our delegation was taught similarly.) The subject of the class was evaluating inequalities and limits, essentially using calculus and analytical geometry.

The classroom was old and spartan, pictures of Lenin hung on the walls, and students were seated in pairs at benches-desks. The teacher commanded attention and knew each student well. After commenting for a minute or two, he wrote a problem on the board; the students worked to solve it singly or in pairs as rapidly as possible. The teacher circulated during this commotion and commented loudly, supportively or critically, on the progress of the students. When the girls were doing well, he teased the boys. The first student done described the solution at the blackboard, typically in an awkward, shy manner. Students or the teacher often added comments to the solution presented. The pace was fast, and notes had to be taken rapidly. Even before the discussion of one problem was completed, the blackboard would be erased and the next problem posed.

The level of material and the amount covered in one class was substantial. The following are examples of the work to prove or solve:

- $\sin x < x < \tan x$
- $\lim (x \to 0) [\sin x/x] = 1$
- determine A and B for which $y = 3 \sin x + 4 \cos x = A \sin B$
- if $y(x) = \tan x$, evaluate y at $x=\pi/4$ and determine the value of x for which $y'(x)=y(\pi/4)$
- determine the area enclosed by the curves $\tan x$ $(0 \leq x \leq \pi/4)$, $\cot x$ $(\pi/4 \leq x \leq \pi/2)$ and the x-axis.

Results of solved problems were used in subsequent problems if needed.

Graduates of School 444 tutored current students who participated in extracurricular activities such as science clubs or science fairs. Students of School 444 received numerous awards; in a recent competition at Novisibirsk, five students presented papers and received awards. Of last year's 96 graduates, 81 entered

universities or technical institutes, and 15 got jobs in industry as computer operators.

Higher Education

Insights into higher education in the USSR came from an informal discussion with Prof. N.F. Nelipa of the Nuclear Physics Institute of the Moscow State University. Although there are entrance requirements, the quality of the students at the university fluctuates considerably. The university degree program requires 5 to 5½ years for the doscenta, which is probably slightly higher than our bachelor's degree. Graduate school requires 3 years of study, and the work is mostly research. Student research is performed at the university or technical institute attended and not at national academies.

Graduate students receive stipends, in return for which they provide some services. The support level is modest, and family assistance is normally required. Upon completion of the graduate program, the student is designated a "candidate scientist." The doctorate is awarded 5 to 10 years later, based on achievements and publications in the field.

Only established scientists are awarded the doctorate. A scientist with the doctorate appointed to the university would hold the rank of professor. It would be very unusual today for a professor not to have this degree.

(In a private discussion with Nelipa, the point was made that the American high-energy-physics community is in a crisis. Significant program development must take place rapidly, if the US is not to lose its leadership role in the field to the European Organization for Nuclear Research [CERN]. CERN is prospering and may already have the strongest contingent of high energy theorists.)

Salary and Living Conditions

The salary of a professor is about $625 per month. A direct comparison of salaries for US and USSR positions would be inappropriate. Salaries in the USSR are supplemented by government subvention of living quarters, transportation, and other costly expenses undertaken by the individual in the US. Physicists are well paid, but not extraordinarily so by any means. The salary of a high school teacher is about half of that of a professor. It was generally agreed that both in the USSR and the US, high school teachers' salaries are low and underestimate the teachers' value.

2/15/84

EDUCATION IN THE PEOPLE'S REPUBLIC OF CHINA

by E.L. Carovillano.

There is a national preoccupation with education in the People's Republic of China (PRC). Newspapers, television, and circulated pamphlets are full of reports on educational activities, achievements, and developments around the country. Since the conclusion of the cultural revolution the government has made vigorous efforts to improve the quality of education nationally in a comprehensive program extending from preschool years through the doctorate. The task requires catch-up and development in all areas, but particularly at the most advanced levels. My information on the status of the educational system is from literature obtained in the country and discussions with Chinese university educators visited in October 1983 by the US physics teachers' People to People delegation.

The Chinese system of education is governed by the national Ministry of Education. The methods and structure of the system are styled after those in the USSR, but changes are evolving quickly. Children begin school at age 7 and attend for 10 years (up to 12 years in some areas). Primary school requires 5 years (6 years in some areas), followed by 3 years of junior middle school and 2 years (3 years in some areas) of senior middle school. The term "middle school" as used by the Chinese essentially means secondary school. A significant preschool system of nurseries and kindergarten also exists to prepare children for primary school and to cope with the enormous cultural differences across the country. More than 12 million children receive preschool education annually.

The government speaks forthrightly about the deteriorated educational system that is being rehabilitated: "During the 10 turbulent years of the 'cultural revolution,' education was adversely affected and an entire generation of young people fell victim to the marked deterioration in educational standards. Things began to look up after rectification in the four years following the downfall of the 'Gang of Four.' In 1980 . . . about 93 percent of the school-age children went to school."

The enormous increase in the number of schools and the number of students attending school at each level between the years 1965 and 1980 is indicated in Table 1.

Preschool and Kindergarten

Development of these schools is widespread and extends into the rural areas. The program is managed by the central government or local authorities. A significant effort has been made by Chinese educators to create a stimulating environment for the children. Nurseries are provided for children less than 3 years old, and kindergarten for children 3 to 6 years old. Kindergarteners are in three grades according to age. The responsibilities of the school include health, physical fitness, oral expression, educational motivation, good manners, and an exposure to arithmetic, the arts, and athletics.

The health and physical fitness of the children are given great emphasis throughout the school program with dramatic results. There is a pronounced contrast in the appearance of the Chinese people of different ages. Young people appear to be healthy, fit, and youthful. Most people over, say, 40 appear to be significantly smaller in size and far less fit and youthful for their age. At any age, an overweight Chinese is a rarity.

Primary Education

It is at the primary school level that the government effort to achieve universal education is strongest. Primary schools have been established in the most remote rural and mountainous regions and may require temporary facilities and traveling teachers. The government estimates that more than 93 percent of the nation's primary-school-age children attended school in 1983.

Primary school is in session for 9½ months per year. Special holidays are provided to pupils in rural areas during harvest seasons. Pupils in grades 4 and 5 are required to spend 2 weeks during the school year doing basic physical labor at tasks such as planting, cleaning, general handiwork, household chores, and farming.

The primary school curriculum has 26 contact hours per week covering Chinese, mathematics, politics, foreign language, physical culture, music, fine art, and a course called "common knowledge" that includes history, geography, and other practical subjects. Daily classroom instruction does not exceed 6 hours. An additional hour of physical training and exercise is required each day.

Rules of Conduct

The Ministry of Education has stated 10 rules of conduct expected of all students and intended to develop proper morals. The rules are widely publicized and presumably enforced in some measure from primary school onward. The rules are: (1) love the motherland and people, study well, and make progress every day; (2) attend class on time and ask for leave if you cannot attend; (3) listen to teachers attentively and do homework conscientiously; (4) persist in physical training and take an active part in recreational activities; (5) pay attention to personal hygiene, keep clothes tidy and clean, and refrain from spitting in public places; (6) love labor and learn to be independent; (7) observe school discipline and public order; (8) respect teachers, get along with classmates, be polite to others, and refrain from swearing and scuffling; (9) show concern for the collective, protect public property, and turn in everything found lost by others; (10) be honest and correct any mistake you have made.

Appearances would suggest that the rules of conduct have been implemented in large measure among the young people. Rule 5 is a difficult one. Facilities and crowdedness can limit cleanliness and tidiness; using the toilet facilities is an experience not to be missed, particularly for females, and can generate among tourists much retrospective discussion and amusement. Older persons,

Table 1

Growth From 1965 to 1980 in the Number of Schools and Student Attendance at Each Level

Level/Year	Number of Schools		Attendance in Millions	
	1965	1980	1965	1980
Higher education	434	675	0.674	1.14
Middle schools	18,102	118,377	9.340	55.10
Primary schools	682,000	917,300	116.200	146.30
Kindergarten	19,200	170,400	1.710	11.50

rather than the young, seem to find it difficult to refrain from spitting. Spittoons are provided in every university conference room.

Secondary Education (Middle Schools)

Secondary schools are in session 9 months a year with 28 contact hours per week. The junior middle school (grades 6, 7, and 8) curriculum consists of 13 courses: Chinese, mathematics, foreign language, politics, history, geography, biology, chemistry, physics, physical culture, physiology, music, and fine arts. Senior middle school excludes the last three subjects, perhaps because the most talented students in fields such as art, music, and drama attend special schools. Two months of vacation are provided each year, and 1 month must be spent at manual labor or farming in rural areas.

In addition to the 10 rules of conduct, middle school students are not allowed to drink wine or to smoke and are admonished not to fall in love in order to devote their energies to study. These policies are in accord with the severe government birth control program.

Most middle school graduates are given government job assignments. Because of a growing sympathy for industrial interests, there is a large movement away from traditional secondary education toward vocational, technical, and agricultural programs and schools. Adult education programs and correspondence courses are also being emphasized and expanded for improving the working capabilities of older people.

Middle school teachers normally graduate from a teacher's college (called a normal school). Teachers have strong training in their disciplines, though normally not up to the standards for a major at a leading Chinese university. The salary and social status of the middle school teachers are modest. The salary of a middle school physics teacher is about $60 to $190 per month. (Our bus driver in Beijing earned about $85 per month.) There is a national shortage of qualified physics teachers.

The Hebei School of the Performing Arts

As mentioned above, certain talented students attend special schools. Our delegation visited the Hebei School of the Performing Arts in Shijiazhuang, a major city in the Hebei Province. The school is run by the state, so all facilities and equipment are provided free of charge to the students. Hebei came to its present site (a small campus-like facility) in 1970. The school has 300 teachers and staff members, 350 students, and six departments. More than 1000 students have been trained at Hebei since 1955.

Student age ranges from seven to 20. They spend 5 to 7 years at Hebei in programs such as opera, dance, music, and acrobatics. All students are in residence at Hebei. They have seven classes of an hour or more per day with an hour of free time. About 70 percent of lecture time is spent on culture studies, and the remainder on standard academic disciplines, including mathematics but not physics or chemistry. Sundays are free, and there are 9 weeks of vacation throughout the year. Students come mainly from the local province, about half from the city and half from rural areas. About half the students are male and half are female.

Graduates of the school have several options. The best are employed by the state for wages and may work professionally. Hebei graduates may also go on to the university. Less capable graduates are on their own.

We were given live demonstrations of dance, music, and opera. The level of talent was truly outstanding; in fact, the students' opera performance was almost indistinguishable in quality from a professional performance of the same opera shown that evening on television.

Higher Education

Although the higher education system is expanding at an enormous rate--so rapidly that quality control is possible only in limited areas--just a small percentage of the middle school graduates go on to the university. A lack of facilities precludes a greater rate of expansion, but the shortage of qualified faculty members poses an even more serious difficulty.

The Ministry of Higher Education has designated 97 of the institutions of higher learning as "key." The key institutions receive preferential treatment in terms of faculty assignments, financial support, and student quality. Of the 97, 26 are "special" and have national or international reputations. Higher education is provided at three types of institutions: universities, science and engineering institutes, and other specialized institutes that provide training and education in areas such as mining, agriculture, finance and economics, medicine, and the arts.

The universities include colleges of science and the liberal arts. Beijing, Nankai, and Fudan are famous Chinese universities (among the special 26). The liberal arts colleges have departments of history, philosophy, economics and law, languages, and

literature. In addition to mathematics, physics, chemistry, biology, and geology, the colleges of science have departments such as geography, radio and electronics, and some cross-disciplinary programs. The US systems of degrees (bachelor's, master's, doctorate) has been used since 1980. The bachelor's degree program is 4 years.

University students must spend 10 weeks each year working at factories, farms, or public welfare and 12 weeks at social services for the government and practical assignments. Universities often have an established network of factories where their students are assigned to work.

Costs of higher education are largely provided by the government. Tuition, lodging, and medical care are free, and students pay--at most--for food and textbooks. Qualified students with financial need are given grants-in-aid. Special allowances are provided to encourage students to study in certain areas. Students who have worked for 5 years before university admission continue on the payroll at full salary.

The university president is appointed by the Ministry of Education and enjoys somewhat more academic power than his US counterpart. Department chairmen, vice chairmen, and deans are appointed by the president. Lower level officials are elected locally with the approval of the university. University, college, and department faculty committees abound, as in the typical US university.

Faculty ranks are professor, associate professor, lecturer, and assistant. Faculty salaries vary with the prestige of the university. Average monthly salary ranges are as follows: professor and associate professor, $190 to $400; lecturer, $110 to $190; assistants earn less. Many Chinese universities are engaged in intensive faculty development and faculty exchange programs. There is a shortage of qualified university physics teachers, particularly at the graduate level. It is not uncommon for successful middle school physics teachers to be reassigned to teach physics at the university.

Graduate programs are expanding steadily, particularly at the key institutions and particularly in the sciences. Centers for scientific research and research institutes are common university units. Student research is done at the university. Graduate degree programs in science or for training university teachers take from 2 to 4 years. About half of the program is course work and half research. A thesis is required of all students. All graduate students receive essentially full support and a salary from the government.

Many key universities have visiting programs that bring in foreign scholars to lecture on a short or extended basis (days to months, and occasionally a year or more). Many nations, including the US, participate in the programs. At an increasing though more modest level, Chinese faculty members are studying or visiting abroad.

