International Society of Biomechanics Newsletter

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AFFILIATE SOCIETIES OF ISB:
American Society of Biomechanics; British Association of Sports Science; Bulgarian Society of Biomechanics; Canadian Society of Biomechanics; China Sports Biomechanics Association; Czechoslovak Committee on Biomechanics; French Société de Biomécanique; Japanese Society of Biomechanics; Korean Society of Biomechanics; Polish Society of Biomechanics; Romanian Comisia de Biomecanica, Ingineria Si Informatica.

ISB News

FROM THE PRESIDENT - Ron Zernicke

First, let me extend my personal best wishes to each of you in the New Year -- the year of the XV ISB Congress. I sincerely hope that you experience a stimulating, productive, and prosperous 1995. There continues to a flurry of activity among ISB Executive Council members. You'll note I used the term "flurry" as it has a distinct meaning to me -- experiencing the Western Canadian winter. When we have a "snow flurry", at first it appears that the flakes are being blown in a haphazard, seemingly random fashion. Over time, however, distinct patterns emerge from the wind-driven flakes.

As the members of the ISB and the Executive Council members are scattered throughout the world, sometimes (at first) there doesn't appear to be any coordinateted activity that emerges from the flurry of activity of the members. Nonetheless, patterns are emerging, and positive actions are moving inexorably forward. For example, Paavo Komi, Kari Keskinen, and the organizers of the XVth ISB Congress, in Jyväskylä, are expertly coordinating the structure of the upcoming meeting (2-6 July 1995). The facilities and locale are excellent, and all indicates that this will be an outstanding scientific and social experience for those who attend. I expect that there will be a significant turnout of members at the Congress.

On another front, Micheline Gagnon (Affiliated Societies Officer) and Sandra Olney (Education Officer) have been particularly active in coordinating efforts of the committee focusing on ISB Affiliated Societies from economically developing countries. Already, an ASB/ISB award has been instituted to be given to an individual from one of these affiliated societies to present at Jyvaskyla. Further, the ASB and ISB have agreed that this award will also be continuing; the funds for 1997 have already been set aside. A distinguished lecture tour is also being developed; here, a prominent biomechanist will visit several of the countries with ISB-Affiliated Societies to enhance communication of scientific information and to highlight the importance of continued support for biomechanical research.

Several other ISB actions are proving fruitful, such as preparations for the XVI ISB Congress in 1997, the Long-Range Planning Committee, sponsorships, and educational and tutorial planning. In 1995, I trust that you will see patterns of positive actions emerging from the current flurry of activities in the ISB. Again, I wish you the best in 1995, and I look forward to seeing you in Jyväskylä in July.

Warmest regards, Ron Zernicke

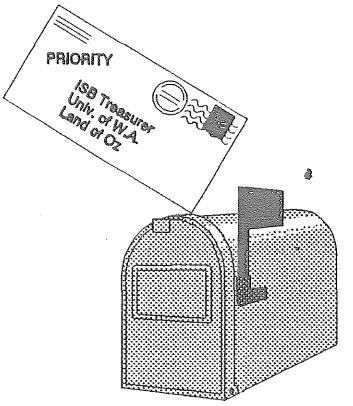
FROM THE TREASURER - Graeme A. Wood

Enclosed with this Newsletter is your 1995 ISB Membership Dues and Journal Subscription renewal form. Please return this form to the Treasurer as *quickly as possible* so as to avoid disruption to Newsletter and journal mailings. In past years the journal publishers have continued to mail journals to members well into the new year even in the absence of a renewal advice from the ISB Treasurer, but this practice has caused some confusion and has consequently now been stopped.

It is equally important that members who do elect to take a journal subscription notify this office promptly if journal issues are not being received from the publishers or if their address changes. There is inevitably some delay in initiating a new subscription, but thereafter journals should arrive on a regular basis and in sequential order.

Please note that there has been a small increase in Journal subscription fees for 1995 but that ISB Membership fees have not been changed despite the movement in the currency exchange rate between the Australian and US dollars. Most of the Society's bills are paid for in Australian dollars but Journal subscription payments are made in foreign monies and therefore the publishers' increased charges have to be passed on to the subscribers. Nevertheless these new subscription rates are still discounted to ISB members, and furthermore, subscribers to the *Clinical Biomechanics* journal will now receive two extra issues per year.

Finally, NO CHEQUES IN $US please! Payment should be in Australian dollars ($AUS) - otherwise your Society incurs significant expense in renegotiating foreign currency amounts. Credit card payments are our preferred method, but any cheque drawn on an Australian bank (preferably WestPac) is quite acceptable.



XVth CONGRESS UPDATE

XVth Congress of the International Society of Biomechanics
Hosted by the University of Jyväskylä
Finland, July 2-6, 1995.

The deadline of abstracts submission for the XVth Congress of the International Society of Biomechanics is approaching. The Scientific committee expects the two-page, camera ready abstracts be submitted no later than December 15th, 1994. While each one of the abstracts will be blind rewieved it is urgent to receive the papers in time. The "Eager Beavers" have already done their job. However, there's still time left for the rest of the Biomechanists to do the same. We wish you a good luck and patience in finalising the scripts!

Also, please note that Tutorial Lectures will be organised by the ISB Council, at the University of Jyväskylä, July 2nd, 1995. Further information can be obtained from:

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NB: If you have not received a Final Announcement and Call for Papers leaflet yet, please, send an email message to:

multasuo@jyu.fi.

or contact the following address:

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JYVÄSKYLÄ CONGRESSES

PROMISING SCIENTIST GRANT
Sponsored by PEAK Performance Technologies

Call for Applications

This Grant is intended to be an encouragement to persons possessing inquisitive minds, a sound and fundamental grasp of basic biomechanics, and promise of future significant contributions to the body of knowledge. The Grant takes the form of US $1500, and is awarded on the understanding that the recipient will spend a minimum of four months in a recognised biomechanics laboratory in a continent other than the one where the grantee usually works, with the intended purpose being to carry out a research project there. Candidates must be under 30 years of age, enrolled in an accreditated PhD or other training program in biomechanics, and both the candidate and his/her academic advisor must be ISB members.

Applicants should forward their request for a grant to the ISB President (address on front cover). All applications must include five (5) copies of the following:

a) a letter of presentation from the candidate's academic advisor;
b) at least one letter of support from a senior scientist in biomechanics working in a different Institution from the applicant who has personal knowledge of the applicant's capabilities;
c) a curriculum vitae and list of publications;
d) copies of a maximum of five relevant publications;
e) a detailed research program and justification for visiting the laboratory abroad;
f) a letter of acceptance of the host Institution indicating that they are aware of the candidate's research program and that they have the required research facilities;
g) an estimated budget.

Applications for a 1995 grant should be in the President's hands no later than Feb 1 of next year. The successful applicant will be expected to complete their project before September 1, 1996 and to present a report of their accomplishments at the time of the XVIth ISB Congress.

UPDATE FROM THE ISB SUB-COMMITTEE ON STANDARDIZATION OF JOINT COORDINATE SYSTEMS

As you may remember, I sent out a message in September looking for volunteers to help the ISB Standardization Committee propose recommendations for Joint Coordinate Systems. On behalf of the ISB, Peter Cavanagh (chairman), David Winter, Ian Stokes, and myself, I'd like to thank those who have expressed interest in participating. Following is a list of the joints that we already have and joints that we are looking volunteers to work on:

Joints that we already have: Knee, Shoulder, hand and wrist, spine, TMJ, and whole body.

Joints that need to be worked on: Ankle and foot, hip, and elbow.

