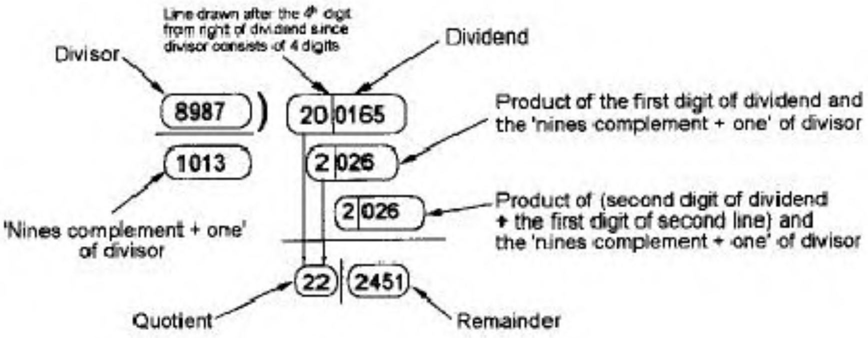

Figure 3. Illustration of division using the 'nines complements plus one' method.

to be known as 'Vedic mathematics.' I believe that Hertzstark's method is not 'derivable' in some formal sense, but is subject to what is called inductive 'proof' – just as the methods delineated in 'Vedic mathematics' are – if it works for n and is found to work for $n + 1$, it works!

Yes, 'Vedic mathematics' had used something like the 'nines-complement method' in various places[2], but not quite in Hertzstark's manner for subtraction. Illustrated with a simple example in Figure 2, is the short-cut Vedic method of multiplication based on the *sutra*: *nikhilam navatascaramam dasatah* (everything from nine and the last from ten, that is, the last digit is to be subtracted from ten).

More generalized procedures are needed to meet contingencies that may arise even in the normal application of the method. For instance, either the multiplicand or the multiplier may not be near an integer power of 10. (This is not the case with the example of Figure 2, where the 'working base,' 1000 is close to both multiplicand and multiplier.) Such procedures, based on the very principles of the Vedic method, are fully described by Bharathi Krishna Tirtha[2].

A similarly simple example of division, based on the same *sutra*, is given in Figure 3. It is interesting to note that, except when taking the nines complements, no subtraction is needed in the division process and only single-digit multiplication is involved.

The originators/propagators of the Vedic procedures have not explicitly stated[2] how a subtraction can be carried out employing the 'nines-complement method' (or a modification thereof, whereby the last digit is subtracted from 10 and not 9). Would it, in effect, have been the same as that of Hertzstark's? If so, Hertzstark can only be regarded as having independently discovered a 'Vedic' method, assuming, of course, that the latter has priority. However, there seems no way of getting to know the date(s) of the origins of that method. We remark that, unlike Hertzstark, the originators of the 'Vedic' method went on to develop procedures for multiplication and division without any impetus from trying to make a mechanical contrivance work on the principles that they discovered.

It is too late in the day to ask whether a mechanical (or even an electronic) device would become 'simplified' when principled to operate using the Vedic procedures of multiplication and division. No one in this Age of Doped Silicon would want to try to construct a purely mechanical device just to answer that question!

1. Stoll, C., *Sci. Am.*, 2004, **290**, 82.
2. Bharathi Krishna Tirtha, *Vedic Mathematics*, Motilal Banarsidas, Delhi, 1992 revised edn (first edition 1965).

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Flaw in statistical method

The article by Bhattacharyya *et al.*[1] on arsenic-polluted groundwater in West Bengal has serious flaws in the statistical methods used for analysis of data based on which some conclusions with far-reaching impact have been drawn. For example, 'the regression of percentage arsenic removal . . . against arsenic concentration produces a best-fit line ($R^2 = 0.001$) that parallels the abscissa'. The authors should know that expecting a best-fit line with an R^2 value of 0.001 for a relationship which is a loose scatter, is not correct. This relationship is statistically non-significant even at the 5% level of probability and therefore does not warrant any conclusions to be drawn from it, definitely not the kind the authors have made. An R^2 value of 0.06 and an r value of 0.250 are necessary (for a sampling size of 62) for the relationship to be called even moderately strong and significant (i.e. at 5% level of probability).