The Foreign Languages Press in Beijing is producing more and more literature in English. Recent publications relate to history, politics, education and science, culture, sports and public health, and tourism. Inquiries may be addressed to:

China Publications Centre
(Guoji Shudian)
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Beijing, China

2/22/84

ENERGY

THE MEDITERRANEAN-DEAD SEA CANAL PROJECT

by Robert Dolan. Dr. Dolan is the Liaison Scientist for Geology and Oceanography in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1984 from the University of Virginia, where he is Professor of Environmental Sciences.

Since the state of Israel was established in 1948 the population has increased several fold. To meet the water demands of the people, virtually every drop of surface water within the borders is used in one way or another, and groundwater is being "mined" at a rapid rate.

An important consequence of this is that waters from the Jordan River and its tributaries, which at one time contributed 1.2 billion m^3 of fresh water per year to the Dead Sea, are now totally used for irrigation, domestic, and industrial purposes; no water is presently getting to the Dead Sea. Evaporation, the only significant water loss from the Dead Sea, occurs at a rate of about 1.6 billion m^3 per year. As a result, the surface area has decreased in 30 years from 1000 km^2 to 800 km^2, and the water surface has decreased

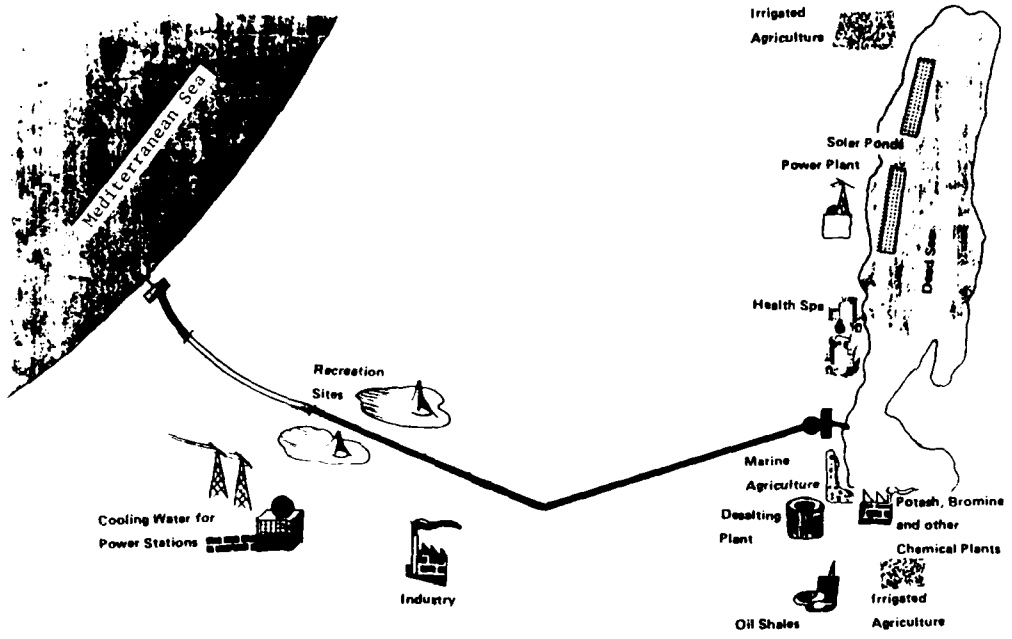

Figure 1. The Dead Sea and the canal.

about 10 m--from 393 m below sea level to the present 402 m below sea level. This process will continue unless water can somehow be added to the system.

The Dead Sea is a unique geological feature; located in the tectonic zone called the Jordan Rift Valley, its bottom is 800 m below sea level, the lowest point on the continents. The topographic drop from the Mediterranean is thus about 1000 m over a distance of about 100 km, with most of the drop occurring within only 15 km of the Dead Sea.

Many visionaries over the past 100 years have seen the possibilities of exploiting the unique topography between the Dead Sea and the Mediterranean. For example, Theodore Herzl, in his novel *Altneuland* (1902), envisioned linking the two seas for the generation of electricity. Others as early as 1850 suggested canals connecting the seas--one for example via Haifa, the Jordan River, the Dead Sea, then on to Elat and to the Gulf of Elat (Aqaba). But the first detailed assessment of a Mediterranean-Dead Sea canal scheme was made by a 1943 commission headed by an engineer, James Hays. His plan was essentially what the Israelis hope to do soon--use the Jordan River for irrigation, compensate for the Dead Sea's loss of Jordan River water by diverting water from the Mediterranean, and exploit the difference in water levels to generate electricity.

In the 1970s detailed plans for the project were developed, and an economic analysis was done. I should add that the Dead Sea is a resource to Israel far beyond geological uniqueness (Figure 1). The concentrations of salts is very high--in fact, near saturation most of the time. The waters are rich in potassium, bromine, and magnesium. The industry that has developed to extract these minerals now represents Israel's second leading source of foreign currency. The leading industry is tourism, and even in this the Dead Sea is important; it is developed with hotels, spas, and resorts. The canal project will provide an important addition to the energy supply in Israel. Today the peak power demand is about 2400 MW; the Dead Sea Canal project will add 570 MW to the system.

The project calls for an intake for drawing sea water into the canal at a point about 13-km north of the Egyptian border. A large settling basin will be constructed on the coast in order to minimize sediment in the water (Figure 2). From this basin, a rectangular canal will carry water to a pumping

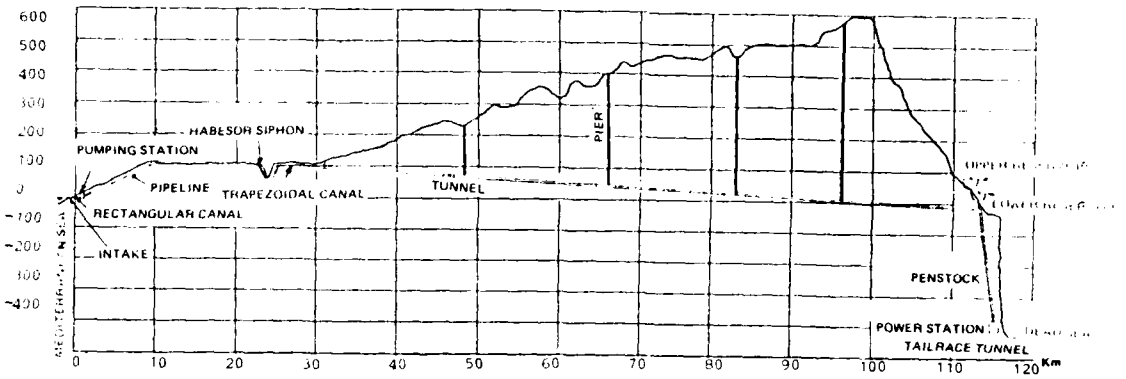

Figure 2. Alignment profile.

station, then on through a 7-km pipeline to the head of a 22-km-long trapezoidal canal 100-m above the level of the Mediterranean. At this point the water will enter an 80-km-long tunnel, 5 m in diameter, dug under the Negev Desert to a point 500-m below the surface of a high plateau overlooking the Dead Sea. Two regulating reservoirs will be built at the edge of the plateau. From there, the water will fall through a high-pressure conduit from a height of 30-m above the settling basin in the Mediterranean to an underground power station near the level of the Dead Sea. There will be four turbines in the station. A tailrace tunnel then will lead the water into the Dead Sea.

The goal is to raise the level of the Dead Sea about 10 to 12 m over a period of 10 years, which would require over 1.6 billion m^3 of water per year. At this flow rate the net electricity production would be 1.1 billion kWh/yr. Then, after the desired level of the sea is reached, the flow would be cut back to about 1.5 billion m^3 per year, with the generation of 700 million kWh/yr from then on.

Construction of the system will cost about $800 million. The benefits have been estimated at $1.3 billion over 50 years, or a net benefit of $500 million. In addition to the power generated, the Mediterranean water will "rehabilitate" the shores of the Dead Sea and thus the tourist industry and the industry for extraction of minerals. But other benefits are anticipated. For example, it might be possible to locate a nuclear power station further inland from the only cooling waters available today (the Mediterranean) and to develop a large inland desalination plant.

Serious planning for the Mediterranean-Dead Sea Canal is moving along at a crisp pace, with perhaps two more years of research and development needed. Actual construction will take 3 to 5 years.

Research under way at this time includes studies of the potential impact of the Mediterranean settling basin on shoreline processes, geochemistry of the Dead Sea waters, and impact studies of potential environmental harm associated with a 10-m rise in the water surface. Finally, there are serious political issues to be resolved, too. Jordan is not at all interested in the project (the Dead Sea is half in Jordanian territory and half on Israeli land); in fact, they have many developments located at the water's edge at the present Dead Sea level. A 10-m rise would flood millions of dollars in industry and tourist facilities; however, if evaporation continues with the inevitable drop in water level, all shoreline developments on the Dead Sea will be left high and dry. In either case it appears that adjustments will be needed in the not too distant future.

2/9/84

MATERIAL SCIENCES

METALLURGY AND MATERIALS AT KTH, STOCKHOLM

by Jack D. Ayers. Dr. Ayers is a researcher in the Physical Metallurgy Branch, Material Science and Technology

Division, Naval Research Laboratory, Washington, DC.

The Royal Institute of Technology, Stockholm, is the premier engineering school in Sweden. The Institute, or KTH, has 10 technical schools, which cover physics, chemistry, architecture, and all the common engineering disciplines.

Research Support

Before looking at metallurgy and materials in more detail, let's briefly consider how research is funded at KTH. Professors can seek research support from various governmental agencies or directly from industry. The most common source of funding is the Swedish government's Board for Technical Development. Money from the board might provide 75 percent of the research support within a department. This article highlights projects in each of the departments of the School of Metallurgy and Materials Technology.

Work at KTH tends to be more closely related to industrial needs than is research at American universities--in large measure because the Board for Technical Development supports research proposals that promise to improve industrial capabilities. Because most of the research has industrial relevance, there tends to be a good relationship between the departments and industry. Consequently, students often do some or all of their research in industrial labs, and Swedish companies often send their employees to KTH to conduct portions of their research. The industrial applications of work in the School of Metallurgy and Materials Technology will become clear as we examine some research in specific departments.

Department of Metal Forming

The department's main areas of research are improvement of production techniques, development of new forming processes, energy conservation, analysis of existing forming processes, and process control to improve material quality. The professors are Paul Huml and Ulf Ståhlberg.

Present research includes the development of a new technique for hot rolling of angle iron. This process employs a final set of rolls in which one V-shaped roll maintains the inner contour of the angle, and the two faces of the V are opposed by individual rolls mounted on shafts which are at 90 degrees to one another. Other research projects on hot rolling include a study of ways to minimize the amount of material lost to end effects. There are also studies of new techniques for straightening bars and for shearing rapidly moving sheet metal. One new process which I found particularly interesting was an extrusion technique for producing pipe. It involves forcing two billets into the die simultaneously. The researchers have experimented with having the billets approach one another on the same axis and with a geometry with an included angle of 90 degrees between the billets. The higher angle geometry generates a higher back pressure, but this geometry is easier to construct and might be expected to generate a higher degree of inhomogeneous flow and hence better weldments.

Department of Casting Metals

This department, headed by Prof. Hasse Fredricksson, works on a wide variety of research problems spanning nearly all specialties within the solidification field. The department has built several specialized instruments needed to conduct these studies. For example, there are various apparatuses for unidirectional crystal growth, a nicely engineered furnace equipped to do differential thermal analysis during controlled furnace cooling, and devices designed to achieve very rapid cooling rates. One experimental apparatus under development at the time of my visit was a two-color pyrometer designed to have sufficient stability to permit accurate temperature measurements over prolonged times. Another device which appeared to be of great value was a dilatometer equipped with a programmable rapid-response furnace. The furnace uses high-intensity lamps and focusing mirrors to uniformly heat small rod-shaped specimens at hundreds of degrees per minute. This device could prove to be invaluable in studies of the kinetics of phase transformations which occur in rapid processes--during welding, for example.

Fredriksson and his associates have had a continuing interest in problems associated with continuous casting; a recent study of macrosegregation during casting in a commercial mill employed a clever technique. They shot steel nails directly through the solidified shell of the billets and studied how the tips of the nails perturbed the fluid flow in the molten core. Extending this technique, they used nails with hollow tips filled with FeS to study how fluid flow redistributed the sulfur within the core of the billet. Another practical and interesting study employed scanning electron microscopy (SEM) to study the thermal breakdown of binders in foundry mold sands. The SEM images provided the means for explaining the degradation of

observed shear strengths with various organic additions to sodium silicate binder.

Department of Physical Metallurgy

The Department of Physical Metallurgy has two professors, Mats Hillert and Yngve Bergström.

Bergström is interested in preventing brittle fracture. He and his students also study strain distribution and plastic fracture during deep drawing. Hillert is widely recognized in the metallurgy community for his many theoretical and experimental contributions to the understanding of solid state phase transformations. He continues to work in this field, but most of his work today is theoretical. Also, in recent years his research activities have given progressively greater emphasis to the prediction of phase equilibria in alloys. This work now centers on the computation of multicomponent phase diagrams. This work has culminated in the development of a very general computer code (POLY) which enables the user to perform phase equilibrium calculations in multicomponent and multiphase thermodynamic systems. Its use is not restricted to metallic systems because it can also treat any liquid or gas--if the thermodynamic properties are known. This code is used at KTH to calculate diverse three-component and multicomponent phase diagrams, particularly ones based on iron and carbon. This code has been released to a limited number of other institutions which use it for similar calculations. Hillert's associates are also using the code to determine thermodynamic parameters required during the calculation of phase transformation kinetics in multiphase systems. These calculations are themselves quite complicated, involving the solution of coupled diffusion equations.