Once again, I'd like to call for volunteers to work on JCS standardization, especially on those "need to be worked on" joints. Based on the responses, the Committee will contact each individual to form subgroups for each joint. I am sure that your contribution to this matter is valuable to the field of Biomechanics and will be deeply appreciated.

Thank you for your attention. Please respond to me at GXW9@psuvm.psu.edu.

Ge Wu
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Phone: (814)865-1972

EDITOR'S NOTE

This Newsletter is published quarterly: February-March (Spring); May-June (Summer); August-September (Autumn), and November-December (Winter). Deadlines for material and articles are the first day of each first named month, and the Newsletter is mailed to members early in the second named month.

Members can submit *Letters, Special Articles, Affiliate Society News, Laboratory Features, Reports,* or *Announcements* of *Meetings, Conferences,* and *Jobs Available.* Also, *Short Abstracts* from biomechanics society meetings and *Thesis Abstracts* can be published. In special circumstances a complete edition of the Newsletter can be devoted to the publishing of a Society's "Proceedings".

Submitted material must be in letter-quality print and computer scannable, or on a computer disk as a text-only file, and in English. Graphics or complex equations must be in camera-ready art form, and photographs must be black and white.

Society abstracts should not be more than 250 words in length. They should be submitted with full details of the conference, and accompanied by any conference or society logos which could be printed as well.

Thesis abstracts should be submitted with full details of:

Title, Student's Name, Department, Name of Degree and Conferring Institution, together with Supervisor's Name.

Thesis abstracts should not be more than one Newsletter page in length.

ISB PUBLICATIONS

These Society publications can be obtained at the special rates shown by writing to the person indicated below.

BOOK OF ABSTRACTS, XIVth Congress of the International Society of Biomechanics.
Price: 550 FF plus postage
Supplier: Professor S. Metral
Explorations Fonction. du Systeme Nervuux
C.H. Bicetre, 78 Avenue du General Leclerc
94275 Kremin Bicetre, FRANCE
Fax: (33.1) 45.21.27.14

BOOKS OF ABSTRACTS, XIIth and XIIIth Congresses of the International Society of Biomechanics.
Price: $AUS 40 plus postage ($AUS40 airmail) ea.
Supplier: Graeme A. Wood
Department of Human Movement
The University of Western Australia
Nedlands, WA 6009, AUSTRALIA
Fax: +61 9 380-1039

BIOMECHANICS XI-A and XI-B, Proceedings of the XIth Congress of the Intn'l. Society of Biomechanics.
Price: 200 Dfl (includes both volumes and postage)
Supplier: Peter Hollander
Faculty of Human Movement Sciences
Vrije Universiteit
van de Boechorststraat 9
1081 BT Amsterdam
THE NETHERLANDS
Fax: +31-20-6442043

BIOLOCOMOTION: A CENTURY OF RESEARCH USING MOVING PICTURES, edited by A.Cappozzo, M.Marchetti and V.Tosi (ISB Book Series-Volume 1; Hard-bound, 356 pages, 180 b&w and 7 colour figures).
Price: $AUS 65 plus postage ($AUD 20 airmail)
Supplier: Graeme A. Wood (address as above)

SECOND WORLD CONGRESS OF BIOMECHANICS ABSTRACT BOOKS (Vols I & II)
Price: NLG 100 (both vols including postage)
Supplier: SWCB Office, Biomechanics Section,
Institute of Orthopaedics
University of Nijmegen
P.O. Box 9101
NL-6500 HB Nijmegen
THE NETHERLANDS
Fax: +31-80-540555

Special feature articles

The following special feature articles have been prepared at the invitation of the Editor. Professor Robert Jensen (Laurentian University, Sudbury, ON, Canada) presents his views on body inertia parameter research, and Dr Virgil Stokes (Karolinska Institute, Stockholm, Sweden) provides some helpful advice on the statistical treatment of time series data. The latter will be the first in a series of articles by Dr Stokes dealing with a range of methodological 'issues'.

BODY SEGMENT INERTIAS

- An Invited Commentary -

by

Robert R. Jensen, PhD
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Laurentian University
Sudbury, Ontario, Canada

After many years of researching human segment inertia parameters I have come to the conclusion that differences between individuals and changes which occur in individuals are important; biomechanics research procedures need to be sensitive to inter-individual differences and intra-individual changes. However, frequently we adopt a *laissez faire* approach to the ways in which we attribute inertia parameters to the segments. Many of the techniques in common use have little regard for differences between individuals in body shape or in size. For example, total body mass is commonly used to predict segment mass. How sure are we that these proportions remain in effect as body mass increases or decreases or as we switch from individual to individual? And should our confidence rise as we increase the number of predictor variables and/or the type of regression? Ultimately the prediction can only be as good as the criterion data upon which the regressions depend. If these data are unsuitable for the current individuals the predictions will lack credibility. As extreme examples, predictions based on elderly adult cadavers are of no use if we are trying to estimate the segment inertias of infants or the changes in the inertias during pregnancy. What if our approach to kinematics was similar? Would we be satisfied by sampling gait patterns of healthy adults and then by using average velocity of the centre of mass as the predictor of segment kinematics?

A recurring question asked of segment inertia researchers is whether estimates of masses and moments of inertia have been evaluated for accuracy. The responses in the negative are understandable; measurements of these parameters in living subjects are virtually impossible. Conversely, although cadaver segment inertias can be measured, larger studies of different populations and sub-populations are impractical and errors are introduced during the preparation of the specimens. Similar concerns about the accuracy of segment kinematic parameter estimates remain largely unanswered.

It has been claimed by some that inaccuracy in the inertia estimates has little effect on the results of an analysis, but what is the relative importance of inertia and kinematic parameter errors on the analysis of movement? This claim has prompted several investigations and these studies are beginning to appear in the literature. Part of the complexity of this issue is that the effects depend upon variables such as the type and speed of a movement. However, if we return to the example of infant movements, it should be clear that differences between infants and changes within infants in segment inertia parameters, including the effects of gravity on the segments, should exert a primary influence on when a movement commences, on control over that movement as the infant grows, and on the progression through subsequent movements. The increasing sophistication and interest in segment inertia research should lead to greater confidence that differences between individuals and changes in individuals are being represented adequately in biomechanics research.

Birdy's Corner

M&M's—A Quick Recipe

Here, M&M's represent the mean and median. I will first define the mean and median as often used in the analysis of the spectral density of EMG data. Then a recipe (algorithm **MMF**) will be given which can be used for their computer implementation. The emphasis is on an accurate computer implementation not mathematical rigor. One of my mathematics teachers once said "Some mathematical tricks are quite easy. Some are extremely difficult. Unfortunately, those who write mathematical textbooks seldom take the trouble to show how easy the easy calculations are." Showing you that some of our most useful tools are actually very easy to implement is one of the goals of this column.

Definitions

I define the mean of x by

$$x_{Mean} = \frac{\int_{x_1}^{x_2} xS(x)dx}{\int_{x_1}^{x_2} S(x)dx} = \frac{M}{A} \tag{1}$$

and the median of x implicitly by

$$\int_{x_1}^{x_{Median}} S(x)dx = \int_{x_{Median}}^{x_2} S(x)dx \tag{2}$$

where, $S(x) \geq 0$ over the closed interval $x \in [x_1, x_2]$. Clearly, x_{Median} is the value of x that divides the area under $S(x)$ into two equal parts; i.e. the "middle" x for the region under $S(x)$. Also, some of you probably recognize (1) as just the x-coordinate of the centroid of the area enclosed by $S(x)$. That is, x_{Mean} is the moment (M) divided by the area (A). The statistically inclined may view these equations with skepticism as the mean and median seem to be rather oddly defined. However, note that if x were a random variable with probability density function $S(x)$ and the limits of integration changed $(-\infty, +\infty)$ then $A = 1$ and (1) would reduce to the classical definition of the mean. Similar reasoning can be used for the median in (2) — I leave this to you (hint: x is already ordered). Now, for our application (spectral density of EMG signals) these can be written as

$$f_{Mean} = \frac{\int_{fL}^{fU} fS(f)df}{\int_{fL}^{fU} S(f)df} \tag{3}$$

$$\int_{fL}^{f_{Median}} S(f)df = \int_{f_{Median}}^{fU} S(f)df \tag{4}$$

where, $S(f)$ is the spectral density of the EMG signal and is positive by definition and $f \in [fL, fU]$.

