his methods and credentials have been made by numerous scientists, but rational analysis of and supportable scientific arguments against Velikovsky's theory have been conspicuously absent.

Some of the few original nonemotional arguments against Velikovsky were statements such as: (1) electromagnetic fields play no important role in the solar system; (2) Venus is cold; (3) Jupiter does not emit radio noise; (4) the last ice age ended at least 25 000 years ago; (5) the sun can have no excess charge; (6) petroleum is not found in recent sediments, and (7) petroleum cannot be formed by the interaction of comets and planets. The errors of (1) through (4) are now obvious. Refutations of the others have been published as follows: statement (5)—V. A. Bailen;[1] statement (6)—P. V. Smith;[2] statement (7)—J. Oro and J. Han.[3]

The writings of Velikovsky involve in intricate detail a new approach to the recent history of the earth and solar system. The scientific evidence necessary to support or disprove this theory is decidedly in favor of Velikovsky. When open discussion is allowed such as in *Yale Scientific Magazine* (Vol. XLI, no. 7, April 1967) the logic and support of Velikovsky's theory becomes apparent.

I would like to suggest that this theory be carefully examined and that documented discussion for and against this theory be allowed in scientific literature. We should no longer permit emotional arguments to direct scientific thought.

References

1. V. A. Bailey, Nature **186,** 508(May 14, 1960); **189,** 43(Jan. 7, 1961); **189,** 994(March 25, 1961).
2. P. V. Smith, Science **116,** 437(Oct. 24, 1952).
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Science newspaper needed?

Your editorial "Physics Forty Years from Now" (June, page 80), brings up the question "Is a national decline from achievement to consumerism inevitable?" If it isn't, how can it be avoided? One answer may be along the following lines. Many scientists are goaded into productivity by their own imagination or curiosity: They can envision intellectual goals for their efforts. Likewise, many young people find challenges in sports. It is a well-known law in human nature that before responding to a challenge, the challenge has to loom large in the imagination. If the nation is to feel challenged, someone has to create and dramatize the challenges and this is probably the most important of all roles in society. In the past 30 years the public imagination has been excited by atom bombs, nuclear power, man-on-the-moon, and practically nothing else! This means the nation now has a crisis in lack of imagination. Who should stir that imagination? The Politicians? The Clergy? The States? The HEW department? The Military? . . . Unless the public imagination is stirred and challenged, then David Riesman's third phase of decline into consumerism is probably inevitable. One suggestion is that the scientific community itself should take up the prime responsibility for stirring the public imagination.

It is reasonable to say that the public lives in a world which is as much technological as it is political. Whereas the political news is dramatized and issued 24 hours a day, the technological news is rarely found or well dramatized, except when it is involved in disasters. One remedy to this situation could be a technological newspaper written and illustrated for the general public. Such a newspaper could be created as a joint venture by all the established scientific associations, institutes and so on. (If they don't do it, who will?) Previously, our scientific societies have been concerned with their own members. Today they also have the duties of communication and of exciting the public imagination with the challenges and benefits from science. A science newspaper is one of the better ways of attempting to do this. Perhaps readers can suggest other ways.

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More on job picture

In the December 1970 issue of *physics today* we advertised: "TENURED POSITION. Preference given to biophysicists and astronomers." This was repeated in the January issue. As a comment on the employment situation I should like to give the number of replies. Actually, we do not know *exactly* how many replies we received, because some letters did not mention our notice in *physics today*. It soon became evident that a form letter of reply would be necessary and 500 copies were ordered. Most of these were used and in addition some applications required special replies. We believe that 500 is a reasonable estimate of the number of applications considered.

If one hour were spent in evaluating each application, that would mean 500 hours, or twelve 40-hour weeks. Even though several men in our physics department were involved this turned out to be a considerable undertaking. We wish to apologize to any applicant who did not receive proper consideration—

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obviously we cannot tell each applicant why he was *not* chosen.

Actually *two* positions were filled, because in addition to my retirement, which vacated one position, Henry Vogel—who placed the advertisement—was made Dean of our School, which created another.

I cannot help but contrast this with my struggles during the 1950's and 60's to find even one applicant for a position in the department. I came to Clemson in 1931 during the Hoover depression and now I am retiring in 1971 during that of Nixon.

Lorenz D. Huff
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Clemson, S. C.

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Recent predictions that there will be several hundred new jobs for physics faculty each year for the next few years are too optimistic. Their authors have overlooked a crucial fact.