Department of Production Technology, Mining, and Steel Industry

This department is headed by Prof. John Olof Edström, who is also Dean of the School of Metallurgy and Materials Technology. This department is unique in the school because it offers only graduate-level courses.

Edström's department is particularly well attuned to the needs of Swedish industry, no doubt in part because before coming to KTH he was vice president of Sandviken, which is one of the largest industrial concerns in Sweden.

Edström is very active in research, supervising eight graduate students, who are involved in many experimental problems and in economic evaluations of industrial problems. The major example of the latter research is a computer-assisted analysis of the economics of steel-making from high-phosphorus ore. This is an important problem because the very large iron-ore deposits in northern Sweden have high phosphorus levels. The analysis uses subroutines for performing heat and mass balances of the many potential process reactions, and then uses these results in other subroutines which do economic calculations.

In a study related to that just described, attempts are made to determine the optimal processing conditions for removing phosphorus and other impurities from steels by the use of different fluxes. This program involves both the determination of equilibrium impurity distribution ratios between the slags and metal samples, and actual fluxing experiments in a 30-kg laboratory furnace. In another study, the combustibility of different types of solid fuels is determined under various operating conditions for blast furnaces. The aim of this study is to find economical ways to use coal in the reduction of iron. Studies are also under way on controlled sintering of fine ores in order to improve the quality of steels and to minimize cost.

Department of Theoretical Metallurgy

This department is headed by Prof. Lars-Ingvar Staffansson. Studies in the department cover both theoretical and experimental aspects of phase equilibria and thermodynamic and kinetic problems in metals processing. Theoretical studies include calculation of phase equilibria either by classical means employing regular or subregular solution models or by the techniques used in the Department of Physical Metallurgy. Theoretical studies of the reduction of sulphur-containing ores are an important part of the work done in the department. These studies use models which consider mass transport in the gas phase and throughout different phases within the ores. Experimental studies employ techniques such as differential thermal analysis. high-temperature galvanic measurements of oxygen potentials, hot stage microscopy, and thermogravimetric analysis. The researchers are using thermogravimetric analysis to accurately measure weight changes of individual copper ore pellets suspended in flowing reducing gases. This idealized geometry simplifies comparison with theoretical calculations.

Department of Process Metallurgy

Prof. Krister Torssell's Department of Process Metallurgy conducts research on a number of topics related to the reduction of ores and the refining of

metals. One project of major interest relates to coal-iron gasification. In this process the gasification of coal and the reduction of iron ore are conducted simultaneously in a pressurized reactor. The objective of this project has been to learn enough about the process to establish its commercial feasiblity. The work has progressed to the point that a 6-ton pilot plant, designed to operate at 6 atmospheres, has been constructed at Luleå in northern Sweden. It is scheduled to begin operation this year.

In an interesting study of the behavior of iron ore pellets during reduction, department members simulated blast-furnace temperature cycles and loads in a furnace which contained just a few pre-reduced pellets in an inert environment. The researchers monitored sintering and shrinkage of the pellets with x-rays, generating very clear shadowgraph images. Studies were also made of the reduction of pellets in multistage reactors; the fine fraction of the charge tended to follow the gas stream and deposited in the nozzles of the adjacent stage. Investigation of this phenomenon in a small-scale device is determining the importance of factors such as the gas velocity, the nozzle design, and the material from which the nozzles are made.

I will mention a final project in the Department of Process Metallurgy because I found it interesting, and because it was one of the few studies described to me which did not have some bearing on commercial problems. An experimental study of early iron-making processes has employed reducing experiments using reconstructions of small historical furnaces. The experiments were concluded a few years ago. Now the work consists of evaluating those experiments and examining old specimens preserved in the KTH museum, with a view toward elucidating the basic metallurgical mechanisms of iron-making in different types of furnaces.

Department of Heat and Furnace Technology

This department, headed by Prof. Rolf Collin, is another with close industrial contacts. Research centers on two areas: combustion and furnace technology. In the area of combustion technology the department has developed and built burners for diverse fuels, with the objective of economically substituting low-heat-content gases for the expensive fuel oil which is widely used now in industry. These studies monitor the concentrations of product gases, flame shape, heat distribution, and other important flame parameters. Results are compared with theoretical models and with results from cold models which simulate flames by blending streams of acidic and basic fluids in transparent reactors. Brightly colored plumes are produced by indicators when the fluids mix. These plumes provide useful insights into conditions within real flames.

In the furnace-technology area, the department employs scaled-down gas furnaces to simulate the behavior of industrial-scale furnaces. These are most useful because of the great expense of providing fuel for conducting sustained experiments in the department's large furnace (which has a hot zone 4.4-m long). Their experiments have shown that the 1:5.56 scale gas furnace simulates the large furnace well if the fuel input is reduced in proportion to the third power of the linear geometric scale. The studies provide a good basis for further development work with alternative fuels and for development of automatic process control by computer.

Department of Materials Technology

This new department is headed by Prof. Rolf Sandström. The department will study problems associated with the selection and development of materials for industrial applications.

2/13/84

OCEAN SCIENCES

DIVING IN THE DEAD SEA

by Robert Dolan. Dr. Dolan is the Liaison Scientist for Geology and Oceanography in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1984 from the University of Virginia, where he is Professor of Environmental Sciences.

The Israel Institute of Oceanographic and Limnological Research (IOLR) has responsibility for obtaining basic information about the physical processes and the chemistry of the waters of the Dead Sea before construction of the Mediterranean-Dead Sea Canal (see page 262). While visiting the IOLR recently I learned of the many unique problems associated with working in water with a

density of 1.5 and supersaturated with a variety of minerals (mainly NaCl, $MgCl_2$, and $CaCl_2$).

The question that must be answered before the canal is built is how well the Mediterranean waters will mix with Dead Sea water (the canal will transport 1.6 billion m^3 per year). Information on stratification was sparse, and data on waves and currents were nonexistent. Therefore, the IOLR research team deployed a number of buoys with wave gauges and current meters.

The diving turned out to be difficult. In order to work beneath the surface the divers had to add weight of about 25 kg distributed evenly over their bodies. Their suits had to be watertight, especially the face plates and breathing systems; leaks could be fatal at a 35-m depth. Water temperatures ranged up to 35°C, with air temperatures on board the diving platforms up to 40°C. Under these conditions, the divers used enormous amounts of energy just to get to their working sites; and once there, the divers could not use the "buddy system" because the breathing devices could not be removed and purged of the supersaturated waters. Finally, at 800 m below sea level and a water density of 1.5, standard compression tables were useless. For further information on the diving problems, contact the Physical Oceanography Department of the Israel Oceanographic & Limnological Research Ltd., Tel Shikmona, Haifa, P.O.B. 8030, Israel.

Preliminary results of the IOLR research suggest that: (1) mixing of the waters will take place rapidly; (2) there will be no major problem with a "unique chemical process," such as rapid precipitation of a mineral constitute; and (3) higher waves than expected occur in the Dead Sea, up to 1.7 m. I was also told that the increase in the surface area of the Dead Sea, from the present 800 km^2 to 1200 km^2 in 10 years (a rise in the surface elevation of 10 m), would have insignificant impact on the local climate.

2/9/84

GLORIA TO THE EXCLUSIVE ECONOMIC ZONE

by Robert Dolan.

In March 1983, President Reagan declared that the US's Exclusive Economic Zone (EEZ) would include all underwater areas out to 200 nautical miles (370 km). When all such US areas are added up, the total amount of "new land" almost exceeds the existing land area of the US.

Regardless of the potential for undersea minerals, there are no mining activities in the US's EEZ now--nor are any anticipated in the near future. The most promising mineral considered exploitable from the ocean floor is manganese; however, the mining of manganese nodules has yet to begin on a commercial scale. Perhaps the best bet for mining in the US EEZ will be phosphorite deposits. The world demand for phosphate is high, and there are large deposits within our EEZ.

One of the first steps toward use of the US EEZ is the exploration and evaluation of the ocean bed geology. I was therefore interested to learn that the British Institute of Oceanographic Sciences (IOS) will help us in this endeavor.

The IOS has entered into a $1.5 million agreement with the US Geological Survey (USGS) to "insonify" much of our EEZ with their side-scan sonar, GLORIA (Geological Long-Range Inclined Asdic). The product of this survey will be strips of pictures of the ocean floor of remarkable clarity and detail (Figure 1). The current version of GLORIA, the Mark II, has ranges up to 30 km on both sides of the ship (track line), the surveying speed can be as high as 10 knots (18 km/hr), so the seabed area insonified is at a rate of 1100 km^2/hr.

The IOS has experimented with and developed GLORIA over the past 20 years. The Mark II is designed to work in relatively deep water (about 500 m or more), sending out acoustical beams between 6.2 and 6.8 kHz. The range resolution is 5.33 m, and the cross-range resolution is 2.5 degrees.

The returned signals are recorded on magnetic tape, played out on a photographic recorder, photographically anamorphased (stretched) to correct for the ship's speed, and printed at various scales as sonographs. At this stage the sonographs look like ordinary pictures of the seabed, but they are not. The eye resolves different objects by angular differences, whereas sonar resolves objects primarily by range differences. To get a "corrected" perspective on a sonograph, one must look toward the source of the beam or sound rather than away from it. In deep water the near-range field is greatly distorted by the angle at which the acoustical beams reach the bottom. At IOS they mosaic the sonographs with substantial overlays to correct for this

Figure 1. Conceptual diagram of GLORIA side-scan sonar (source: IOS).

inherent distortion. However, with the data collected in this summer's surveys of the US's EEZ, the USGS--in collaboration with the US Jet Propulsion Laboratory--will further process the digital recordings using image enhancement techniques. Slant range distortion is already being removed, and further research shows that shaded relief, stereo imaging, and more accurate representation of signal strengths will be possible. The final product of the US/UK surveys will be an atlas of the ocean floor, scheduled for publication soon after the surveys and data reduction have been completed.

During a recent visit to IOS to discuss developments in GLORIA and the interpretation of side-scan data, I was shown several sonographs from Atlantic Ocean sites. The most impressive images are of structural trends along the axis of mid-ocean ridges. The side-scan gives strong reflections off steep slopes facing the instrument and off rough seabed, such as mud and sand waves. The IOS GLORIA team has found that almost all the faulting near the ridge axes is confined to a narrow zone only a few kilometers wide. The fault blocks are about 2-km wide on average, which suggests that the lithosphere was only 2-km thick when the faulting took place. The fault scarps run at right angles to the seafloor spreading direction, as shown in Figure 2.

The GLORIA sonographs also show large-scale mudwave fields on the continental margins, and slump sediment masses on the edges of the continental slopes and out on the abyssal plains. They also show a view of underwater meanders (2 to 3 km in wavelength) 10-m deep, well offshore from the mouth of the Amazon River (Figure 3).

So far IOS has operated GLORIA for 10,500 hours, producing data on 7 million km² (this area represents over 2 percent of the world's ocean bed). The data are from cruises in the Gulf of Mexico in 1982, the Cocos-Nazca Rise, the East Pacific Rise, and tracks along the Atlantic of North America. Since the surveying speed is about the same as the cruising speed of most oceanographic vessels, IOS researchers routinely run GLORIA wherever they go, thus rapidly building up a data bank of major

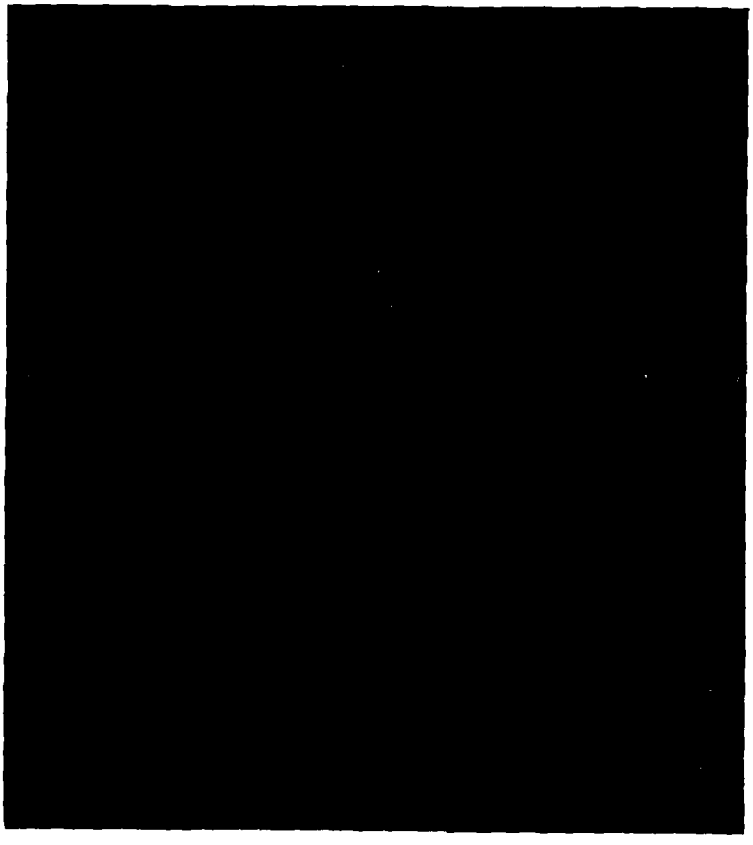

Figure 2. Fault scarps of seafloor spreading (source: Jet Propulsion Laboratory).

importance. This summer's survey will begin in May at San Diego and end 3 months later at the US/Canadian border. Additional North American cruises are being planned for the next several years.