Numerical approximation

Assume we have sampled $S(f)$ at discrete frequencies with uniform spacing (e.g. the periodogram of the EMG signal). That is, we have $\{f_i, S(f_i); i = 1, 2, \ldots, N\}$ and $f_i = (i-1)\Delta f + fL$ for $i = 1, 2, \ldots, N$, where Δf is the frequency spacing and $f_N = fU = (N-1)\Delta f + fL$. This uniform spacing assumption is only used to simplify the derivations and will be relaxed later.

We now derive an approximation for the definite integral

$$A = \int_{f_1}^{f_N} S(f)df \tag{5}$$

Suppose we constructed the following plot. Connect the sequence of discretized $S(f)$ values with straight lines (linear approximation between data values) and then drop vertical lines from each $S(f)$ value to the frequency axis (see the figure for the example which follows). Clearly, an approximation to the area under $S(f)$ is easily obtained by summing the areas of these generated trapezoids — and you thought this was going to be hard. Now that you see the big picture let's go back and see if we can derive a recursive area estimator.

If we connect the first two points $(f_1, S(f_1)), (f_2, S(f_2))$ of the discretized spectral density with a straight line and calculate the area under this trapezoid we obtain

$$A_2 = \Delta f \left(\frac{S(f_1)}{2} + \frac{S(f_2)}{2} \right)$$

where, A_2 is the area under $S(f)$ through f_2 (you might want to look again at the example below). Similarly, if we connect $S(f_2)$ and $S(f_3)$ with a straight line, adding another trapezoid, we obtain

$$A_3 = \Delta f \left(\frac{S(f_1)}{2} + \frac{S(f_2)}{2} + \frac{S(f_2)}{2} + \frac{S(f_3)}{2} \right).$$

We substitute A_2 into A_3 to obtain

$$A_3 = A_2 + \Delta f \left(\frac{S(f_2)}{2} + \frac{S(f_3)}{2} \right).$$

It is now straightforward to show that,

$$A_k = A_{k-1} + \frac{\Delta f}{2}(S(f_{k-1}) + S(f_k)). \tag{6}$$

Congratulations, you have just derived the trapezoid rule in recursive form. We now drop the assumption of uniform spacing (as promised) and write (6) in the form

$$A_k = A_{k-1} + \frac{(f_k - f_{k-1})}{2}(S(f_{k-1}) + S(f_k)) \tag{7}$$

where, $A_1 = 0$ and $k = 2, 3, \ldots, N$. As we shall later see this will be very useful for the estimation of f_{Median} and can also be used for the approximation of integrals in (3) and (4).

Now, we will find an approximation for

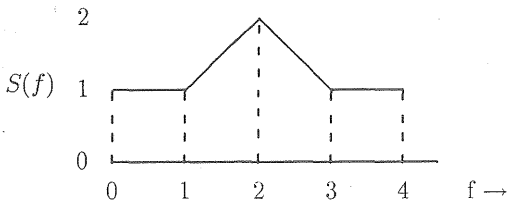
$$M = \int_{f_1}^{f_N} fS(f)df. \tag{8}$$

One may be tempted to use the recursive trapezoid rule above in (7) with $S(f_{k-1})$ replaced by $f_{k-1}S(f_{k-1})$ and $S(f_k)$ by $f_kS(f_k)$. We call this the trapezoidal approximation to M (or TAM for short). Don't use TAM — unnecessary errors can be introduced and these may be rather

large. Why? Remember, when we connect two adjacent discrete values of the spectral density with a straight line a trapezoid (or rectangle) is generated. Also, recall that our recursive trapezoid rule is exact for trapezoids (linear); but not for trapezoids multiplied by f and herein lies the problem. In brief, the multiplication of the integrand by f increases its degree by one; thus, the integrand becomes quadratic in f. I now give without proof a recursive estimator for the first moment defined by (8) which is exact for straight lines between discrete values of $S(f)$.

$$M_k = M_{k-1} + \frac{(f_k^2 + f_k f_{k-1} + f_{k-1}^2)}{3}(S(f_k) - S(f_{k-1}) + \frac{(f_k + f_{k-1})}{2}(S(f_{k-1})f_k - S(f_k)f_{k-1}) \quad (9)$$

where, $M_1 = 0$ and $k = 2, 3, \ldots, N$. Note, I will gladly supply the proof (rather messy and boring) via e_mail if you so desire. A reasonable question to ask at this point is, how much better is this estimate of M than TAM? Before I try to answer this question let's apply these newly derived equations to a simple example, one for which exact values of A and M are easily determined. This will be a good check on our derivations.



It should be obvious that the total area of $S(f) = 5$, $M = 10$ (well perhaps this isn't so obvious), and $f_{Mean} = f_{Median} = 2$. These can be obtained directly from their definitions (the definite integrals are easily evaluated) — I leave this as an exercise for you. We can now proceed with our verification of the recursive equations.

$$\begin{aligned}
[k=2, f_k=1]: \quad A_2 &= \frac{(1-0)}{2}(1+1) = 1 \\
M_2 &= \frac{(1+0+1)}{3}(1-1) \\
&+ \frac{(1+0)}{2}(2-0) = \frac{1}{2} \\
[k=3, f_k=2]: \quad A_3 &= A_2 + \frac{(2-1)}{2}(1+2) \\
&= 1 + \frac{3}{2} = \frac{5}{2} \\
M_3 &= \frac{1}{2} + \frac{(4+2+1)}{3}(2-1) \\
&+ \frac{(2+1)}{2}(2-2) = \frac{1}{2} + \frac{7}{3} = \frac{17}{6} \\
[k=4, f_k=3]: \quad A_4 &= A_3 + \frac{(3-2)}{2}(2+1) \\
&= \frac{5}{2} + \frac{3}{2} = 4 \\
M_4 &= \frac{17}{6} + \frac{(9+6+4)}{3}(1-2) \\
&+ \frac{5}{2}(6-2) = \frac{17}{6} + \frac{11}{3} = \frac{13}{2} \\
[k=5, f_k=4]: \quad A_5 &= A_4 + \frac{(4-3)}{2}(1+1) = 4+1 = 5 \\
M_5 &= \frac{13}{2} + \frac{(16+12+9)}{3}(1-1) \\
&+ \frac{7}{2}(4-3) = \frac{13}{2} + \frac{7}{2} = 10,
\end{aligned}$$

which verifies (7) and (9). If you now substitute these values into (3), $f_{Mean} = 10/5 = 2$, which is correct of course — nice work. But, what about f_{Median}? Well here, due to symmetry of $S(f)$ about $f_3 = 2$, $f_{Median} = f_{Mean}$. However, it is very unlikely that $S(f)$ will have such symmetry in reality — so how can we estimate f_{Median} for any $S(f)$? Of course, one thing which may pop into mind is an iterative approach; i.e. iterate on the integrals in (4) until we find the f_{Median}. I would like to propose the following non-iterative solution which is the *rasion d'être* for the recursive trapezoid rule. Suppose we first compute the integral in (5); then use (7) to compute the area through f_k. Clearly, if $A_k = A/2$, then $f_k = f_{Median}$ and we are finished. Unfortunately, it is almost never that easy, since we will almost never find a k for which this is true; but rather find a k such that $A_{k-1} < A/2$ and $A_k > A/2$; i.e. $f_{k-1} < f_{Median} < f_k$. Obviously, it is very unlikely that f_{Median} will be located exactly at the edge of a trapezoid (as in my contrived example). Now, you probably see where I'm headed. Once, we find the f_k which nearly splits the area into half (i.e. located inside a trapezoid which contains f_{Median}) then we can use linear interpolation to estimate f_{Median} — this is included in the **MMF** algorithm.