Physics teaching loads at PhD-granting institutions are often much lower than teaching loads for other disciplines. The low teaching loads came about because of Federal funding and a widespread belief that scientific progress is essential to the continued security of our country. Now that Federal funds have been cut and antiscience feelings have grown in strength, it is likely that physics teaching loads will go back up. Higher teaching loads mean fewer faculty, hence faculty will be fired. Some jobs will disappear. Has anyone tried to estimate how many?

Teachers fired will have trouble finding jobs at institutions at lower levels in the pecking order of higher education, because they might threaten the seniority of established faculty, who will prefer to hire fresh PhD's. When students see their teachers fired and not finding jobs, they will leave physics at an increasing rate. When the enrollment drops, there will be less need for physics faculty, and there will be more firings. This is an instability in overextended physics departments that is bounded below only by the introductory service courses taught for other departments. It is likely that at some institutions the physics major will be abolished altogether, for reasons of economy, and to find an excuse to fire tenured faculty.

Robert G. Boyd
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While the physics community is correctly concerned over the current employment problems of physicists in terms of today's economy, it is useful to realize that there must be substantial economic expansion if there is not to be massive unemployment during the next 20 years. The US reproduction rate jumped from approximately 1.1 in the early 1940's to 1.7 in the 1950's and 60's. This, of course, greatly increased the proportion of young people in the population. In the US population between 25 and 50 years of age, there are approximately 2.4 million persons in each annual age group, whereas there are 4 million in each annual age group in the population under 21 years of age. This 1.6 million annual excess has placed a heavy demand on our school system and colleges during the past decade, and we are just beginning to see the effects on the labor market as these individuals reach working age. There is no longer a problem of finding individuals born during the depression or wartime period to teach this excess of children; employment opportunities for young elementary-school teachers are not much better than those of new PhD's in physics, chemistry, English, history, sociology and so on.

The Bureau of Labor Statistics estimates that on the basis of population alone, the US labor force will grow by 1.5 million individuals per year through the 1980's. This 1.5 million figure is the net annual increase *after* one has made allowances for death and retirement of the older members of the population. This number is a low estimate if the demands of women's equality and civil rights continue and large numbers of these individuals, currently excluded from effective competition in the labor market, seek employment.

It seems unlikely that our democratic and political institutions will survive if the nation's economy is unable to find the 30 to 40 million *new* jobs required over the next two decades to provide gainful employment for our youth. It is not easy to forecast where these jobs will be, but we can define certain areas that are not likely to see significant expansion. There is sufficient food for current population levels, and the educational facilities are adequate. The present mood of the country does not seem to favor sizable expansions in either the defense or space industries, and there is mounting resistance to highways and urban-renewal projects.

While the national goals may change significantly, it does seem reasonable to expect that the world's most highly developed technical economy will continue to develop along technical lines. If half of the jobs in the US today are based on the discoveries of physics since 1900, it seems certain that physics will play a vital part in any expansion of the economy capable of yielding 1.5 million new jobs a year. It does not seem unreasonable to assume that at least a tenth of one per cent of this increase will require training equivalent to a PhD in physics.

From this viewpoint we should be expanding the current PhD production of physicists to cope with the increased demands of a technical economy. It is largely irrelevant that there are currently limited job opportunities in universities.

The US economy uses 50% of the world's resources and cannot be significantly expanded unless there is resource recycling and a reduction of pollution. The additional labor pool should enable us to do this while increasing current levels of production. Methods being developed for reclamation of solid waste illustrate some of the possible new recycling technology. Hydropulping techniques have achieved recovery of the usable paper fibers, while hydrogenation can convert 50% of the organic material to a sulphur-free, paraffin-base oil. Sorters have been developed to separate and sort the nonferrous metals, such as aluminum, brass, zinc, copper, stainless steel, and so on. These sorters have fairly complicated magnetic fields and came from the Vanderbilt experiments to measure the magnetic moment of the Σ^+ hyperon.

Historically, our basic technology has been created by scientists, and then developed by engineers. While more physicists may not be needed in the universities or even in existing industries, they will surely be required if 30–40 million people in our society are to have jobs.

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Much has been said about the plight of young physicists with most of the discussions being cries for help rather than offers of solutions. While I don't have a solution to the unemployment problem for PhD holders, I have a suggestion that could permit us to continue training physics undergraduates, without harming their future employment opportunities.

The idea is simple. When a student declares himself a physics major, counsel him to plan on taking a masters' degree in business administration either as a terminal degree or as a prelude to a PhD in a third field such as computer science. In other words, prepare the student to use his physics training as a corner stone for his future, not as an edifice for his future.

If this is done, the knowledge of physical laws and research methods will be carried more than ever before into other fields; and possibly even more important, a pool will be maintained out of which the most promising minds can be netted for advanced physics training.

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