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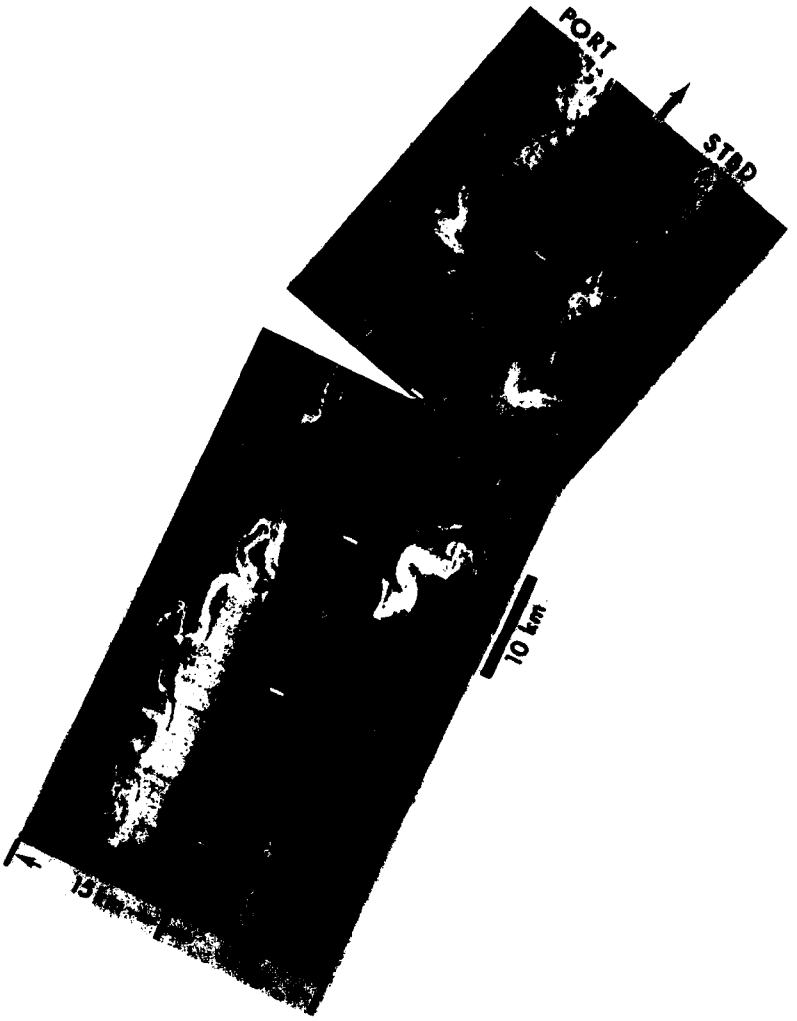

Figure 3. Meander loop traces of the Amazon River 150-km offshore from the river mouth (source: IOS).

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2/10/84

SHALLOW WATER ENVIRONMENTAL RESEARCH AT WEST GERMANY'S FWG

by Chester McKinney. Dr. McKinney is the Liaison Scientist for Underwater Acoustics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1984 from The University of Texas at Austin, where he is Senior Research Scientist at Applied Research Laboratories.

The Federal Republic of Germany (FRG) conducts much of its research and development in a bewildering array of research institutes. One of the smaller and less well known laboratories, which has several projects of direct interest to the US Navy, is the Forschungsanstalt der Bundeswehr für Wasserschall- und Geophysik (Research Institute for the Federal Armed Forces for Underwater Sound and Geophysics), mercifully known as FWG.

FWG, located on the harbor in Kiel, was established in the mid-1960s to conduct basic research and exploratory development (equivalent to the US Department of Defense's 6.1 and 6.2 categories). This was to be work which was needed by the FRG navy but which, because of its specialized or classified nature, would not be available from universities, industry, other institutes, or the North Atlantic Treaty Organization allies. FWG does not get involved in system or hardware development. Most of its effort is devoted to conducting its own research projects, but it also works on some projects with other FRG institutes and is involved in at least two US cooperative programs. FWG also has the responsibility to consult with the Ministry of Defense (MOD), especially on matters relating to underwater environmental problems, and it monitors some MOD contracts with industry. It is fully funded by the MOD, under the administrative supervision of Bundesant für Wehrtechnik und Beschaffung (BWB) and under the professional supervision of Bundeminister der Verteidigung (BMVg).

The first and only director of FWG is Professor Doktor Gunter Ziehm, who has held the position since 1968. Ziehm was involved in research at Krupp Atlas Electronik for 7 years before coming to Kiel. The staff totals 130; 26 of these are scientists. The relatively large number of supporting staff is due in part to personnel requirements for two major research facilities--the North Sea Research Platform (NSP) and the research ship *Planet*.

The major research areas and relative effort are: underwater acoustics (45 percent), geophysics (34 percent), and underwater electromagnetic (EM) waves (7 percent), with the remainder being in support of research facilities. Primary operating areas for the FRG navy are the Baltic and the North Sea, and the FWG program reflects the importance of these areas. Underlying threads of the work in acoustics, EM waves, and oceanography are shallow water, cold waters, rough seas, and high currents. For the past several years much of the field work has been concentrated on the eastern Baltic--since they expect much of that body of water soon to be closed to unimpeded oceanographic cruises, because of countries extending territorial limits to 200 miles offshore.

The underwater acoustics research is largely done at the NSP (for temporal variation studies) and on *Planet* (for spatial variation studies in both the North Sea and Baltic). The NSP is about 75-km northwest of Helgoland. A crew of eight mans the platform, and there are accommodations for 15 scientists. The water depth is about 30 m, with the top working level about 30 m above the water line. An inclined elevator can carry a large transducer (usually employed as a projector) to any depth within the water column. Typically a receiving array is planted up to several miles from the tower. One array is 48-m long and is composed of 17 hydrophones. Typical measurements include variation in propagation loss with time, back scattering from the ocean floor and surface, and ambient acoustic noise. Most research is done at frequencies below 10 kHz and much of it below 1 kHz. Some of the NSP acoustics work is done in cooperation with the US Naval Underwater Systems Center (NUSC), New London. Another NSP project is to measure and correlate ocean-bottom-pressure variations with surface waves and wind speed. This project is a joint effort between FWG and the US Naval Surface Weapons Center (NSWC), White Oak.

The research ship *Planet* is used mostly for acoustic work, which includes the usual experiments on propagation, ambient noise, and bottom and surface reverberation. The goal is to measure oceanographic and acoustic characteristics in operating areas and use these data to develop models which, with meteorological forecasts, can be used to predict operational sonar performance. *Planet* was commissioned in 1967, and cruises started the next year. The ship, which displaces 2000 tons, has five labs and accommodations for 15 scientists. The arrangements for propagation

measurements are fairly conventional, consisting a vertical line array suspended from the ship. An aircraft flies radially outward, dropping a small explosive charge sound source every mile out to about 30 miles.

One of the major projects in the geophysics program is to characterize the bottom sediment in regard to shear strength (in addition to other parameters). They would like to be able to predict the shear strength of the sediment from depth-sounder data. Most of this work has been done at 18 kHz using an ELAC instrument. Their goal is an old and difficult one, but they seem to be making some progress. Another aspect of the same project is to study underwater migrating sand waves. These have wavelengths of 300 to 500 m and amplitudes of a few meters. Often there is a higher frequency wave superimposed on the long wave. These sand waves move at speeds of about 10 to 20 cm per day in open water and up to 3 m per day in rivers.

The electromagnetic wave group is quite small but has done some interesting research over the past decade. Measurements include underwater ambient noise levels (from about 30 Hz to 20 kHz) and transmission loss from a shore-based transmitter (radiating into the air). Loop antennas or ferrite core inductors are used for underwater sensors. The underwater noise level is dominated by the 50-Hz line and its harmonics (power-line frequency), which are many decibels above the continuous background noise. This ambient noise decreases steadily as one moves offshore and varies inversely as the frequency squared. There are several potential applications for this work, with the major one being reliable communication between a shore base and a submerged submarine. The typical shallow-water and often near-shore situation in the Baltic and North Sea areas of prime interest to the FRG make underwater electromagnetic ambient noise an interesting field to investigate. There have been some surprises, such as anomalous peaks in the spectrum and unusual spatial variations. It is not a simple environmental problem.

In another project, FWG has been experimenting with using several US-made commercial side-scan sonars for bottom mapping. They have been disappointed in the performance, but in fact these sonars have been doing precisely as well as the parameters would allow. Such sonars are heavily used in the US and are available from several manufacturers. Evidently this type of sonar is not yet very popular in Germany; I am not aware of any locally made side-scan sonar, although much more sophisticated systems are marketed by companies such as Krupp Atlas Electronik.

Research on the shallow water environment--oceanographic, acoustical, and electromagnetic--is the forte of FWG. In my view the US undersea community traditionally has neglected this important segment of the oceans. For this reason it is prudent to follow the FWG projects closely, exchange relevant information, and continue to engage in joint projects (as NUSC and NSWC are doing already).

2/17/84

UNDERWATER ACOUSTICS AT SACLANT ASW

by Chester McKinney.

SACLANT ASW Research Centre is interesting both because of its scientific program and its structure, which differs from other activities engaged in comparable work. Located in La Spezia, Italy, it is a North Atlantic Treaty Organization (NATO) research and development laboratory that was established in 1959 to provide additional R&D effort to meet the growing ASW threat to NATO. (For the nonspecialist reader, SACLANT is the acronym for Supreme Allied Command, Atlantic, and ASW is Anti-Submarine Warfare).

It was felt that a NATO-wide organization could supplement and complement on-going national programs and would have the added advantage of using human resources from countries which on their own would not be able to support viable ASW research centers. A policy of rotation of scientists allows each country to have the opportunity for some of its best people to obtain valuable experience and then return home to serve in responsible positions.

At present the total staff numbers about 230, approximately 45 of these being professional scientists. By US standards this is not a large establishment, but it is above the critical size needed to undertake significant projects, and the quality of the work is high. About a dozen NATO countries have representatives on the research staff, with about nine new members joining each year to replace those returning home. The standard tour is 3 years, which in some cases is extended another 1 or 2 years. A few staff members have stayed on for 15 years or more. Rotation is essential if the goals of the center are to be met, but such a policy has the obvious disadvantage of discontinuity on

research projects. Having at least a few long-tenure staff is especially valuable for operation and use of specialized complex equipment and in conducting sea trials and experiments. Dr. Ralph R. Goodman (US) has been director since 1 November 1981, and his tour will be extended to 5 years. Dr. Ronald S. Thomas (Canada) is Deputy Director.

NATO funds the center and its scientific program entirely and on a single annual budget basis. Once a budget (with specific projects identified) has been approved by NATO, the center and staff are assured of the funds. NATO organization allows the administrative matters to be handled in the directorate, thus freeing the scientific staff to concentrate on research work.

The current program of 12 projects is split about equally between basic research and development. Development does not proceed beyond the identification and establishment of feasibility for systems and subsystems and possible system development in NATO. Approximately two-thirds of the work is unclassified. Member nations and the various NATO offices have the opportunity to recommend projects and to express their level of interest in the on-going projects. These inputs are taken into account in structuring the program. The primary scientific advisory group for the center is the Scientific Committee of National Representatives (SCNR) which meets twice a year to review the program and make recommendations. I was pleased to attend a recent meeting of SCNR in which all of the projects were reviewed.

The basic research program in underwater acoustics was reviewed by O.F. Hastrup (department head), T. Akal, R.M.H. Heitmeyer, and F. Jenson. The experimental program involves research on low frequency (6 to 800 Hz), long range (up to 700 km) propagation using explosive sound sources, mostly in the Mediterranean, with some in the eastern Atlantic. Emphasis has been on measuring the periodicities in propagation loss due to temperature changes and tides in both shallow and deep water. Low-frequency reverberation studies have been made also in the Mediterranean and along the eastern Atlantic coastal area. Data have been collected with both vertical and horizontal arrays. Ambient noise studies cover both shallow waters (hard and soft bottoms) and deep waters. The aim is to develop models to resolve the contributions of shipping (low frequency), wind (high frequency), and other features, such as rain-generated noise. Again both vertical and horizontal arrays are employed for the field work, and it is planned to implement a high-resolution array.

An extensive model-development program is conducted in parallel with the experimental data collection program. The ultimate aim (in addition to obtaining a better understanding of basic underwater acoustic processes and phenomena) is to provide models for predicting, spatially and temporally, propagation loss, ambient noise levels, and reverberation--especially in the Mediterranean and eastern Atlantic coastal areas. These can be of operational use to NATO ASW forces. Clearly the SACLANT Centre program is filling a need in this regard. Emphasis is placed on having models which can be used readily by new employees of the center. This is important in an organization which has a rotating staff.

In the area of oceanographic research, Brian Wannamaker briefed the committee on a small but very interesting program which involves using satellite infrared (IR, 10 to 12 μm) data received at La Spezia. He has developed the hardware and software to display the IR pictures in a way to show features such as currents, gyres, and internal waves. The IR data provide information on sea-surface skin temperature, but not an absolute calibration. The satellite data are used to indicate interesting areas to investigate with a surface ship and oceanographic probes. Wannamaker feels that the presently available satellite IR data, if properly processed, can be operationally useful in ASW.