Based on these loose relationships (Figure 3 for clay-candle filter and Figure 5 for membrane filter), the authors conclude that 60% of the arsenic is removed by filtration using the clay-candle filter, irrespective of initial arsenic content. This, if true, has immense benefits in tackling this grave problem which affects thousands of ordinary people in West Bengal, where arsenic in groundwater is a serious problem. The data and the relationships shown in the article do not warrant such a conclusion.

1. Bhattacharyya, D. *et al.*, *Curr. Sci.*, 2004, **86**, 1206–1209.

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Response:

The authors appreciate the comments of Shashidhar and find that there is absolutely no difference of opinion so far as interpretation of regression analysis is concerned. However, it seems that a careful reading is needed to remove the misunderstanding. The conclusion that 'irrespective of the arsenic content, 60% of the arsenic is removed by filtration using the clay-candle filter . . .', has not been drawn from the regression analysis. It has been drawn from the actual data shown in Table 2 of our article. The scatter plot with a best-fit line has been shown to emphasize the fact that there is, in fact, no statistically significant correlation. In other words, the 'per cent arsenic removal' has no linear dependency on arsenic concentration. As shown in Table 2, 100% removal has been achieved for samples with arsenic concentration as low as 0.02 to as high as 0.2 mg/l. On the other hand, less than 20% removal has been achieved for other samples with similar arsenic concentration (0.06 to 0.3 mg/l). The non-dependence of arsenic removal on concentration is evident from the data itself. Regression analysis was not used for reaching this conclusion. Similarly, 60% arsenic removal is also reflected in the data.

The central theme of our article is that if a set of factors is present in the environment, arsenic can be removed to an optimum extent by clay-candle filter, to benefit a large section of people. In the conclusion, it has been mentioned that these areas where favourable factors operate, can be identified by field studies. In these areas mitigation can be done by inexpensive clay-candle filter. For other areas, expensive filters can be used. We emphasize that our conclusions do not hinge upon any simple statistics as understood and expressed by Shashidhar.

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Error in angles

There is an error in the angles shown in Figure 3 of the communication by Balasubramaniam and Dass[1].

According to the formula of spherical astronomy,

$$\sin\delta = \sin\phi \cos Z + \cos\phi \sin Z \cos A,$$

where δ is the declination of a celestial body, ϕ is the latitude of the place, Z is the Zenith distance of that body and A its azimuth measured from north. At sunrise or sunset $Z = 90°$, so $\cos A = \sin\delta/\cos\phi$.

On 21 June of AD 400, $\delta(\text{sun}) = 23°39'$, while ϕ (Udayagiri) = $23°31'$. These give $A = \pm 64°4'$ from north. Similarly, on 21 December of AD 400, $\delta(\text{sun}) = -23°39'$ which gives $A = \pm 115°56'$ from north. Consequently, with respect to EW line the angles will be $25°56'$ and not 23.5°.

1. Balasubramaniam, R. and Dass, M. I., *Curr. Sci.*, 2004, **86**, 1134–1142.

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Response:

We had provided the angle of 23.5° in Figure 3 in the general sense and did not calculate the exact angle based on spherical astronomy. We stand corrected and acknowledge Abhayankar for his valuable input. As was pointed out in the communication, the Udayagiri site needs to be studied in great detail by knowledgeable astronomers. The relationship of the early morning sun with the archaeological structures at Udayagiri must be carefully recorded over a period of at least a year, and critically analysed.

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NEWS

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Grid computing: Technology propelling frontiers of research

I believe grid computing will revolutionize the way we compute, in much the same way as the World Wide Web and Internet changed the way we communicate.

— John Ellis
Adviser to Director General, CERN

The Internet and the World Wide Web

CERN, the European Organization for Nuclear Research near Geneva on the French/Swiss border, changed the way in which the world interacts with computers, through the work of the then CERN-based British researcher Tim Berners-Lee. He is credited with the creation of the World Wide Web a decade ago, as a means of allowing physicists to share documents. His vision created an 'information space of meaning built upon the World Wide Web'. In the words of Berners-Lee, 'The first breakthrough was the Internet, and I can't emphasize too often that I didn't invent the Internet! There were many networks, but they were of different types, some small, some large, and they used different sorts of connection. A computer could be on more than one network, and it was Vint Cerf and his colleagues who realized that a computer connected to more than one network could act as a kind of postal sorting office, and be used to forward information between the networks. Even though the little networks might use different numbering schemes for different computers, they imagined that each computer was on some