Before I give the pseudo-code for the algorithms which we have derived let's consider the question which I posed earlier on how much better (9) is than TAM. For the example given, I calculated $M = 10$ using TAM which is exactly correct (try it yourself)! Confused? At first this may seem so, since I have claimed that TAM *can* give errors. Have I deceived you? No, I haven't, this is indeed a contrived example. What happened, is error cancellation; i.e. TAM was in error (+1/6 to be precise) after going from $k = 2$ to $k = 3$ but this was exactly cancelled going from $k = 3$ to $k = 4$. In fact, this leads us to an easy to remember "rule-of-thumb" for errors in TAM: $S(f)$ increases (positive slopes) cause overestimation of M and decreases (negative slopes) underestimation. For those of you still in doubt, I invite (beg) you to try both methods on an example of your choice and compare results.

Algorithms

Pseudo-code is given for the algorithms which I recommend for the estimation of f_{Mean} and f_{Median}. Hopefully, you will find the pseudo-code easy to implement in the language of your choice.

PROCEDURE **RTR** ($i1, i2, f, S, Integral$)
% Purpose: Moment (zero) - Area
% Method: Recursive trapezoid rule, eq. (7)
% (R)$Integral = \int S(f)df$ from f_{i1} to f_{i2}
$Integral = 0$
FOR $k = i1 + 1$ TO $i2$ DO {

```
        delta = (f(k) − f(k − 1))/2
        Integral = Integral + delta∗(S(k − 1) + S(k)) }
END RTR

PROCEDURE RM1 (i1, i2, f, S, Integral)
% Purpose: Moment (first)
% Method: Recursive first moment, eq. (9)
% (R)Integral = ∫ fS(f)df from f_i1 to f_i2
    Integral = 0
    FOR k = i1 + 1 TO i2 DO {
        Integral = Integral + (f²(k) + f(k − 1)∗f(k)+
        f²(k − 1))∗(S(k) − S(k − 1))/3+
        (f(k) + f(k − 1))∗(S(k − 1)∗f(k) − S(k)∗f(k − 1))/2 }
END RM1

PROCEDURE MMF (i1, i2, f, S, fMean, fMedian)
% Purpose: Mean, median frequencies for spectral density
% i1, i2 =first, last indices for f, S(f)
% f =array of frequency values
% S =array of spectral values
% (R)fMean =Mean frequency from f_i1 to f_i2
% (R)fMedian =Median frequency from f_i1 to f_i2
    RTR (i1, i2, S, Integral1)          % ∫ S(f)df
    RM1 (i1, i2, S, Integral2)          % ∫ fS(f)df
    fMean = Integral2/Integral1
    HalfArea = Integral1/2
    Area = 0; MedianFound = false
    k = i1
    REPEAT
        k = k + 1
        PrevArea = Area
        delta = (f(k) − f(k − 1))/2
        Area = Area + delta∗(S(k − 1) + S(k))
        IF Area > HalfArea THEN {    % linear interpolation
            MedianFound = true
            Slope = (Area − PrevArea)/(2∗delta)
            fMedian = (HalfArea − Area)/Slope + f(k − 1) }
    UNTIL MedianFound
END MMF
```

These algorithms are of $O(N)$; i.e. their execution speed increases linearly with N (the number of data points). The PASCAL (Borland vers. 7.0) code is available via FTP (FTP address: ftp.ki.se//pub/outgoing/ISB01.ZIP). Please feel free to use the algorithms as you see fit. I only ask in return that you acknowledge where they came from.

Epilogue

Some of you may be disturbed by my of lack of rigor and lack of attention to detail (e.g. computer roundoff errors) — I apologize for that. My intent was and is to make this material both readable and useful to the ISB membership as a whole. Also, some may have noticed that I have excluded the "mode" which according to its French meaning is the most fashionable or according to its statistical meaning the most frequently occurring value — I don't apologize for this exclusion. Why have I not included this "M"? I leave this with you to ponder. Any questions/comments which you may have on this article can be directed to me via e_mail: birdy@neuro.ki.se. Incidentally, this article was written completely in LaTeX 2_ε. *Th-th-tha-that's all folks*!

MORE OF BIOMECHANICS IN POLAND

In the last issue of this Newsletter Dr Kazimierz Fidelus described the activities of the main biomechanics centers in Poland. The following additional information, concerning the Section of Biomechanics of the Polish Committee for Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences and seminars in the field of biomechanics organized by the International Centre of Biocybernetics (ICB) of the Polish Academy of Sciences, has since been supplied by Professor Adam Morecki and Maciej Nalecz.

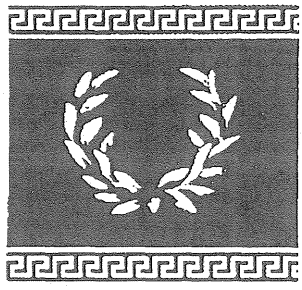
1. *Section of Biomechanics of the Committee for Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences.*

The Section consists of the following members:
A. Morecki (chairman), J. Kiwerski (deputy chairman), K. Kedzior, A. Wit, J. Wojnarowski. Main forms of the Section activity: organization of seminars and conferences, evaluation of activities in the field of biomechanics in Poland.

2. *Seminars, in the field of biomechanics, organized by the ICB. During the period 1988-1994 the ICB has organized the following seminars:*

    1. Biomechanics of organ of motion. Modelling, measurements, clinical applications. Madralin, 15-25.10.1989.
    2. Medical biomechanics of spine. Theory, modelling and clinical applications. Podkowa Lesna, 15-25.10.1990.
    3. Mechanics of bloodcirculation. Madralin, 14-21.10.1991.
    4. Biomechanics of motion.Measurements, modelling and clinical applications. Warszawa, 19-23.10.1992.
    5. Biomechanics of spinal system. Theory, modelling, clinical and ergonomic applications. Warszawa, 15-20.11.1993.
    6. Biocybernetical and biomechanical aspects of man-machine systems. Warszawa, 16-19.09.1994.

IOC OLYMPIC PRIZE



PRIX OLYMPIQUE DU C.I.O.

In order to recognize the evolution of scientific research related to human movement, the International Olympic Committee, under the sponsorship of Parke-Davis, has created a prestigious prize–the **IOC Olympic Prize.** This Prize will be awarded for findings resulting from outstanding research in the field of science applied to human movement, physical exercise, and sport. The Prize may be awarded in the following fields:

- biological sciences
- medical sciences
- physical sciences
- psychological sciences

The IOC Olympic Prize will be awarded every two years in connection with the Olympic Summer and Winter Games and consists of:

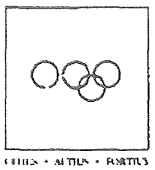
- a medal
- a diploma and
- $250,000.00 (U.S.)

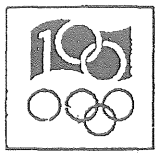
The initial IOC Olympic Prize will be awarded at the Games of the XXVI Olympiad in Atlanta in 1996.

