letters

Prices for physics equipment outstrip inflation

How has inflation affected the prices of laboratory equipment? What is the economic burden that results from the ever changing "state-of-the-art" in measurement and instrumental techniques? These questions provide different answers, depending on whether they are asked, for the instructional laboratory or the research laboratory.

To determine the effect of inflation on the instructional laboratory, standard items whose specifications have remained static—for example, a meter stick—were randomly selected from the catalogs of the Central Scientific Company and the Sargent-Welch Scientific Company (previously the Welch Scientific Company). The prices of fifteen such items from Central Scientific have increased by an average of 174% over the period 1950–73. Similar items were selected from the catalogs of Sargent-Welch. For twenty items from Sargent-Welch, the prices have increased by an average of 200% over the period 1949–73.

How do these percentage increases compare with other economic indicators? Over essentially the same period, 1950–72, the Consumer Price Index (CPI), based on the prices of about 400 items selected to represent the movement of prices of all goods and services purchased by wage earners, has gone up by 75%. The price of a standard model Chevrolet (no accessories) has increased 125% over the 1950–73 interval. Textbooks have gone up in price by approximately 105% over the same period.

Because of the dynamic character of the product lines of those companies serving the research laboratory, it is harder to assess the effect of inflation. Therefore, we have examined a shorter time interval: 1961–73. Items whose specifications remained essentially unchanged were selected from the catalogs of General Radio Company, Hewlett-Packard, and Tektronix, Inc. For the period 1961–73 the results are as follows: for twenty items from General Radio the prices increased by an average of 90%; twenty items from Hewlett-Packard increased in price by an average of 62%; and the increase in price of twelve items from Tektronix averaged 79%. Over the same period the CPI increased by 39%. The teaching-oriented companies are compared

PRICE INCREASES OVER PERIOD 1961-1973

	Average increase (%)	Increase per year (%)
CPI	39	3.25
Central Scientific (15 items)	99	8.25
Sargent-Welch (20 items)	122	10.16
General Radio (20 items)	90	7.50
Hewlett-Packard (20 items)	62	5.17
Tektronix (12 items)	79	6.58

with the research-oriented companies in the table. As can be seen, the ills of inflation have afflicted metersticks *et al* more severely than oscilloscopes *et al.* We wonder why this should be so.

The question concerning the state-of-the-art has two aspects. The first derives from the fact that new forms of equipment become available. The second is a matter of style. Certain experimental techniques become fashionable, with the result that yesteryear's luxurious frill becomes today's basic necessity. For example, 100% of the physicists we polled regarded an oscilloscope camera as an essential teaching tool. It is doubtful that it would have been so regarded a dozen years ago.

To examine the state-of-the-art question in the teaching lab context, we have focused on specific experiments and equipment. For example, by 1960 Fletcher's trolley had logged many miles as it rolled in freshman laboratories demonstrating the principles of dynamics. Today, teachers would undoubtedly opt for an air track and would employ photocell gates or stroboscopic photography to take the data. The 1960 car-and-track version cost $234 as compared to the 1973 frictionless-glider-system price tag of about $850—a 263% increase.

Or consider a general-purpose oscilloscope. Again we polled several physicists. The result: Today's acceptable scope for teaching purposes is about 180% more costly than the 1961 model. From these and other specific situations we have examined, it appears that in 1973 the physics teacher can expect to pay about 371% more than in 1961 as a direct consequence of the state-of-the-art.

How does the state-of-the-art affect the researcher? We have answered this question by assuming that supply is created by demand and therefore we have looked at top-of-the-line instruments. We have again focused on specific situations: fastest oscilloscopes, most accurate digital voltmeters, and so on. For those instruments we have examined, the prices of top-of-the-line instruments have increased by an average of 262% during the period 1961–73.

To summarize, the budgets of physics departments are hit about three times harder by the state-of-the-art effect than they are by inflation. However, the rate of inflation over the 1961–73 period is three times greater for teaching equipment and two times greater for research equipment than the average inflation rate for other consumer items. Further, the data somewhat surprisingly suggest that keeping up with inflation and staying abreast the state-of-the-art may be harder for the physicist *qua* teacher than for the physicist *qua* researcher. These data make abundantly clear the stress our departmental budgets are enduring. The resulting strain makes it harder to do our jobs. Anyone for mathematics?