A related project involves research on gyres and internal waves. These two phenomena are created independently, but they do interact. Measurements include vertical STD (salinity, temperature, depth) probes through gyres and sound propagation losses. The direction of rotation of a gyre at a 200-m depth may be the reverse of that at the surface.

The system-concept evaluation program was reviewed by T.G. Goldsberry (department head), L. Lloyd, T.J. Knudsen, and R. Thompkins. These are projects to explore new concepts in active and passive sonar.

One project involves the study of the concept of using multiple-influence, short-range underwater sensors in ASW. A major component of the system is the telemetry subsystem for locating the sensors and for communicating from the sensors to the command base. Much of the work is directed toward the development of the telemetry equipment. Some hardware has been built and preliminary data collected.

Two other projects include work on synthetic aperture sonar and

improvements in bearing determination. For the latter, the group has developed a different type of split beam processor which involves use of the cross correlation of both the real and imaginary components of the received signal. This system has been compared with a conventional beamformer and a maximum likelihood beamformer. Another project deals with computer interpretation of sonar-echo data using artificial intelligence techniques (expert system approach and blackboard techniques, which are a combination of several expert systems). Another project involves the analysis of low-frequency reverberation data in terms of temporal and spatial statistics, scattering strength, Doppler spectral shapes, and threshold levels. Software packages have been developed for data acquisition and single-ping processing. Their equipment involves multiple beams and both continuous wave and linear-frequency-modulation pulse transmission.

The operations research (OR) program, reviewed by R. Root, specializes in conducting force-employment studies for NATO. This group has compiled an environmental data bank which, when combined with sensor-performance estimates, can be used to make tactical performance estimates. The data bank is also used to support other research groups at the center. The OR group has developed a number of computer models to use in its various studies.

The center has five special support groups (headed by R. Thomas): one for computer-based equipment and the others for instrumentation development, electronics, ship operation, and technical information. The computer group, headed by R. Seynaeve, is responsible for computer selection and the development of associated hardware and software, including array processors, beamformers, and other signal-processing devices. They maintain two real-time systems--one for use at sea and one for the laboratory. The Ocean Engineering and Electronic Instrumentation groups, under F. de Strobel and A. Barbagelata, are responsible for development of a variety of mechanical and electronic equipment for use at sea. These include deep drifting floats, oceanographic moorings, sound sources and sensors, data transfer devices, and acoustic calibration facilities.

Next year SACLANT ASW Research Centre will celebrate its silver anniversary. It is now a mature laboratory with a vigorous research and development program. Their new research ship, to be delivered in 29 months, will give the center a significantly greater at-sea capability (*ESN* 38-1:34 [1984]). Furthermore, this new ship surely will influence future directions for the research program. The number of current projects may seem large for the small professional staff, but each project seems healthy. I suspect that when the center was established there were many who wondered if such a laboratory could be successful. From this vantage point it appears that the experiment worked well indeed.

2/13/84

PHYSICS

AN ADAPTIVE MESH TECHNIQUE FOR THE SOLUTION OF RADIATION-HYDRODYNAMIC EQUATIONS

by David Mosher. Dr. Mosher is the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until July 1984 from the Naval Research Laboratory, where he is Supervisory Research Physicist.

Numerical solutions of fluid dynamics equations by large-scale computers have enhanced basic understanding of natural phenomena spanning the scales of elementary particle physics to cosmology. By solving the differential form of the equations along with realistic initial and boundary conditions, these computations are also appled to practical problems in meteorology, aerodynamics, material response, hydrodynamics, weapons and detonation physics.

Straightforward numerical solution of the differential equations becomes difficult when shock fronts or contact discontinuities appear in the flow. The integral form of the equations can be used instead to derive the Rankine-Hugoniot relations which link the two sides of a fluid discontinuity. To take advantage of these discontinuity jump conditions in a computer code, one can usually track the interface or shock front with a moving calculational mesh. However, this approach becomes complicated and cumbersome when a large number of discontinuities are generated and when external forces or radiation impose additional time and length scales on the flow. Complicated features with steep density gradients can develop which cannot be adequately resolved with standard Eulerian or Lagrangean finite-difference techniques.

In a February visit to Germany, I spoke with Karl-Heinz A. Winkler (Max-Planck-Institut für Physik und Astrophysik in Garching bei München) about his use of adaptive mesh techniques to solve this difficult class of problems. He described an implicit finite-difference technique designed to locate and track arbitrary fronts, interfaces, and other narrow structures in a radiation hydrodynamic flow. The mesh is constructed so that localized features can be resolved a million times finer than with a grid consisting of the same number of equispaced mesh points. The crucial feature, worked on by Winkler for several years, is the use of a stiffness operator in the mesh algorithm which provides a smooth and stable change of grid spacing between regions of rapid and slow variation.

An elliptic equation for the grid motion is solved implicitly and simultaneously with the equations describing the flow variables. During each time step, narrow features can travel many times their own width in true space, though motion relative to the adaptive mesh is always less than one computational zone. Thus, the accuracy limitation imposed by the Courant condition (R. Courant et al., 1928) is always fulfilled--even though there is no intrinsic time-step limitation associated with the implicit numerical procedure. The choice of time step in the adjustable mesh is based only on physical accuracy requirements.

After describing the numerical procedure, Winkler presented the solution of two classic one-dimensional problems using the adaptive mesh technique. The first problem, a simple shock tube with analytic solutions, provided a test of the technique's accuracy. The second, protostar formation, demonstrated the ability to follow extremely steep gradients. The performance of the adaptive mesh technique in the solution of these problems was remarkable.

The adaptive mesh algorithm treats all flow features as smooth. Shock fronts are artificially smeared to a small fraction of an equidistant zone size and are treated as are other flows. The equations for the grid distribution and fluid flow are solved implicitly and iteratively by a quadratically converging Newton-Raphson method. The grid distribution equation, describing the locations x(j) of zone boundaries indexed by j, provides a prescription for moving the grid lines in time so as to make optimal use of the given number of zones. The spatial position of each grid point is updated every time step by solving the elliptical equation

$$df(j) = f(j-1)-f(j) = 0 \qquad (1)$$

with function f defined by

$$f(j) = \sum_{\psi} W_{\psi} d\psi(j) + \sum_{\psi} W_{\psi 1} d\psi 1(j) + \text{stiffness terms.} \qquad (2)$$

The W terms are constant weighting factors for each of the dependent variables ψ (including the grid point x values). The quantities $d\psi$ and $d\psi 1$ represent changes between grid points defined by

$$d\psi(j) = \psi(j) - \psi(j+1) \qquad (3)$$

$$d\psi 1(j) = \left|\Psi(j)-\Psi(j+1)\right| / [\psi(j)+\psi(j+1)]. \qquad (4)$$

When a single term of the form of equation (3) is used for f(j) in equation (1), the solution is an equidistant mesh. When a term of the form of equation (4) is substituted, a mesh which is equally spaced in the logarithm of ψ results. Winkler uses a sum of weighted $d\psi$ terms with ψ representing the variables x, m--the Lagrangian mass variable, and μ--the mean molecular weight. (A nuclear propagating burn can have a sharp interface with different elemental abundances on each side. Thus, a contact discontinuity in μ can occur.) Other flow variables, which can vary by many orders of magnitude over the mesh, contribute to the sum of $d\psi 1$ terms. These variables include logarithmic differences for x and m, and the following: the specific internal energy e, the energy density of the radiation field E, the gas density ρ, the gas pressure P, the nuclear energy generation rate N, the Eulerian velocity of the gas u, and the ratio of kinetic to internal energy q. This last quantity is important for pulling grid points into shock fronts.

In general, one wants grid distributions in which all variables are resolved equally well. Therefore, the various weighting factors usually are chosen to be of order unity. The grid distribution equation is then solved simultaneously with the radiation-hydro equations in an iterative fashion at each time step.

For many applications, the difference terms already considered give an excellent grid distribution--grid points run closely together when physical variables vary sharply over short distances and are far apart where their variation is slow. However, in some cases, a numerical instability develops in which the grid distribution assumes alternately narrow and wide zones. This difficulty can be overcome by use of the

stiffness operators indicated in equation (2). These addition terms take the form:

$$\text{stiffness terms} = W_z dx(j)^2/[dx(j-1)dx(j+1)] + W_{z1} dx1(j)^2/[dx1(j-1)dx1(j+1)]. \quad (5)$$

The terms result in a widening of narrow zones and vice versa, thereby stabilizing the mesh. They also anticipate steep flow features so that the mesh becomes gradually and smoothly narrower as the feature is approached.

Figure 1 shows the geometry and dynamic evolution of pressure, density, internal energy and velocity in a simple shock-tube problem. At t = 0, a diaphragm separating a high-density, stationary, ideal gas on the left (P = 1, ρ = 1, e = 2.5, u = o) from one of lower density on the right (P = 0.1, ρ = 0.125, e = 2, u = o) is instantaneously removed. The initial discontinuity leads to the formation of two waves. The wave going to the right is a shock front; that going to the left, a rarefaction wave. The early stages of the flow (before reflection from the walls at x = 0 and 1) can be solved analytically (Chorin, 1976), and that solution at a normalized time of t = 0.25 is shown in Figure 1c.

Figure 2 shows the numerical solution at t = 0.228 using an adaptive mesh of 292 grid points. For this calculation, the weight factors were chosen to be $W_x = 1$, $W_z = 0.5$, $W_{e1} = 2$, $W_{\rho 1} = 4$, and $W_{P1} = 1$. The artificial viscosity length was set to 0.005 of an equidistant zone width. Since the widths of the artificially broadened shock fronts are four to five times this length, the front occupies only a tiny fraction of an equidistant zone width.

Comparison of the analytic and numerical solutions shows that all significant flow features agree to better than 0.01 percent at the times shown. The numerical solution has also been carried out to much later times than can be treated analytically, demonstrating the ability to follow multiple shock reflections and merging. Figure 3 snows the grid spacing dx as a function of the zone index j at the time of Figure 2. The shock front and contact discontinuity features contain most of the grid points in a very narrow real space region with grid spacing varying by five orders of magnitude in the computational interval.

Gravity imposes an additional length scale so that, in contrast to usual free hydrodynamic flows, gravitational flows are not scale invariant.

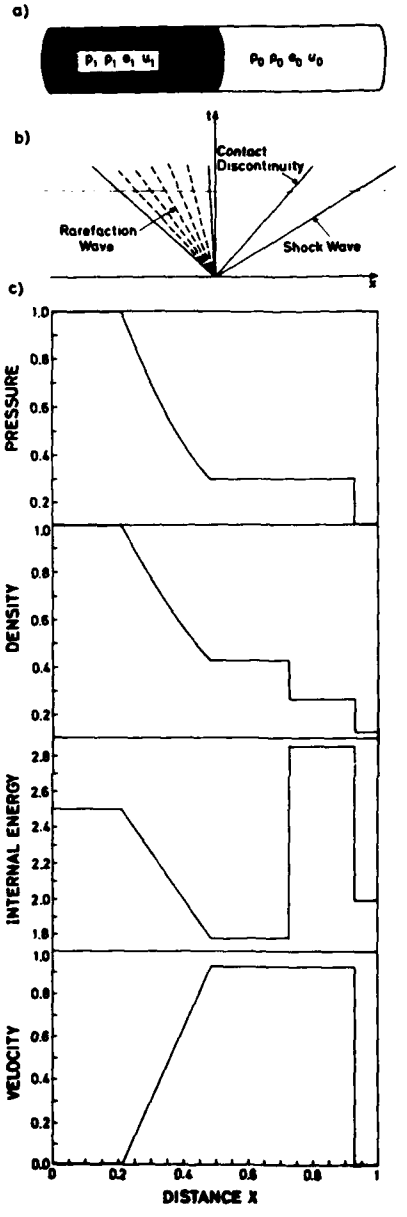

Figure 1. Analytic evolution of the shock tube.

Matter will tend to bunch up and be compressively heated. Temperature gradients will then lead to stratification of all flow variables on a number of length and time scales set by local conditions and nonlocal radiation effects. Traditional Eulerian and

Lagrangean techniques are inadequate to model the very steep structures which arise. Fine Eulerian zoning in space and time can result in an unacceptably short time step, and the mass elements of a Lagrangian mesh would be stretched and compressed by many orders of magnitude, leading to numerical errors. The adaptive mesh has been specifically designed to handle this difficult problem.

Winkler demonstrated the influence of gravity alone by considering a one-dimensional, spherically symmetric accretion flow with a simplified equation of state (a $\gamma = 5/3$ ideal gas) and constant opacity (1 cm²/g). For initial conditions, he assumed a homogeneous gas cloud of 1 solar mass at 10°K filling a sphere of radius 1.0×10^{17} cm and embedded in a 10°K background radiation field. With these parameters, the cloud is gravitationally unstable and rapidly collapses. A tiny high-density core forms, onto which the remaining cloud slowly accretes. The infalling gas is accelerated until it stagnates in the thin stellar atmosphere surrounding the core. An accretion shock forms in the atmosphere where density, temperature, and flow velocity change by orders of magnitude. This problem is more challenging than the shock tube because of the large variation in flow parameters across the shock.