For further information about the IOC Olympic Prize please contact the IOC headquarters in Switzerland:

International Olympic Committee
Medical Commission
Château de Vidy
CH-1007 Lausanne
Switzerland
Tel: 41.21 621 61 11
Fax: 41.21 624 61 66

Chairperson Selection Committee
Benno M. Nigg
Human Performance Laboratory
The University of Calgary
Calgary, Alberta, Canada, T2N 1N4
Tel: 403 220 3436
Fax: 403 284 3553





COMITÉ INTERNATIONAL OLYMPIQUE
INTERNATIONAL OLYMPIC COMMITTEE

Announcements

XIIITH MEETING OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS IN SPORTS (I.S.B.S.)

July 18-22
Hosted by the School of Kinesiology at Lakehead University in Thunder Bay, Ontario, Canada.

Thunder Bay is located on the north-western shore of Lake Superior, approximately 800 kilometers east of Winnipeg, Manitoba and 1,400 kilometers north-west of Toronto. The United States border's approximately 60 kilometers to the South with the city of Minneapolis, Minnesota roughly a 6-hour drive away. Thunder Bay is a multi-cultural, industrial port city of 110,000 people. The city functions as the major cultural centre for a far-reaching area north of Lake Superior and east of the Manitoba border. The region is part of the Canadian Shield which is primarily a forested, rugged wilderness territory with numerous lake systems and rivers banking the Great Lakes Network. The area abounds with beautiful scenery, lakes, rivers and forests plus an abundance of natural fauna, wild life and recreational feasibilities.

Lakehead University is the major university institution in the region, small by Canadian standards (6,000 students) with a regional focus including forestry, engineering, business, educational, nursing and kinesiology programs, together with the Arts and Science faculties.

The Conference activities will be located on campus, with the major presentations and related scheduled events taking place in and around the university. Conference delegates will be residing in comtortable condominium residences set in an attractive natural area adjacent to the campus.

A variety of recreational and social programs focusing on the local culture and the natural recreational areas are planned. The academic program will be designed to approach the major objectives of the I.S.B.S. and bring together researchers and practitioners in a variety of sporting fields including skiing, gymnastics and sports medicine.

The objectives of the Society are:

> "To provide a forum for researchers, teachers, coaches and practitioners of sports biomechanics." (Article 1.0 ISBS constitution).

The second call for papers will be mailed out during October and November and details for early registration, accommodations and abstracts will be mailed on request during December and January. The deadline for abstract submissions will be March 30th, 1995. For further information contact:

Tony Bauer: Tel: (807)343-8654; Fax:(807)343-8944
E-mail: tbauer@cs_Acad_Lan.Lakeheadu.Ca

ELECTRICAL STIMULATION - CLINICAL SYSTEMS

First announcement and call for papers

Bioengineering Unit
University of Strathclyde
Scotland, United Kingdom
6th - 7th April 1995

This is the fourth meeting on Electrical Stimulation organised by the Biological Engineering Society, previous meetings having been held at Hexham, Salford and Liverpool. The conference theme is Clinical implementation of electrical stimulation. Planned session titles are:

Standing and walking systems
Electrical stimulation in physiotherapy practise
Stroke rehabilitation
Muscle reconditioning
Cardiac assist
Micturition and respiration
Instrumentation and technology transfer

The Meeting place will be in the Court Senate Suite of the University of Strathclyde situated above the Collins Art Gallery. Overnight accommodation is at Baird Hall situated in Glasgow s famous Sauciehall Street and the cost is inclusive of breakfast.

Registration includes coffee, tea and a book of abstracts. There will be a conference banquet on the shores of Loch Lomond on the Thursday evening.

Deadline for receipt of registration and abstracts is 1st February 1995. Further details can be obtained from:

Dr Malcolm Granat
Bioengineering Unit
106 Rottenrow
University of Strathclyde
Glasgow, G4 0NW
Scotland, U.K.
Tel: +44(0)141 552 4400
FAX: +44(0)141 552 6098

BIOMECHANICS & NEURAL CONTROL OF MOVEMENT IX

Neural-Mechanical Control: Interaction Between Neural Circuits and Biomechanics

June 17-22, 1995

Deer Creek Resort and Conference Center
Mt. Sterling, Ohio
(22 miles south of Columbus)

The Engineering Foundation announces its 9th conference on "Biomechanics and Neural Control of Movement." The intent of this conference series, which began in 1967, is to increase the level of interaction between engineering and life sciences so that each may benefit from the approaches and findings of the other fields. The life sciences have benefitted from the quantitative and analytical approach to movement control problems characteristic of engineering. Likewise, the engineering sciences have benefitted from the knowledge of how nature has solved similar motor control problems. In addition to the integrated nature of the formal presentations, the structure of these conferences fosters close informal interaction by providing time for ad hoc sessions and discussions in a relaxed setting.

Chair: Patrick E. Crago, Ph.D.
Biomedical Engineering Department
Case Western Reserve University
Applied Neural Control Laboratory
Charles B. Bolton Building #3480
Cleveland, Ohio 44106
Phone: 216-368-3977
Fax: 216-368-4872
E-mail: pec3@po.cwru.edu

Co-Chair: Jack Winters, Ph.D.
Biomedical Engineering Program
Catholic University of America
Room 105 Pangborn Hall
620 Michigan Avenue
Washington, DC 20064
Phone: 202-319-5843
Fax: 202-319-4499
E-mail:winters@pluto.ee.cua.edu

For a copy of the General Announcement/Call for Abstracts, please contact the Engineering Foundation at
E-mail: engfnd.aol.com
Fax: 1-212-705-7441.

BONE CELL AND TISSUE MECHANICS COURSE

The International Centre for Mechanical Sciences
CISM (Centre International des Sciences Mecaniques)

July 9-15, 1995

The goal of this course will be to review the entire area of bone cell and tissue mechanics, with an emphasis on bone remodeling. Besides being informative, it is planned that the course will function as a forum for the exchange of data, philosophy, and ideas across disciplinary divides and so provide further stimulus for a comprehensive approach to the problems of bone mechanics.

LECTURERS

Elisabeth Burger
Oral Cell Biology
ACTA-Free University, Amsterdam

John Currey
Biology
University of York, ENGLAND

Stephen C. Cowin
Mechanical Engineering
City University of New York

Rik Huiskes
Orthopaedics
University of Nijmegen

Lance E. Lanyon
Principal, Royal Veterinary College, London

Information and fees for the course may be obtained from:

CENTRO INTERNAZIONALE Dl SCIENZE MECCANICHE
Palazzo del Torso? Piazza Garibaldi, 18
33100 UDINE (ITALY)
Tel.: +39 0432 - Secretariat 294989 or 508251 - Administration 294795, Fax: 501523

From US
Tel.: Secretariat 011-39-432-294989 or
011-39-432-508251
Administration 011-39-432-294795
FAX: 011-39-432-501523

Biomechanics positions available

DOCTORAL RESEARCH ASSISTANTSHIP AVAILABLE - MOTOR DEVELOPMENT

A research assistantship is available for a student interested in pursuing a Ph.D in motor development or, motor development/adapted physical activity. The assistantship involves participation in federally funded research with infants, focusing on a) investigating the fit between dynamic systems theory and change in patterns of motor behavior and b) factors that relate to the delayed development of infants with Down syndrome.

During the next three years our primary focus will be on a study of the effects of treadmill practice on the onset of walking and quality of walking patterns in infants with Down syndrome.