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Indexing astronomy

The recent editorial on "Indexing the physics literature" (July, page 96), was a useful means of bringing AIP efforts in this area to the attention of the readership, but perhaps it is possibly a bit misleading as to the current operability of the system. Recently, several members of the University of Texas astronomy and physics departments, who are participating in a SPIN evaluation here, met to discuss performance. As an astronomer (and a peculiar one at that!), I expected my experience to be

atypical. Much to my surprise, every person present was as emphatic as was I in their opinion that the AIP indexing categories were either not adequately designed or not being used completely by the indexers. In addition, many very important journals are being ignored. For many of us, the SPIN system has proved only an interesting irrelevance.

Because the indexing categories are viewed as a flexible system, that part of the problem will presumably improve. To cite an example relevant to my own situation, numerical integrations of 11 particles are classed as "dynamics of stellar systems" (7.40.10.20) if the author calls the particles "stars," but if he calls them "planets" they must go under "classical mechanics of discrete systems" (1.40.10). Much of modern celestial mechanics, at least of that part dealing with real objects in the solar system, are *not* "classical mechanics" but may involve general relativity, non-rigid bodies, resisting fluid medium, electrodynamics and/or a variety of other phenomena that violate the indexing. For consistency with other categories, as well as for greater utility in the system, there should be a subcategory "dynamics" in both category 7.20.30 (Planetary System) and 7.20.40 (Moon). My impression from local discussions is that similar examples exist in many areas of the index scheme.

The matter of journal coverage is more difficult perhaps, because the natural course of events is that AIP begins by indexing AIP journals. Unfortunately, it is exactly these same journals that are readily available to most of us. It would be a much kinder service if more emphasis were placed on the more obscure or more specialized journals that most of us are less likely to check regularly ourselves. The fact that *Science* is not indexed is no problem, but if something of interest to me ever appears in *Cosmic Electrodynamics,* I'll never know it. *This* is where the SPIN system could be invaluable.

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Comment from AIP: PACS was designed as a compromise, both for use in printed displays of the literature, such as AIP's *Current Physics Titles, Current Physics Advance Abstracts,* and the various cumulative journal indexes, and for use *in conjunction with other elements* in SPIN tape searches. In practice an average of about 2.5 PACS numbers are assigned to any one article, which is bound to give poor recall when used in "AND" Boolean combinations within a search algorithm using PACS alone. The true value of SPIN for retrieval emerges when, after a broad search using PACS, more sophisticated algorithms are then applied to all the other data elements available on SPIN, particularly the keywords. No other tape service on the market has as broad a selection of data elements available to the searcher as SPIN.