A snapshot of the accretion flow is shown in Figure 4. The grid distribution was determined from equation (1) with $W_{x1} = 1$, $W_{z1} = 3$, $W_{m} = 50$, $W_{m1} = 0.01$, $W_{q1} = 3$, $W_{e1} = 1$, $W_{\rho 1} = 5$, $W_{p1} = 1$, and $W_{e1} = 1$. As the thickness of the shocked region is very much less than its radius, the variations across it can be compared to planar analytic jump conditions. Agreement with the numerical solution is within 0.7 percent for the density jump.

Winkler and coworkers have extended this work to the evolution of a realistic protostar by improving the equation of state and opacity models and by including nuclear burn (Winkler et al., 1983). The solution demonstrates the ability of the adaptive mesh technique to follow a series of collapses and shock waves on time scales ranging from 10^3 s to 10^{12} s into the nuclear burning phase of the mature star. They have also formulated one-dimensional, adaptive-mesh radiation hydrodynamics with relativistic corrections to model larger astrophysical systems (Mihalas et al., 1983).

The problem of greatest current interest to Winkler is extension of the adaptive mesh technique to flows of more than one dimension. Although his

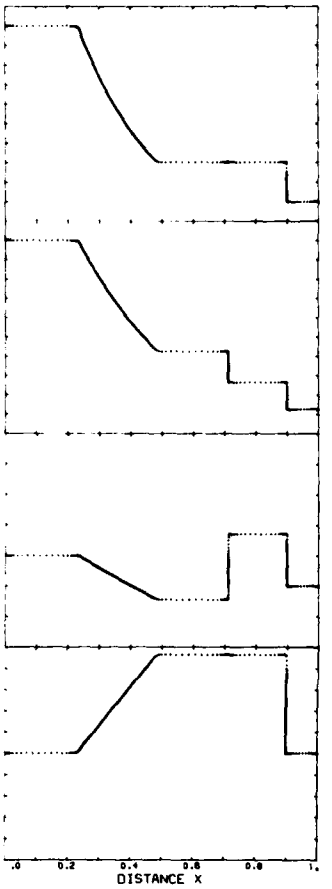

Figure 2. Numerical solution at a similar time.

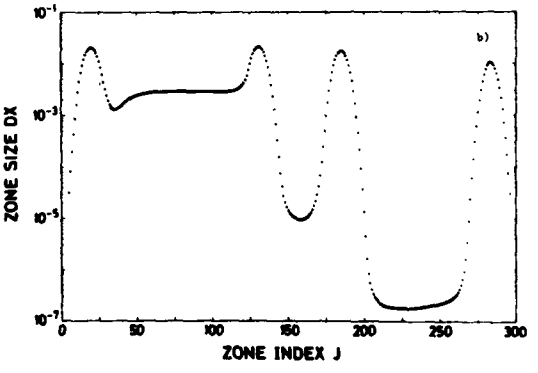

Figure 3. Grid distribution for the time of Figure 2.

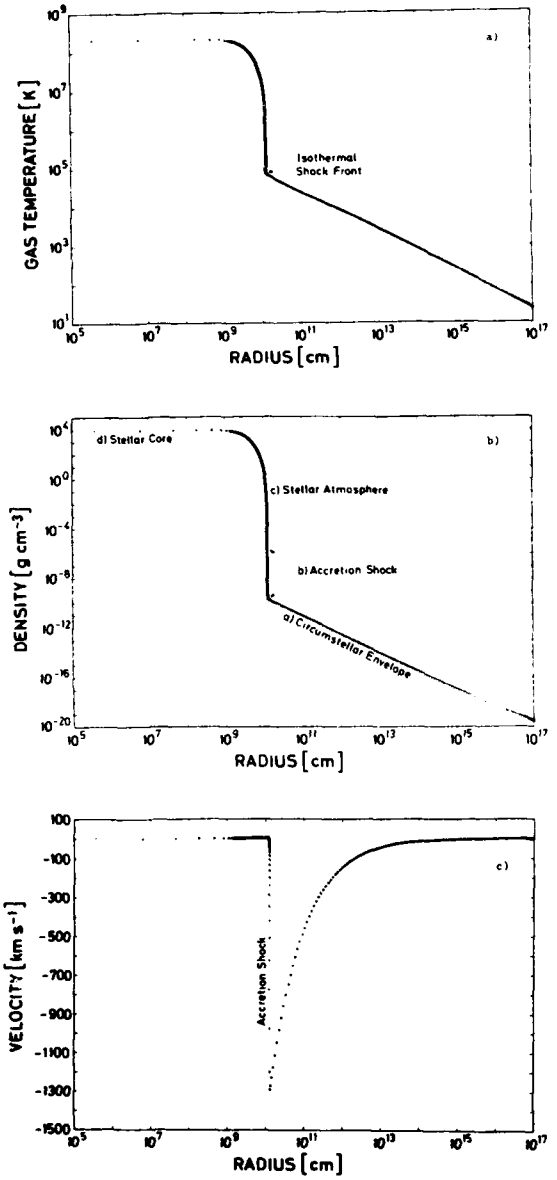

Figure 4. Flow variable profiles for an accreting shock.

technique is elegant, one-dimensional problems are usually tractable with large computers. An adaptive mesh in two dimensions, however, could have a major impact since problems of interest are often quite lengthy or even intractable on the biggest machines. Winkler will be immigrating to the US this summer and will continue work on the adaptive mesh technique at the Los Alamos National Laboratory, New Mexico.

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2/22/84

A NEW TYPE OF NATURAL RADIOACTIVITY

by David Mosher.

The means by which radioactive nuclei decay to other elements have been known for many years. Decay by emission of the alpha (helium nucleus) and beta (electron) particles was studied at the beginning of this century. Positron emission, internal conversion of an atomic electron, and nuclear fission are less common forms of decay but are also well documented.

Now, research in the Department of Nuclear Physics at the University of Oxford has shown that unstable nuclei can also emit carbon. H.J. Rose and G.A. Jones have observed a few ^{14}C nuclei among the decay products of ^{223}Ra, otherwise considered to be a simple α emitter with a half-life of 11.2 days. With a measured ^{14}C-to-α ratio of about 10^{-10}, it is easy to understand why this novel form of radioactive decay has not previously been observed.

The isotope ^{223}Ra is an intermediate product of the decay scheme starting from ^{235}U and ending in lead with the emission of α particles and electrons. Rose and Jones demonstrated that it is possible for a parent nucleus to take a shortcut in the decay by shedding a larger chunk of charge and mass. This by-pass decay process is extremely rare, so observation of a radioactive sample for more than 6 months was required to assemble a meaningful number of measurements.

The radioactive source was ^{227}Ac with a half-life of 21 years, so that

^{223}Ra is a daughter nucleus in secular equilibrium. A solid-state counter telescope was used to identify the emitted species through stopping power and total energy measurements. The main problem with the rare carbon detection was discrimination between its electronic signature and that of several simultaneous α particles. Although multiple pile-up is rare with only about 4000 alpha decays per second, the probability of occurrence is significant for the long measuring period required to gather carbon statistics. Another problem with the long measuring times is α-particle damage to the detectors and the resulting unreliable energy measurements. One cannot shield against the α particles because their range is comparable to that of the carbon nuclei. New detectors and careful monitoring of single α events during the 189-day measurement run was required for a reliable ^{14}C energy determination. Data gathered using on-line LSI-11, Camac-based, two-dimensional storage techniques are displayed in Figure 1. The system was energy-calibrated using a ^{241}Am source whose 5.48-MeV α-particles have similar fractional energy losses in the detector as the carbon.

The dashed lines in the figure indicate the energy loss dependence on total energy for carbon nuclei. The two arrows indicate the total energies expected for ^{12}C and ^{14}C from the Q-values of their ^{223}Ra decay reactions. The solid dots indicate individual measurements, and the crosses are spurious measurements associated in one case with quadruple α-particle buildup and in the other with electrical failure. The ^{14}C decay product is clearly identified.

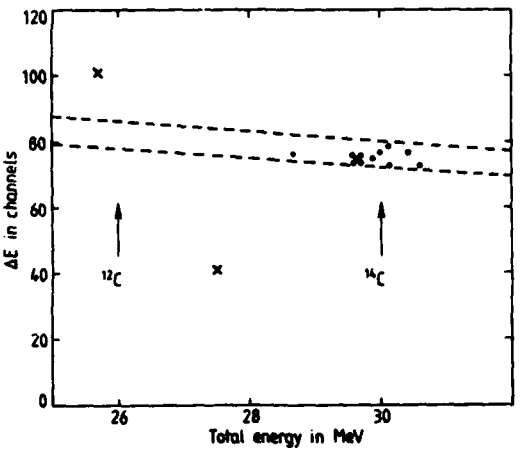

Figure 1. Energy loss versus total energy for detected nuclear fragments.

At this point, it is interesting to ask why nature has chosen radioactive ^{14}C for the short decay rather than the stable ^{12}C form. After all, the normal decay scheme of ^{223}Ra involves the successive emission of three α-particles, and ^{12}C can be viewed as such a group. Rose and Jones answered this question by assembling the Gamow factors--essentially the probability of tunneling through the nuclear barrier--for plausible heavy particle decay modes of ^{227}Th, ^{227}Ac, ^{223}Ra, and ^{219}Rn. The decay ^{223}Ra → ^{14}C + ^{209}Pb had a Gamow factor five orders of magnitude larger than its nearest competitor, and seven orders of magnitude larger than radium decay via ^{12}C. The calculated probability for ^{14}C tunneling was from 10^{-3} to 10^{-5} times as likely as α decay. However, the probability of observing the decay depends not only on tunneling but also on the probability that a nuclear cluster of the correct charge and mass will form in the parent nucleus. For ^{12}C to be observed, its preformation probability would have to be comparable to that of α particles. For the observed $8.5\pm2.5\times10^{-10}$ ratio of ^{14}C nuclei to α-particles, Rose and Jones calculate a preformation probability in the range of 7×10^{-5} to 4×10^{-7} times that for α particles in the same nucleus.

The researchers feel that similar by-pass decays must occur in other neutron-rich nuclei but that candidates are likely to be man-made rather than naturally occurring. Applications for such novel reactions are not obvious because of their infrequent occurrence. But however rare, the reactions do occur, and such exceptions to the rule have frequently been responsible for profound changes in our understanding of nature. At a minimum, the work of Rose and Jones rules out the possibility that such decay is forbidden by some unknown nuclear selection rule.

2/22/84

SCIENCE POLICY

EUROPEAN SCIENCE ASSESSMENT AND PLAN AVAILABLE

by James W. Daniel, Scientific Director for Europe and the Middle East for the

Office of Naval Research's London Branch Office. Dr. Daniel is on leave until August 1985 from the University of Texas, where he is Professor of Mathematics, of Computer Sciences, and of Education.

The bold new objective-based plan of the European Economic Community (EEC) to improve its scientific and technological output was described briefly in Thomas C. Rozzell's article "Toward a European Research and Science Strategy" (*ESN* 37-12:455-456 [1983]). As of this writing the EEC Council--the decision-making body--has not adopted a 1984 budget, so the resources actually to be allocated to the new strategy are still unknown. However, we have obtained the documents containing the EEC's self-assessment of its science and technology--which led to the creation of the new strategy--and those containing the detailed goals proposed for 1984-87 in support of the strategy's general objectives. This material is available as ONR, London (ONRL) Report R-2-84; it gives a picture of the present and the possible future of a community that produces one-fifth of the world's R&D and whose nonmilitarily provided R&D funding is twice that of Japan and three-fourths that of the US.

EEC Council Resolution

Chapter I of the ONRL report presents the background and wording of the EEC's formal resolution of 25 July 1983. That resolution states that "...a common strategy in the field of science and technology..." shall be developed in terms of "...framework programs setting out the scientific and technical objectives to be pursued at Community level together with selection criteria for Community action, relative priorities, and financial indications...." The Council clearly stated that specific R&D activities would be evaluated from the viewpoint of the framework program's objectives; the objectives for 1984-87 were approved as:

- Promoting agricultural competitiveness by developing productivity and improving products in both agriculture and fishing;
- Promoting industrial competitiveness by removing and reducing barriers, by introducing new techniques and products in traditional industries, and by developing new technologies;
- Improving the management of raw materials;
- Improving the management of energy resources by developing fission, fusion, and renewable energy, and by rationally using energy;
- Stepping up development aid;
- Improving living and working conditions by improving safety, protecting health, and protecting the environment; and
- Improving the effectiveness of the EEC's scientific and technical potential.

The Council resolution confirmed the need to increase R&D spending, but of course chose to await the outcome of general budget deliberations before allocating specific amounts. It did, however, "take note" of the financial indications attached to the resolution, which are to serve as the guide for later Council actions. Table 1 displays those indications in millions of European Currency Units (1 ECU in November 1983 was worth about $.85).

EEC's Self-Assessment

When the EEC Commission--the permanent staff--first proposed the so-called "Framework Program" to the Council in a 21 December 1982 document, included in the supporting materials was the Commission's assessment of the Community's international position in science and technology in 1982; that assessment is reproduced in the ONRL report's Chapter II. General conclusions in the assessment were that:

- European creative scientific productivity is declining;
- Insufficient multidisciplinary research is conducted;
- Large areas of research are untouched because universities consider it too applied and industries too basic; and
- Scientific supply and demand are rarely well matched.