Preference will be given to applicants with a background in motor development, child development, or biomechanics. This research assistantship pays between $7,000 and $8,000 plus a waiver of tuition for 30 credit hours of graduate work annually. The position will remain open until a qualified candidate is found. The assistantship will begin in late
August of 1995. A letter of application, vita, copies of academic transcripts, and the names and addresses of three references should be sent to:

Dr. Beverly Ulrich
Department of Kinesiology
Indiana University
Bloomington, IN 47405
E-mail: ulrichb@ucs.indiana.edu

POST-DOCTORAL POSITION IN BIOMEDICAL ENGINEERING

Institute for Biomedical Technology
University of Twente

One of the Institute's research programs is aimed at the development of a hybrid walking system to restore the mobility of paraplegic patients. The hybrid system consists of Functional Electrical Stimulation (FES) in combination with a tailor made orthosis. The project in which the Post Doc will work is embedded within this program. This project is based on a close collaboration between the following organisations:

- The Faculties of Mechanical Engineering and Electrical Engineering of the University of Twente.
- The Rehabilitation Centre 'Het Roessingh' in Enschede.
- The Morphological Laboratory of the Faculty of Human Movement Sciences of the Free University in Amsterdam.

The major aims of the project are:

- Evaluation of selectivity of surface electrical stimulation.
- Identification of joint angle - moment characteristics of individual hip joint muscles by means of electrical stimulation.
- Identification of direction of the moment of force of selectively stimulated muscles as a function of joint angle.
- Quantification of inter-individual variation of these variables in a limited number of patients.
- Evaluate the necessity of adaption of stimulation parameters due to effects of training.
- Relate the results to biomechanical models in use to simulate FES-induced walking.
- Contribute with the results to the design process of the hybrid system.

Candidates should have a PhD in Biomedical Engineering, Human Movement Sciences or related fields. They should be able to work in a multidisciplinary team. The position is available
for a period of maximally two years under standard conditions.

For further information, please contact:

Dr.ir. Bart Koopman
Faculty of Mechanical Engineering
Laboratory of Biomedical Engineering
University of Twente
P.O.Box 217, 7500 AE Enschede
The Netherlands
Tel: +31-53 892465 (892514)
Fax: +31-53 356490
E-mail: h.f.j.m.koopman@wb.utwente.nl

FACULTY POSITION

Department of Physical Therapy
The University of Vermont

The University of Vermont Department of Physical Therapy invites applications for a 9-month, tenure-track faculty position. The University of Vermont Department of Physical Therapy offers baccalaureate entry-level and advanced masters degrees in physical therapy. Applicants must have expertise in the areas of anatomy, kinesiology, biomechanics, and the musculo-skeletal bases of physical therapy practice. Responsibilities include co-teaching musculo-skeletal bases of physical therapy practicce and scientific inquiry in the baccalaureate program; teaching and thesis advising in the graduate program; research and scholarly work; advising and service responsibilities, curricular responsibilities in musculo-skeletal content. A doctoral degree in physical therapy or a related field is

required, as well as research experience and plans for continued investigations. Candidates must have clinical and/or academic teaching experience and be philosophically supportive of the problem-based learning approach to professional education. Aplicants must meet the requirements for working in the U.S. and be eligible for licensure in the State of Vermont.

Submit curriculum vitae, names of three references and letter of intent to:

Mary Moffroid, Ph.D., P.T.
Search Committee Chair
University of Vermont
Department of Physical Therapy
305 Rowell Bldg.
Burlington, VT 05405-0068
USA
E-Mail address: MMoffroid@cosmos.uvm.edu

BIOMECHANICAL ENGINEER

Yale University School of Medicine is seeking a qualified engineer to assist in designing and implementing biomechanics research experiments with focus on the spine. The candidate should have either a bachelor's or master's degree in engineering (mechanical, civil, bioengineering, etc.). This is a one year position, which may be extended. Salary commensurate with experience. Yale University is an equal opportunity employer. For further information, please contact:

Manohar M. Panjabi, Ph.D.
Biomechanics Research Laboratory
Department of Orthopaedics
Yale University School of Medicine
P.O. Box 208071
New Haven, CT 06520-8071
U.S.A.
Tel.(203) 785-4924; Fax (203) 785-7069

LABORATORY TECHNICIAN - BIOENGINEERING

Department of Orthopaedic Surgery
University of California at San Franisco

The Department of Orthopaedic Surgery at the University of California at San Francisco seeks applications for a laboratory technician for the Bioengineering Research Laboratory. Responsibilities will include the setup and execution of mechanical experiments on hard and soft tissue, protocol refinement, cadaveric specimen preparation, specialized fixture fabrication, and programming of data acquisition software. Position requires close interaction with clinical faculty, residents, and engineering students.

This position is responsible for:

a) the software and protocol development for the materials testing machines within the Bioengineering Laboratory. Both the hydraulic testing machines (MMED and MTS) are controlled by computers, which requires programming to specify the parameters for the desired tests. (40%)

b) the design and fabrication of special fixtures and hardware necessary for the successful completion of nonstandard tests. This will require knowledge of standard biomechanical testing configurations for both hard and soft tissue, as well as an understanding of the appropriate ASTM (American Society of Testing and Materials) standard tests. Knowledge of electronics and instrumentation technology is preferred. (20%)

c) the data collection and post-processing, which includes digital filtering and statistical analysis (10%)

d) preparation of animal and human specimens for testing. This will include harvesting from cadavers, dissection of critical tissues, and imbedding into appropriate fixturing. (10%)

e) support for medical and engineering students who have projects approved for the laboratory (20%)

BS or MS in Bioengineering with 5 years experience preferred. Familiarity with orthopaedics or biomechanics required. Interested persons should contact:

Jeffrey C. Lotz, Ph.D.
Orthopaedic Bioengineering Laboratory
Department of Orthopaedic Surgery
University of California at San Francisco
533 Parnassus Ave.
San Francisco, CA 94143-0514

ASSISTANT PROFESSOR - SPORTS MEDICINE

Illinois State University

QUALIFICATIONS: Doctoral degree in Physical Education/Sports Medicine with a specialization in Exercise Physiology or Biomechanics. NATA certification is preferred. College teaching experience is desirable.

RESPONSIBILITIES:

1) TEACHING: undergraduate courses (anatomy and physiology, kinesiology and/or athletic training), and graduate courses in exercise physiology and/or athletic training. Direct master's theses and independent studies.
2) SCHOLARSHIP: Conduct research, involvement in scholarly projects with faculty and students. Disseminate research results through refereed publications and professional presentations, state through international levels. Submit internal and external grant proposals.
3) SERVICE: Departmental, College, and University

Committee membership, and involvement and contributions to professional organizations.

APPOINTMENT: Tenure track position. Assistant Professor. Rank and salary commensurate with qualifications and experience.

PERTINENT DATES: Review of applications will begin February 15, 1995. Position available August 15, 1995.

APPLICATION PROCEDURE: Send letter of application, resume, and 3 current letters of reference (including phone numbers) to:

Dr. L. Marlene Mawson, Chairperson
Department of Health, Physical Education, Recreation and Dance
5120 Illinois State University
Normal, IL 61790-5120
Phone: (309) 438-8661
FAX: (309) 438-5559
Internet: MMAWSON@ILSTU.EDU

BIOMECHANICS: ASSISTANT/ASSOCIATE PROFESSOR IN THE MOTOR LEARNING

Department of Movement Sciences and Education
Teachers College, Columbia University

A tenure-track professorial position

Position requires competencies in computer-based, kinematic/kinetic analysis of human movement. The individual must be able to use biomechanics as a tool for elucidating processes underlying skill learning, development or neuromotor control processes. Teach graduate courses; design/supervise research in rehabilitation and clinical settings, maintain an active research program; direct doctoral dissertation research. Candidates must be committed to excellence in teaching. Earned doctorate required; postdoctoral research training preferred. Research publications should provide evidence of potential for external funding. To apply: Send a letter of interest, Vita, brief statement of research plans, copies of publications, a list of three references to A. M. Gentile, Teachers College, Columbia University, New York, NY 10027. Review of candidates will begin Jan.15, 1995 and continue until the search is concluded.