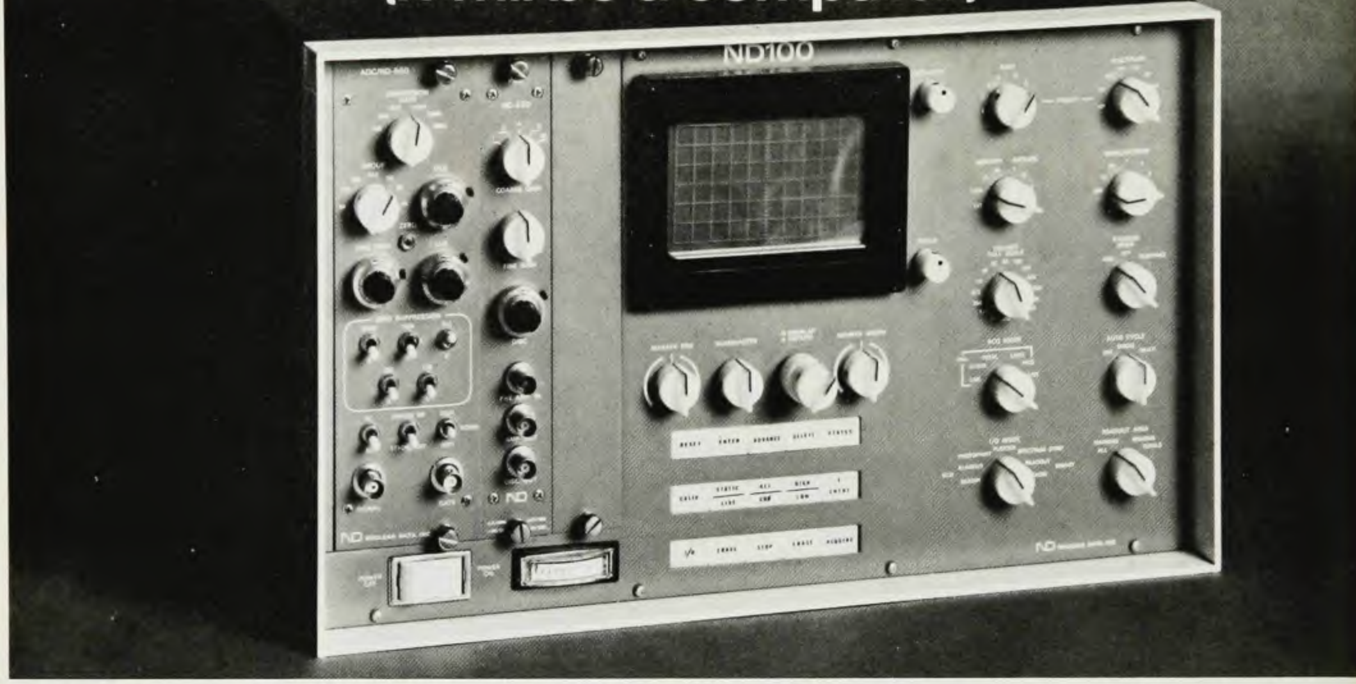
As to the substance of PACS, we agree, of course, that its present version is not by any means satisfactory for everyone's indexing needs. In particular, the astronomy–astrophysics area is still in the zeroth approximation. We are grateful for specific suggestions such as those offered by Mulholland, and we plan to modify PACS extensively in this area after collecting further input through the American Astronomical Society. The 1974 edition of PACS will already show major changes in the areas of acoustics, education, optics, instrumentation and so on, in each case through the cooperation of the editors of the relevant journals and the member societies of AIP. As Mulholland correctly points out, a crucial aspect is how well the indexing is done. The most beautiful set of boxes is no good if articles are put into the wrong boxes. The expense of using professional indexers adds substantially to the cost of producing SPIN and other products. Therefore, we have opted for author-indexing followed by professional review, and we fully expect that as PACS gains acceptance and widespread use, the accuracy of indexing will increase.

What we are really saying is that the usefulness and the use made of PACS will very strongly depend on the interest and support of the physics–astronomy community.

The question of journal coverage is largely a matter of expense again. The primary purpose of AIP's secondary-information products is for current awareness and not for comprehensive retrospective searches. It has been shown (for example, by A. Herschman, Physics Today, November 1971, page 23) that most citations in all physics journals are to a small set of "core" journals. We now cover about 70 of these core journals and aim to expand soon to about 100. Thereafter, the law of diminishing returns rapidly takes over. Our information Advisory Committee of distinguished physicists helps us decide on the list of "core" journals.

Finally, it is perhaps worthwhile to point out that our secondary information products such as SPIN, CPT, and so on, are not intended solely for physicists or astronomers. We feel that there is a substantial need for these products in the wider technological community, among those who use the

If we make just one more improvement in this hardwired multichannel analyzer, it won't be a multichannel analyzer any more. (It will be a computer.)



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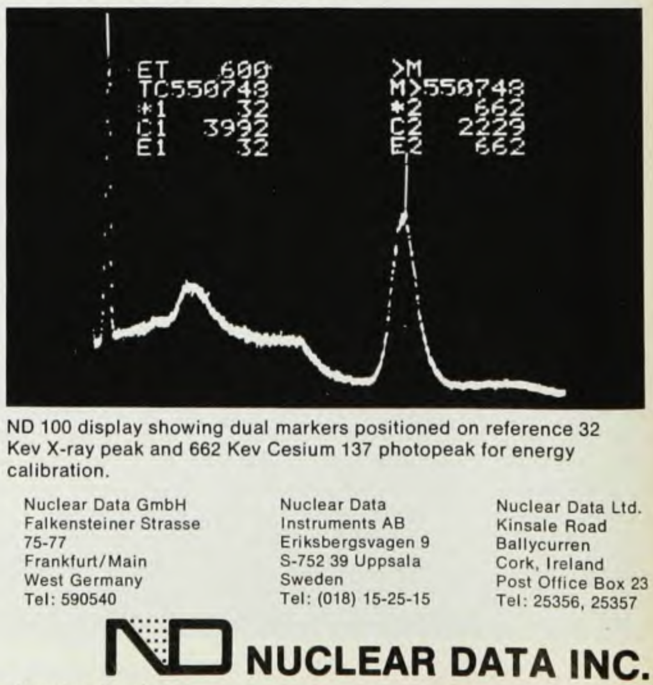

ND 100 display showing dual markers positioned on reference 32 Kev X-ray peak and 662 Kev Cesium 137 photopeak for energy calibration.