Detailed Objectives and Goals

Another section of that 21 December 1982 proposal is contained in Chapter III: the detailed specifications of and arguments for the general Framework Program as well as its specific objectives. In the list of roughly 70 objectives are:

- Improving use of waste and by-products;
- Modeling and evaluating fish resources;
- Standardizing nuclear measurements;
- Developing information technology;
- Developing biotechnology;
- Improving use of minerals;
- Improving reactor safety;
- Operating the Joint European Torus;
- Developing direct solar energy;

Table 1

Proposed Funding

		MioECUs[1]	Percent
1.	Promoting agricultural competitiveness	130	3.5
	- developing agricultural productivity and improving products: agriculture	115	
	fisheries	15	
2.	Promoting industrial competitiveness	1060	28.2
	- removing and reducing impediments	30	
	- new techniques and products for the conventional industries	350	
	- new technologies	680	
3.	Improving the management of raw materials	80	2.1
4.	Improving the management of energy resources	1770	47.2
	- developing nuclear fission energy	460	
	- controlled thermonuclear fusion	480	
	- developing renewable energy sources	310	
	- rational use of energy	520	
5.	Reinforcing development aid	150	4.0
6.	Improving living and working conditions	385	10.3
	- improving safety and protecting health	190	
	- protecting the environment	195	
7.	Improving the efficacy of the Community's scientific and technical potential	85	2.3[2]
	- horizontal activities	90	2.4
		3750	100.0

[1] In ECUs at 1982 constant values.

[2] Corresponds to 5 percent by the end of the period.

- Boosting agriculture, breeding, forestry, and desert management in less developed member states;
- Improving health technology;
- Controlling pollution and preserving the environment; and
- Stimulating R&D in key fields such as oceanography, surface chemistry and surface physics, and composite materials.

Full details are available in ONRL Report R-2-84.

2/10/84

NEWS & NOTES

MICROCOMPUTERS IN EDUCATION

The application of microcomputers in public education is spreading rapidly in Europe. Research in the field, which began as early as the 1970s in some countries, is hard pressed to keep pace. The research is difficult because of the time needed to develop courseware and because of the multidisciplinary character of the work: instructional psychology, differential psychology, teacher education, curriculum design, computer technology and programming, and several

related specialties must usually be involved.

Now a UNESCO Joint Study Commission has been formed to put together a survey of microcomputer use and related research in education. The countries involved are: Austria, Canada, the Federal Republic of Germany, France, Hungary, The Netherlands, the United Kingdom, and the USSR. National coordinators from each of these countries met for the first time in Amsterdam in May 1983. It is expected that the study will proceed to final report by December 1985. For information, write to Drs. Jos Beishuizen, International Coordinator, Vrije Universiteit, De Boelelaan 1115 C-122, 1081 HV Amsterdam, The Netherlands.

In a related development, Sweden has adopted a common microcomputer system called COMPASS for all its public schools. It is scheduled to appear in the schools within the year. A distinct advantage of the plan is the common courseware, including extensive computer graphics, that will be used. It is expected that research will proceed rapidly once the system is in place. For information, write to Dr. Berner Lindström, Department of Education, University of Göteborg, Box 1010, S-431 26 Mölndal, Sweden.

Richard E. Snow
2/10/84

AERIAL PHOTOGRAPHY OF PALESTINE

While visiting Israel recently I was referred to what must be among the oldest collections of aerial photography available in the world. In November 1917 the German army unit occupying part of Palestine conducted a series of aerial photo flights over what is now Israel and Lebanon. The photo collection, which is now in Germany, consists of 100 near-vertical and oblique black and white pictures of virtually every city and town in Palestine, as well as many excellent views of the coastal zone, the Dead Sea, and the Negev Desert. For a full description of the flights, a map of the flight paths, and interpretations, reference should be made to Von G. Dalman, *Schriften des Deutschen Palästina--Instituts* (Gütersloh: Druck and Verlag von C. Bertelsmann, 1925), Vol 2, *Hundert deutsche Fliegerbilder aus Palästina*. There is a complete set of the photos in Israel. For additional information on their availability, ordering, and costs, contact:

Professor Victor Goldsmith
Israel Oceanographic & Limnological Research Ltd.
Tel Shikmona P.O.B. 8030
31080 Haifa
Israel

Robert Dolan
2/9/84

THE UK NATIONAL ENGINEERING LABORATORY

The National Engineering Laboratory (NEL), one of the six research establishments of the UK Department of Industry, is a center for mechanical engineering research and development located on a 65-acre site in Scotland. NEL performs advanced engineering design and testing in areas relating to fluids, materials, machinery, and energy. NEL's services can be engaged on a fee-basis, by contract, by consultancy, or by other arrangements.

An important NEL activity that publicizes its capabilities and services is the sponsoring of conferences, seminars, and courses of international industrial interest. Past and future NEL courses and conferences for 1984 include: International Conference on Flow Measurement in the Water Industry, 10 to 12 April; Principles and Practice of Flow Measurement (course), 14 to 18 May; A Practical Introduction to CADCAM, 20 to 23 March, 1 to 4 May, and 12 to 15 June; and the IAHR symposium on Hydraulic Machinery in the Energy Related Industries, 27 to 30 August.

For further information write to:

Publicity & Information Section
National Engineering Laboratory
East Kilbride, Glasgow G75 0QU
United Kingdom

NEL also distributes a newsletter on its programs and services, along with announcements relating to matters such as management and personnel, exhibitions, courses, and conferences.

R.L. Carovillano
2/6/84

INTERNATIONAL SYMPOSIUM ON THE SILENT SHIP

The North Atlantic Treaty Organization's SACLANT ASW Research Center, La

Spezia, Italy, is sponsoring an international symposium called "The Silent Ship: Research Applications and Operations." The symposium will be held from 1 through 5 October 1984 at La Spezia. The purpose of the meeting is to bring together those who use quiet ships in underwater research with those who operate them. Recent developments in the quieting of ships have offered new opportunities for underwater research, while at the same time the increased complexity of the shipborne equipment has placed greater demands on those responsible for maintaining and operating ships at their maximum efficiency. Readers desiring additional information should write or telephone:

Pierre Blavier
SACLANCEN
Viale San Bartolomeo 400
19026 La Spezia
Italy
Telephone: 39 187 560 940 Ext. 282.

Chester McKinney
2/24/84

EUROPEAN PHYSICS MEETING IN PRAGUE

The European Physical Society (EPS), in collaboration with the Union of Czechoslovak Mathematicians and Physicists, will hold its 6th General Conference from 27 through 31 August 1984 in Prague. The general conferences of the EPS cover wide areas of physics and of the concerns of physicists. The Prague meeting will include plenary sessions, the Powell Memorial Lecture "On Being a Physicist," a business meeting of the EPS, and symposia with invited talks and contributed papers.

The planned plenary sessions are: Contemporary Cosmology; X-ray Sources; Ion-Molecule Collisions on Surfaces; Laser Spectroscopy on Molecular Ions; Theoretical Science and the Future of Large Scale Computing; Atomic Hydrogen; Quantized Hall Effects; Superconductivity of Quasi One-Dimensional Systems; Recent Collider Results; Symmetries in Nuclei and Molecules; Einstein-Rosen-Podolsky Paradox; Scanning Tunneling Microscopy; The Use of Electric and Ionic Beams for the Investigation of Surfaces; Superfluid ^{3}He; and Physics--A Fundamental Science.

The scheduled symposia, and the number of sessions for each are as follows: (1) Non-Linear Plasma Astrophysics, 4; (2) Neutrino Physics and Astrophysics 2; (3) Hard Hadron Collisions, 1; (4) e^+e^- Collisions, 1; (5) Atomic and Molecular Physics 3; (6) Phase Diagram and Structure of Coulomb Fluids, 1; (7) Lattice Calculations in Condensed Matter and Particle Physics, 1; (8) Localization and Disorder in Two-Dimensional Electron Systems, 1; (9) New Methods for Surface Physics, 1; (10) Total Energy and Dielectric Properties of Semiconductors, 1; (11) Organic Superconductors, 1; (12) Electronic Properties of Polymers and Applications, 2; (13) Sensor Research and Technology, 2; (14) Physics Taught as a Philosophy or as a Technique, 1; (15) Public Awareness of Physics, 1; (16) A Catastrophic View of Planet Earth, 1; (17) Physics and Agriculture, 1.

For registration or further program information write to:

Physical Section
Union of Czechoslovak Mathematicians and Physicists
Na Slovance 2
182 00 Prague 8
Czechoslovakia

R.L. Carovillano
1/30/84

SYMPOSIUM ON NONLINEAR PLASMA ASTROPHYSICS

The Symposium on Nonlinear Plasma Astrophysics will be held 27 through 31 August 1984 in Prague during the 6th General Conference of the European Physical Society. The Astrophysics Symposium will have daily afternoon sessions, each consisting of invited talks and contributed oral or poster presentations. The members of the organization committee are E.R. Priest, C. Cesarsky, M. Dobrowolny, K. Schindler, and Ya B. Zeldovich.

Invited talks are planned on the following topics: magnetoconvection and dynamos, magnetic reconnection and magnetohydrodynamic turbulence, radiation from turbulent plasmas and particle acceleration, and nonlinear structures such as solitons, shocks, and double layers. Additional astrophysics talks are planned for plenary sessions of the 6th General Conference on contemporary cosmology and x-ray sources. (For information on the 6th General Conference, which includes many additional symposia, write to the address given in the preceding note.)

For further information on the Symposium on Nonlinear Astrophysics, contact:

Dr. E.R. Priest
Applied Mathematics Department
The University, St. Andrews
Scotland KY16 9SS

R.I. Carovillano
1/30/84

INTERNATIONAL SYMPOSIUM ON HYPERTHERMIC ONCOLOGY

Aarhus, Denmark, will be the setting for the 4th International Symposium on Hyperthermic Oncology from 2 through 6 July 1984. The symposium is being organized by the Institute of Cancer Research Aarhus and the Aalborg University Center.

The objective of the symposium is to provide a comprehensive presentation of the status and recent achievements within the biological, physical, and clinical fields of hyperthermic oncology. The official language will be English, and all papers and discussions must be presented in Englisn.

The Call for Papers lists an ambitious array of topics intended to provide an updated general picture of different biological, clinical, and physical aspects covering the following areas:

- Clinical hyperthermia--dosimetry and temperature measurements.
- Clinical and practical problems of hyperthermic techniques.
- Electromagnetic and ultrasonic heating.
- Temperature measurements and thermal dosimetry.
- Clinical experience with local hyperthermia alone or chemotherapy.
- Clinical experience with local hyperthermia and radiation.
- Environmental factors, blood flow, and microcirculation.
- Molecular and cellular mechanisms of hyperthermia alone or combined with other modalities.
- Normal tissue response to hyperthermia or combined with other modalities.
- Tumor response to hyperthermia alone or combined with other modalities.

Fourteen workshops have been planned, the aims of which are to discuss controversial or recent topics. All contributed (i.e., not invited) presentations will be given in the form of posters. There will be an exhibition of commercial equipment related to hyperthermic oncology.

To receive the registration information, write to:

Jens Overgaard, M.D.
The Institute of Cancer Research
Radiumstationen
DK-8000 Aarhus C, Denmark

Thomas C. Rozzell
2/6/84

EIGHTH INTERNATIONAL BIOPHYSICS CONGRESS

The International Union for Pure and Applied Biophysics (IUPAB) and the Royal Society of London will jointly sponsor the 8th International Biophysics Congress in Bristol, UK, from 29 July to 4 August 1984. The scientific program for this meeting, which usually draws 2000 to 3000 attendees, includes five plenary lectures, 28 symposia with invited speakers, and 29 poster sessions. The first plenary lecture will be delivered at 5 p.m. on 29 July, after the opening ceremony, and the last will be on 3 August at 5 p.m., before the closing ceremony. The remaining three plenary lectures will be scheduled throughout the week.

Large meetings such as this often have a number of parasite meetings associated with them. There will be two "Affinity Group" meetings, 10 satellite meetings (in locations from Bristol to Paris), and four associated meetings (one of which will be in Hamburg, Federal Republic of Germany).

Information about the main and associated meetings can be obtained from:

Congress Secretariat
8th International Biophysics Congress
Meon Conference Services
Petersfield, Hampshire GU32 3JN
United Kingdom
Telephone: Petersfield (0730)-66561
Telex: 86181 MEON

Thomas C. Rozzell
2/6/84

SCOTLAND TO HOST MEETING ON MEDICAL AND BIOLOGICAL ENGINEERING

The Department of Bio-Medical Physics and Bio-Engineering of the University of Aberdeen will host a joint meeting of the Nordic Association of

Medical and Biological Engineering Societies and the Biological Engineering Society from 22 through 26 July 1984. The meeting will be based on two central themes, with specialist sessions devoted to different aspects of these themes. In addition, there will be a number of workshops, tutorial lectures, and poster displays. A special session will be set up to allow informal discussion with the authors of posters.

The main themes of the meeting are:

1. Computer-aided biomedical imaging and graphics. This will include computer methods for the acquisition, display, processing, and analysis of nuclear magnetic resonance (NMR), ultrasonics, radiological, radioisotope, and microscope images.
2. Physiological measurement and control. Papers addressing this theme will include applications in cardiovascular, respiratory, and neuromuscular studies; neonatal and ambulatory monitoring; patient assessment; and therapy. In addition, there will be presentations on transducers, telemetry, signal processing, and computer and electronic methods of instrumentation.