Teachers College as an institution has long been committed to a policy of equal opportunity in employment. In offering graduate studies in education, psychology, and health services, the College is committed to providing expanding employment opportunities to persons of color, women, and persons with disabilities. The College actively prohibits all discrimination based on grounds such as race, ethnicity, religion, gender, sexual orientation. age, and disability status. Candidates whose qualifications and experience are directly relevant to complementary College priorities (e.g.urban concerns) may be considered for a higher rank that advertised.

POSTDOCTORAL POSITIONS

The reserch center of ISTITUTI ORTOPEDICI RIZZOLI invites applications for postdoctoral or senior contracts. The main research topics in the laboratory are computer- and robot- assisted orthopedic surgery and lower limb biomechanics (expecially knee). Candidates must have experience in one of the two fields and the exact research project will be discussed with successful applicants. Salary is commensurate with qualifications and experience.

Applications and nominations will be received until positions have been filled, but individuals are encouraged to apply immediately. Candidates should submit a curriculum vitae, statement of research interests, reprints of significant publications to:

Dr Sandra Martelli
Ist. Ortopedici Rizzoli, Lab. Biomeccanica
via di Barbiano 1/10
I-40136 BOLOGNA, ITALY
Fax: +39-51-583789

POSITION FOR MATERIALS SCIENTIST

The Eastern Regional Research Center (ERRC), Agricultural Research Service, USDA, has a research opening for a permanent full-time Scientist specializing in mechanical properties of fibrous materials. The research is directed at relating deformation processes in animal skin and hide and leather to macroscopic structure, microscopic texture, and chemical composition, using the methods of biomechanics and physical chemistry. Ability to measure viscoelasticity and to perform optical measurements on fibers is desirable. The Center is located on an attractive 27-acre campus just outside of Philadelphia, in Wyndmoor, Montgomery County, Pennsylvania. It has over 250 scientists, engineers, and support staff working in diverse areas of agricultural research. Employees enjoy a flexible work schedule and have access to state-of-the-art instruments, computer center, and library. Candidate must be a U.S. citizen and must have a knowledge of biomaterials such as collagen fibers and ability to design, plan, conduct research and publish results. Salary commensurate with experience ($38,107 to $50,297).

For information regarding the research project contact:
Dr. Paul Kronick
USDA-ARS-ERRC
600 E. Mermaid Lane
Philadelphia, PA 19118, USA
Tel: (215) 233-6505; Fax: (215) 233-6795
E-mail: pkronick@arserrc.gov

For copy of the application package contact Angela Canterini at (301) 344-1920. Applications in response to this advertisement must be marked 5N010 and be postmarked by January 23, 1995.

Thesis abstract

A BIOMECHANICAL COMPARISON BETWEEN TECHNIQUE AND SHOOTING DISTANCE IN BASKETBALL

by

Stuart A. Miller

Master of Science Thesis
Department of Orthopaedic Mechanics
Salford University, England
September, 1992

Adviser: Roger Bartlett

This study sought to establish the relationship between the kinematics of the basketball jump shot and shooting distance as performed by players of the three major positions. Three dimensional cinematographic techniques (R.M. Bartlett, Biomechanical Analysis of Performance in Sport. Leeds: BASS, 1992) were used to record successful shots as performed by guards, forwards and centres (all n=5) at each of three distances from the basket (2.74m, 4.57m, 6.40m), using two Photosonics 1PL cine cameras. The resulting film sequences were digitised at 100Hz and smoothed using cross-validatory quintic splines.

Ball release speed was found to increase with shooting distance for all groups, the differences between 2.74m and 6.40m shots being significant for all groups ($p<0.01$). Increases in shooting distance were also associated with a change in direction of the centre of mass velocity vector at release towards the basket. This, in combination with a release of the ball sooner after take-off as shooting distance increased, allowed the utilisation of a greater amount of upward and forward body momentum as partial provision of the required release speed. Increases in release speed as shooting distance increased were also derived, for forwards and guards, by an increased contribution by the elbow extensor muscles, whereas for centres the greatest contribution of shoulder, elbow and wrist was at the intermediate shooting distance, suggesting that the latter group utilised body momentum in the direction of the basket to the greatest extent. Coordination patterns also changed with increasing shooting distance such that the maximum angular velocity of the elbow and wrist joints occurred closer together and nearer to the moment of release.

Ball release angles were similar for all groups, the majority of which were in the range 52-55°, which provides maximum margin for error in release parameters. The smallest difference between the actual release angle and that which would have resulted in maximum range was found for all groups at the 6.40m distance. This suggests that as shooting distance increases, the benefits of release angles which provide maximum margin for error become outweighed by the need to release the ball closer to the angle which provides maximum range i.e. requires minimum impulse and, thus, release speed.

The relationship between shooting distance and release height for centres was found to be inverse Despite having the greatest average stature, the release height for centres was significantly lower than that for forwards ($p<0.01$) at 6.40m. The minimum value of this parameter for guards and forwards was at the 4.57m shooting distance. Decreases in release height tended to be due to both release of the ball sooner after take-off and a change in the orientation of body segments at release, especially the upper arm. All groups exhibited considerable leftwards rotation (9-32°) of both the hip and shoulder axes prior to release, which supports the need for three-dimensional analysis techniques of basketball shooting. Whilst forwards exhibited the greatest amount of rotation, values tended to increase with shooting distance for all groups. Such rotations are contrary to many recommendations in the coaching literature.

It was concluded that forwards and guards, who tended to exhibit more consistent trends between kinematic parameters and shooting distance, would seem more able to adjust to shooting from the range of distances used in the current study. Centres, who are not familiar with the longest shooting distance, did not display such trends. It would therefore seem that familiarity with the longer shooting distances is beneficial in terms of adaptation to unfamiliar ones.

Calendar of events

March 4-5, 1995
Second International Comparison Meeting on Motion Measuring System '95, AMADA FORUM 246 Concourse, 350, Ishida, Isehara-City, Kanagawa-Prefecture, Japan. Contact: Sectreary General, International Comparison Meeting '95, Tokyo Prosthetic and Orthotic Research Institute, 3-17-3, Toyama, Shinjuku-ku, Tokyo 162, Japan. Fax: 81-33203-3576.

April 26 - 30, 1995
Second National Conference on Sports Medicine and Science in Tennis, Sonesta Beach Hotel, Key Biscane, Florida. Contact: USTA, Sports Science Department, 7310 Crandon Blvd., Key Biscane, FL 33149, USA. Tel: (305) 365-8710.

June 1-3, 1995
Second Annual North American Clinical Gait Laboratory Conference, Waterloo, Ontario, Canada. Contact: Betty Bax, Department of Kinesiolgy, University of Waterloo, Waterloo, ON Canada N2L 3G1; Tel: (519) 888-4567 ext.2610; Fax (519) 742-9312; E-mail: bax@healthy.uwaterloo.ca

June 21-23, 1995
BIOMED '95: Third International Conference on Simulations in Medicine, Palazzo delle Stelline, Milan, Italy. Contact: Jan Evans, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA UK. Tel: 44(0)703 293223; Fax: 44(0)703 292853; E-mail CMI@ib.ri.ac.uk.

June 28-30, 1995
5th International Symposium on Computer Simulation in Biomechanics. University of Jyväskylä, Finland. Further information from: Dr. Erkki Laitinen, Laboratory for Scientific Computing, University of Jyväskylä, PO Box 35, FIN-40351, Jyväskylä, Finland. Tel: +358 41 602745; Fax: +358 41 602731; E-mail: biomech@math.jyu.fi.