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results of physics, who do not belong to the "invisible colleges" and do not have informative colleagues and graduate students nor familiarity with the primary literature. If SPIN, and all other products can be useful in this way, they will in turn directly aid the financial health of the physics community.

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Ultrahigh fields

Your news story on ultrahigh field magnets, "Hybrid Magnets Promise High Field for Low Power" (October, page 20), does not, in our opinion, fully reflect today's state-of-the-art and, as such, is possibly misleading to your readers.

As a manufacturer of superconducting Nb_3Sn material as well as superconducting magnets and magnet systems, our corporation is very involved in the technology of ultrahigh magnetic fields. For several years, the limit to the magnetic field strength of superconducting magnets has been 150 kG. Finally, in the summer of this year, a significant breakthrough occurred whereby the 150-kG barrier was decisively penetrated, and a Nb_3Sn magnet of 165 kG was successfully demonstrated by Intermagnetics (see October, page 34). Although this magnet has a bore of only 25.7 mm, the nature of the advance is such that the new design and material that enabled this breakthrough can almost certainly be extended to much higher fields (using V_3Ga superconductor) and to magnets with a much larger bore.

With regard to your news report, we take no exception to your discussion that it is less expensive to produce steady fields of 200–300 kG by placing a small-bore, water-cooled magnet within a large-bore superconducting magnet rather than with a single water-cooled magnet only, since the field produced by the superconducting magnet consumes no input power and the field produced by the two magnets, is, of course, additive. Thus with the hybrid approach, fields in the range of 200–300 kG can be accomplished at a power level of only about 5–10 megawatts, rather than the 20–30 megawatts that would be required if a water-cooled magnet only were used. In economic terms the hybrid approach translates into a savings of at least \$1 000 000–\$3 000 000 in initial capital expenditure, and hundreds of dollars per hour in operating costs.

When you discuss the question of superconducting magnets themselves, however, your remarks seem to miss the point. In mentioning the achievement of a 165-kG field at IGC, you fail to take note that such a magnet facility has both an initial capital cost and an operating cost of less than 10% of a comparable water-cooled magnet; a complete 165-kG superconducting magnet facility costs about \$100 000 while a comparable conventional facility is priced in excess of \$1 500 000. Another important point is that this breakthrough, coupled with new superconductive materials now available, should shortly enable fields much higher than 165 kG to be achieved with superconductors only, and that such a superconducting magnet will reflect even larger dollar savings when compared either to a comparable hybrid magnet or a conventional water-cooled magnet.

Finally, you make a remark most confusing to your readers when you state that "a 165-kG superconducting magnet with a 40-cm bore would be very costly." This comment is not relevant to *any* of the issues presented, since a 165-kG magnet with a bore as large as 40 cm is not required even if a composite field as high as 300 kG is sought in a small bore, water-cooled insert magnet. Furthermore, while a 165-kG superconducting magnet with a 40-cm bore would indeed be very costly, your readers should know that such a magnet would still cost only a small fraction of a comparable water-cooled magnet facility and would operate at zero input power rather than at the several tens of megawatts required by such a water-cooled magnet.

Finally allow me to correct a small error made in your reference to the IGC magnet—its bore is 25.7 mm, not 20 mm as you state.

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Reply to Soviet requests

I recently received a request from E. M. Nadgornyi of the Institute for Solid State Physics of the Academy of Sciences of the USSR in Moscow for a reprint of one of my papers as well as for exact details of special search techniques for digital computer simulation.

I hesitated to send the information requested because of the recent increased repression of Soviet advocates of civil rights and of Soviet scientists who have applied for permission to emigrate to Israel and decided to adopt a different approach in sending the requested information in this instance.

I informed Nadgornyi that while I personally favor cooperation, collaboration and dissemination of information between scientists of all countries, I cannot condone the official attitudes of