Workshops will be organized on three subjects of current interest: the technology and medical evaluation of NMR imaging, space and underwater medicine, and technological aids for the disabled.

Tutorial sessions will be aimed at explaining the general principles of areas such as: NMR, digital technology in biomedical instrumentation, and interfacing computers to measurement devices.

For more information and a registration package, write to:

Dr. M. M. Jordan
Biological Engineering Society
Royal College of Surgeons
Lincoln's Inn Fields
London WC2A 3PN
United Kingdom

Thomas C. Rozzell
2/6/84

IFAC WORKSHOP ON AUTOMATED MANUFACTURING

The International Federation of Automatic Control (IFAC) sponsored a workshop on the design of work in automated manufacturing systems, with special reference to small and medium-size firms. A collection of preprints for the meeting, held from 7 through 9 November 1983 in Karlsruhe, Federal Republic of Germany, is available from VDI/VDE Gesellshcaft Mess- und Regelungstechnik (GMR), P.O.B. 1139, D-4000 Düsseldorf 1. Plans also exist for formal publication of the proceedings.

The workshop included representatives from Austria, France, the Federal Republic of Germany, the German Democratic Republic, Hungary, Italy, The Netherlands, Norway, Sweden, Switzerland, the UK, and the US. The 29 contributed papers emphasized new design concepts and practical implementations--most of them represented case studies. The main topic areas were: computer numerical control and work design, including the relation of automation to skill development, work organization, and the design of man-machine interfaces; general work design principles, including regulation requirements and group technology strategies; alternative work organizations, including training, social and economic aspects, and the problem of individual differences among workers; autonomous production; worker participation in the design of automatization, including consideration of unplanned side effects; robots and work design; and trends and effects of flexible automation.

Richard E. Snow
1/30/84

PROCEEDINGS PUBLISHED FOR SPACECRAFT/PLASMA INTERACTIONS SYMPOSIUM

The European Space Agency (ESA) has announced the publication of the proceedings of the 17th ESLAB Symposium on Spacecraft/Plasma Interactions and Their Influence on Field and Particle Measurements. The symposium was held from 13 through 16 September 1983 in Noordwijk, The Netherlands. The symposium was organized by A. Pedersen (Space Science Department, European Space Research and Technology Center [ESTEC], Noordwijk), who edited the proceedings with D. Guyenne and J. Hunt, also from ESA/ESTEC.

The 210-page publication includes an introduction by Pedersen, papers from the five sessions of the conference, and a list of participants with addresses. The scientific sessions were "Experience From Recent Spacecraft," "Theory and Modeling," "Impact Ionization," "Passive and Active Control of Satellite Potentials," and "Large Structures in Space."

The publication may be ordered from:

Distribution Office
ESA Scientific Technical
Publications Branch
ESTEC, POSTBUS 299, 2200 AG
Noordwijk
The Netherlands

The price is $34 for the proceedings and $7 for postal charges.

R.L. Carovillano
1/30/84

BIBLIOGRAPHY OF GUIDES TO NATO AEROSPACE R&D

AGARD Report No. 718, *Guides to Aerospace Research and Development in NATO Countries--Bibliography*, should be of special interest to librarians seeking adequate reference sources on European aerospace research and development information. AGARD (the North Atlantic Treaty Organization's Advisory Group for Aerospace Research and Development) provides only initial distribution. Others should order their copies through NTIS, Springfield, VA 22161. The publication date is January 1984.

Fifty-six citations in the bibliography relating to international and national R&D have broad applications to information specialists, marketing specialists, and the scientific and technical community.

D. Mott
1/30/84

ESA-IRS PROVIDES ON-LINE DATA RETRIEVAL

The European Space Agency-Information Retrieval Service (ESA-IRS) may be the most powerful on-line data service in Europe. It is certainly a major competitor of DIALOG, the Lockheed on-line data service.

ESA-IRS was established in 1966 for the use of ESA scientists, but went on-line 5 years ago. Current services include bibliographic database access, factual databank access, electronic mailbox service, on-line document ordering capabilities, and offline current awareness service in specific fields.

Originally the available indexes were mainly related to space science. The subjects in the ESA-IRS files now range widely and include areas such as science, engineering, business, the environment, health, remote sensing, safety, and transportation. As of late 1983 ESA-IRS databases and databanks exceeded 50 files and more than 26.5 million references. Searches can be performed on a portion of a file, a desirable feature since even the largest databases are provided as single files. The largest files, subject fields, and the number of references in the file are as follows: CHEMLABS, chemistry, 6.07 million; PASCAL, multidisciplinary, 4.59 million; BIOSIS, biosciences, 2.87 million; INSPEC, electronics, computer and control, physics, 1.87 million; NASA, aerospace and related sciences, 1.3 million; COMPENDEX, engineering, 1.2 million; and NTIS, US government reports, 1 million. The references on file increased by about 10 percent in 1983. Access to the NASA file is restricted to ESA member states.

ESA-IRS is headquartered at the European Space Research Institute, an ESA facility in Frascati, Italy. The services are simple to use from anywhere in the world. The data service may be accessed at all standard transmission speeds and through public data transmission networks, including TELEX. There is no subscription fee; customers are charged only when they use the service. The system is cheaper for Europeans to use than Lockheed's DIALOG because each year ESA-IRS accounting units are assigned by currency, thereby fixing the rate for the entire year. DIALOG, on the other hand, undergoes price fluctuations in accord with currency exchange rates. For example, last year DIALOG charges increased by 25 percent as the dollar continued to gain strength. Hence, ESA-IRS is a very popular database with major search brokers such as the British Library, which contracts for a large portion of the UK market.

Persons interested in the European on-line information industry should consider subscribing to *Infotecture Europe*, the European newsletter on the industry; the cost is F195 (about $25) per year and includes a free issue of the 1983 *European Data Base Guide*. Write to: 11, Rue du Marche Saint Honore, 75001 Paris. In addition, a useful book on computerized files is *Online Bibliographic Databases*, third edition (1983). It is published by Aslib, 3 Belgrave Square, London SW1X 8PL.

D. Mott
R.L. Carovillano
2/24/84

PHYSICAL METALLURGY: 1983

The third, revised and enlarged edition of *Physical Metallurgy* has been published. It was edited by Robert W. Cahn (until recently at Université de Paris-Sud, Orsay, France, and now at Clare Hall, Cambridge, UK) and Peter Haasen (Universität Göttingen, Federal Republic of Germany). Distributed in the US by Elsevier Science Publishing Company, Inc. (52 Vanderbilt Avenue, New York, NY 10017), the two-volume work costs $185.

At 2007 pages, it is 50 percent larger than the second edition of 1970. Twenty-two of the 30 chapters are by new contributors; a number treat topics not previously covered. This new edition gives a very up-to-date treatment, especially of the more rapidly developing topics. Most chapters have comprehensive lists of key references.

Topics in *Physical Metallurgy* include solidification, principles of microstructures, defects, electron theory, surface microscopy, transmission electron microscopy, several less familiar uses of x-ray and neutron scattering, structure and properties of solid solutions, recovery and recrystallization, intermetallic compounds, multiphase alloys, and metallic composites. Fracture, diffusion, phase diagrams, and thermodynamics are treated from a fundamental viewpoint. Fatigue and sintering are now covered, and there is a comprehensive chapter on solute segregation at surfaces and interfaces and its consequences. Phase transitions are now covered in two distinct chapters on diffusive and nondiffusive transformations. Magnetic materials, superconducting materials, and alloys rapidly quenched from the melt each receive a chapter to themselves.

R.W. Armstrong
1/30/84

ONRL COSPONSORED CONFERENCES

ONR, London, can nominate two registration-free participants in the conferences it supports. Readers who are interested in attending a conference should write to the Scientific Director, ONRL, Box 39, FPO New York 09510.

Note: Two conferences that appeared on this list in the March *ESN* are not being cosponsored by ONR, London: International Conference on the Physics of Highly Ionised Atoms, New College, Oxford, UK, 2-5 July 1984; and Second International Conference on Science of Hard Materials, Rhodes, Greece, 23-28 September 1984. ONR, London, regrets the error.

Third International Symposium on Halide Glasses, Université de Rennes, Rennes Cedex, France, 24-28 June 1984.

International Conference on Laser Processing and Diagnostics--Applications in Electronic Materials, Linz, Austria, 15-19 July 1984.

Tenth General Assembly of the European Geophysical Society, Louvain-la-Neuve, Belgium, 30 July - 4 August 1984.

Fatigue '84, Birmingham, UK, 3-7 September 1984.

International Conference on Digital Signal Processing, Florence, Italy, 4-8 September 1984.

Surface Modification of Metals by Ion Beams, University of Heidelberg, Federal Republic of Germany, 17-21 September 1984.

Ninth European Specialist Workshop on Active Microwave Semiconductor Devices, Veldhoven, Netherlands, 10-12 October 1984.

ONRL REPORTS

To request reports, check the boxes on the self-addressed mailer and return it to ONR, London.

C-18-83: *Fast Electrical and Optical Diagnostic Principles and Techniques: A NATO Advanced Study Institute*, by M. Frank Rose. The institute was divided into the following major sections: (1) overview of applications and needs, (2) voltage and current measurements, (3) data acquisition, (4) grounding and shielding, (5) fast photography, (6) refractive index measurements, (7) X-ray diagnostics, (8) spectroscopy, and (9) active optical techniques. The report examines these topics and provides tables comparing various nanosecond instrumentation techniques.

R-8-83: *Armament Acquisition by the French Ministry of Defense*, edited by Larry E. Shaffer. This report discusses the responsibilities and organization of France's Delegue General Pour l'Armement. The DGA guides the Ministry of Defense's acquisition policy.

C-1-84: *Sixth International Conference on Computing Methods in Applied Sciences and Engineering*, by J.F. Blackburn. The conference, held in December 1983, covered the following areas: structural and fluid mechanics, nonlinear analysis, oil reservoir simulations, compressible fluids, numerical algebra and software, semiconductors and hysteresis, multigrid methods, and parallel computing.

R-1-84: *Bibliography of the Research Staff of the UK Institute of Oceanographic Sciences, Bidston Observatory (1979-83)*, by Robert Dolan. This report provides an up-to-date listing of IOS Bidston's publications, many of which are in journals and report series that are not routinely available to oceanographers in North America.

R-2-84: *Science in the European Economic Community: A Self-Assessment and a Detailed Plan of Action*, by James W. Daniel. This report summarizes the European Economic Community's (EEC's) new scientific policy, provides the EEC Commission's assessment of the Community's international position in science policy, and presents the detailed scientific and technological goals of a program for coordinating and planning future policy.

R-3-84: *Statistics and Operations Research in Europe--1983: Summary Report*, by D.R. Barr. This report examines work in statistics, operations research, and closely related fields in Europe. The report updates *Statistics, Operations Research, and Management Science in Europe--1982: Summary Report*, R-2-83 (US Office of Naval Research, London, 1983).

R-4-84: *A Survey of European Robotics Research*, by Scott Harmon. This report describes the results of a 1981 survey to gather information about European robotics research that might be tailored to meet the US Navy's needs. The objectives of the study were: (1) to identify key research organizations and scientists, and (2) to determine the nature of the research and technology. The survey covered Belgium, France, the UK, Italy, Switzerland, and the Federal Republic of Germany.

R-5-84: *European Research on Polymers and Composites*, by R.W. Armstrong and Vivian T. Stannett. This report discusses the strategies and funding for research on polymers and composites in the UK, the Federal Republic of Germany, and France.

FEBRUARY MAS BULLETINS

The following *Military Applications Summary (MAS) Bulletins* were published by the ONR, London, Military Applications Division during February. *The MAS Bulletin* is an account of naval developments in European research, development, test, and evaluation. Its distribution is limited to offices with the US Department of Defense. DoD organizations should request copies of the *Bulletins*, by number, from ONR, London.

MASB Number	Title
4-84	European Aerospace Updates
5-84	Förster Magnetomat System
6-84	Notes on Environmental Remote Sensing Space Technology in Europe
7-84	ADA in Europe: UK Products Announced

EUROPEAN VISITORS TO THE US SPONSORED BY ONR, LONDON

Visitor	Areas of Interest	Organizations to be Visited	Want Information? Contact at ONRL
Dr. C.A. Brookes Dept. of Engr. Science University of Exeter North Park Road Exeter, Devon, EX4 4QF	Engineering Science/ Hardness Testing	Naval Research Laboratory NSWC Silver Spring, MD (9-20 July 84)	James W. Daniel
Prof. Brian Ridley Department of Physics University of Essex United Kingdom	Semiconductors	ONR HQ NRL (July 1984)	James W. Daniel
Prof. David Tabor Univ. of Cambridge Cavendish Laboratory Madingley Road Cambridge CB3 0HE	Physics/Friction & Wear	ONR HQ Naval Research Laboratory NSWC (9-20 July 84)	James W. Daniel
Dr. T.P. Obrenovitch CERB. HIA, Sainte Anne F-83800, Toulon Naval France	Hyperbaric Physiology	Beth Israel Medical Cen., NY (21 May 84) Univ. of Penn. Medical Center (22-23 May 84) Natl. Inst. of Health, Bethesda, MD (24 May 84) Uniformed Serv. Univ. of the Health Sciences Bethesda, MD (25-26 May 84) Gerontology Research Center Baltimore, MD (27 May 84) George Washington Univ. Med. School Washington, DC (28 May 84)	T. C. Rozzell

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