July 2-6, 1995
XVth Congress of the International Society of Biomechanics. Jyväskylä, Finland. Contact: XVth ISB Congress, Jyväskylä Congresses, P.O. Box 35, FIN-40351 Jyväskylä, FINLAND. Tel: +358 41 603621; Fax: +358 41 603 664.

July 18-22, 1995
XIII International Symposium on Biomechanics in Sports, Lakehead University, Thunder Bay, ON Canada. Contact: Tony Bauer, Chairperson, Department of Kinesiology, Lakehead University, 955 Oliver Rd., Thunderbay, ON Canada. Tel: (807) 343-8654; Fax: (807) 343-8944; E-mail: Tony.Bauer@Lakeheadu.ca.

September 20-25, 1995
17th Annual International Conference of the IEEE Engineering in Medicine and Biology Society & 21st Canadian Medical and Biological Engineering Conference, Montreal, QC, Canada. Conference secretariat: Coplanaor Congres inc., 511 Place d'Armes, Suite 600, Montreal, QC, Canada H2Y 2W7. Tel: 514-848-1133; Fax: 514-288-6469; E-mail: embc95@coplanor.qc.ca. Up-to-date information on World Wide Web at http: //ralph.biomed.mcgill.ca /EMBC95.

November 9-12, 1995
2nd Interdisciplinary World Congress on Low Back Pain: The Integrated Function of the Lumbar Spine and Sacroiliac Joints, La Jolla, USA. Contact: UCSD, Office of Continuing Medical Education, UC San Diego School of Medicine, La Jolla, CA 92093-0617, USA.

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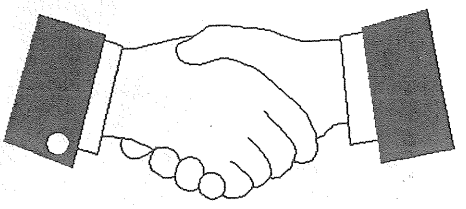

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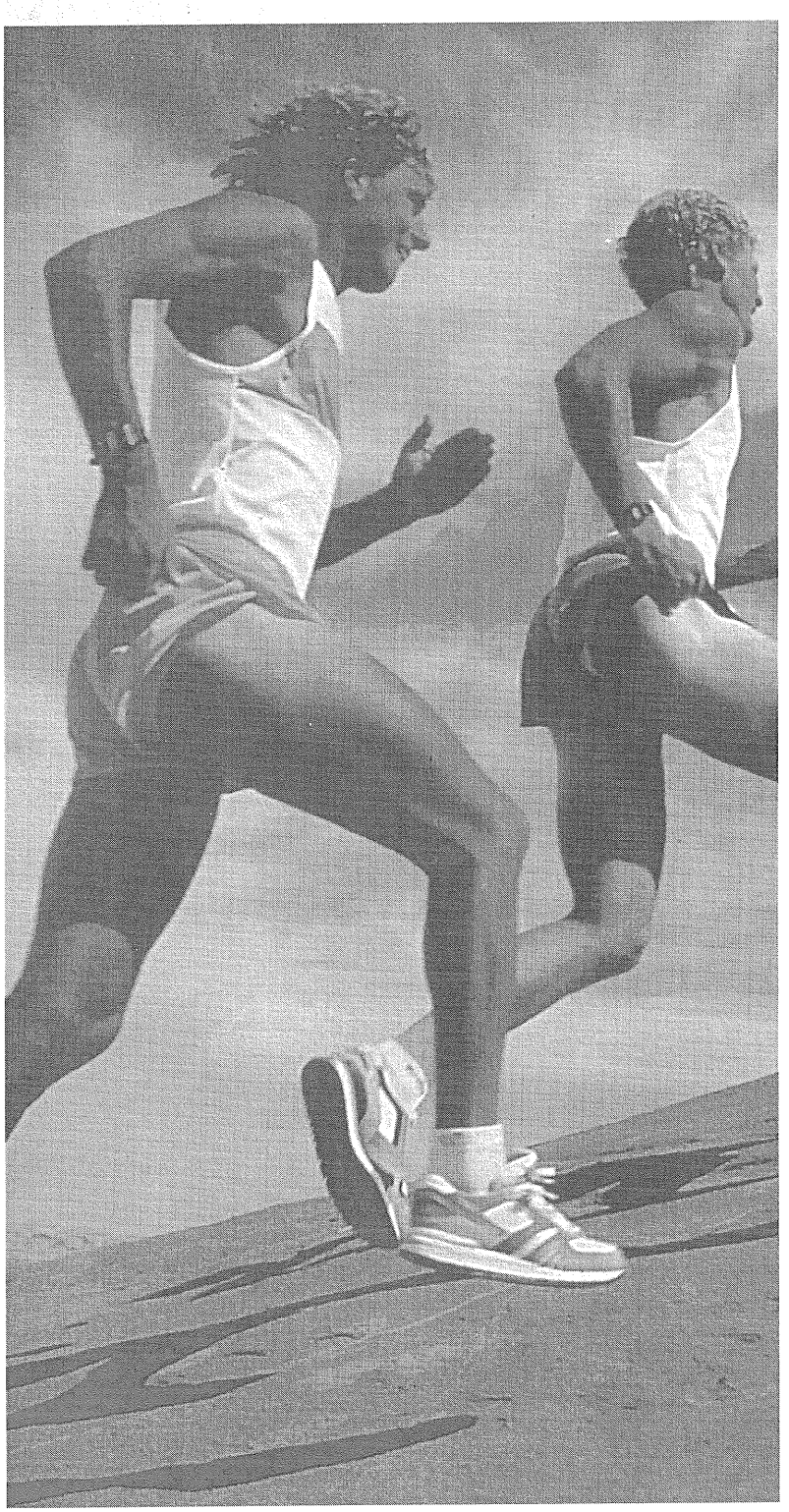

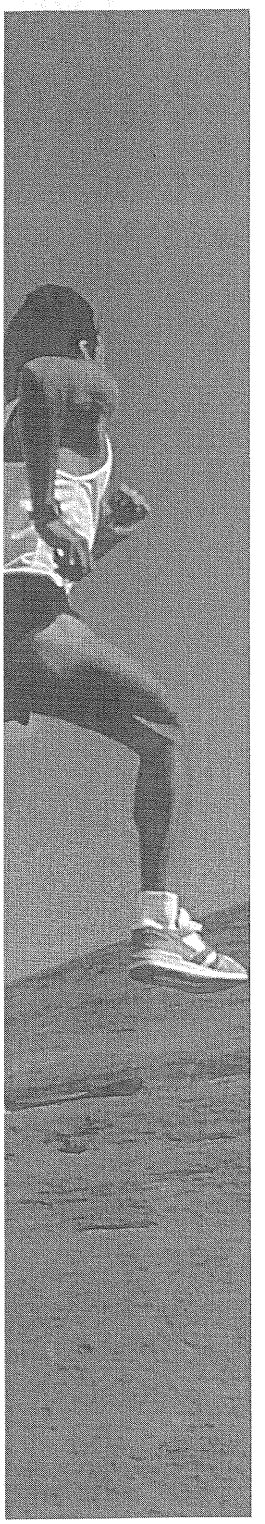

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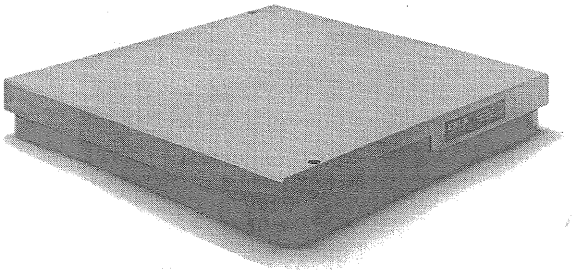

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