Faculty Association of the University of Waterloo

FAUW Forum

NUMBER 117

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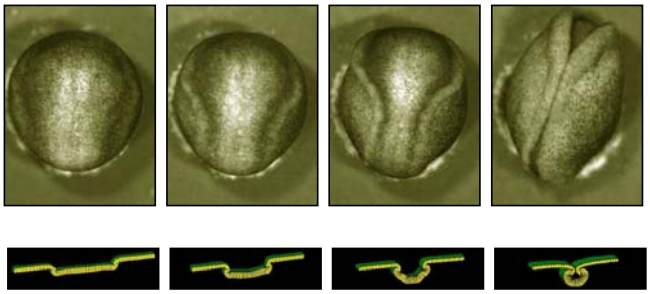
MODELLING THE FORMATION OF AN EMBRYO



In order to form organs and other critical structures, thin, fragile embryonic tissues must undergo precise, self-driven changes of shape. Wayne Brodland of Civil Engineering describes an ongoing research programme that seeks to understand how subcellular forces drive such morphogenesis. A better understanding of such processes could lead to medical procedures that prevent serious and often debilitating birth defects.

EYE SURGERY OR GLASSES?

According to David Williams (School of Optometry), "the public is being offered a procedure which is experimental and whose outcome is still to a significant extent unpredictable. This method is being offered as an alternative to a method whose safety and efficacy have been established for centuries."

LETTERS FROM FACULTY CRITICIZE SISP, MANDATORY RETIREMENT

In "Conspiracy of Grumbles," Roydon Fraser (Mechanical Engineering) assesses UW's new Student Information System Program (SISP). In his opinion, "UW is on a path of institutionalizing a student information system that I believe will negatively affect the quality of employment and the student experience at UW for years to come." Prof. Fraser asks why UW cannot adopt a "Made in Waterloo" software system in place of SISP.

Frank Zorzitto (Pure Mathematics) challenges the policy of mandatory retirement at age 65 and asks for a re-examination of Article 11.3 of the Memorandum of Agreement.

COUNCIL OF REPRESENTATIVES MEETING
Thursday, November 14
4:30 p.m., DC 1568
(light dinner provided)

FALL GENERAL MEETING
Wednesday, December 4
2:00 p.m., MC 2066
(refreshments)

RECEPTION FOR NEW FACULTY
Wednesday, December 4
4:30 p.m., DC 1301
(Lounge)

Inside this issue:

EDITORIAL

We are pleased to present this "100% home grown" issue of the *Forum* with a number of stimulating as well as provocative contributions from UW faculty members. I wish to thank all authors for their compositions and trust that the seeds sown in this issue will yield many future discussions in the *Forum*.

Wayne Brodland's "How is an Embryo Formed?" is, I hope, the first of many future expository articles that will describe the research activities of UW faculty members. (I learned about Wayne's research in a conversation that we had after serving as examiners in a Civil Engineering Ph.D. thesis defence.) The *Forum* invites suggestions for future articles.

We also hope that David Williams' critical examination of the question of refractive surgery vs. eyeglasses will not be the only article on this extremely important health issue.

Roydon Fraser's letter (Page 9) regarding SISP was written in response to a lively discussion of UW's new software system in a recent FAUW Board of Directors meeting. Indeed, comments from several Board members seemed to confirm Roydon's own assessment of "cynicism, disregard, frustration and even anger" throughout campus. We sincerely encourage members of UW's community to provide feedback, either as confidential letters to the FAUW Board or in the form of letters to the *Forum*.

Frank Zorzitto's commentary (Page 10) on the policy of mandatory retirement at age 65 is most timely. As Catherine Schryer writes in her President's Message (Page 16), OCUFA has released a discussion paper on mandatory retirement. The FAUW Board of Directors is now preparing to discuss this matter. We encourage responses to Frank's letter.

I was extremely pleased to see that Glenn Heppler's thought-provoking article on humanities and social sciences education in universities (*Forum*, Summer 2002) was not completely unnoticed by our readers. I wish to extend a special invitation to others in the humanities to follow Joe Novak's lead (Page 12) and share their thoughts. Surely there must be more opinions on this matter.

Finally, Bruce Richmond (Page 12) may be correct in his suspicions that hoaxes similar to the "Sokal hoax" (*Forum*, Summer 2002) have been played in scientific journals. Even more sobering, however, is the increased incidence of fraud in scientific and medical research. We would like to devote a future issue of the *Forum* to the subject of ethics in science.

Do you know where your car is?

This was precisely the question that I asked myself in B parking lot at 4:30 p.m. on Friday, September 27. Being 99.99% sure of the spot in which I parked that morning, my immediate fear was that it was towed away for some mysterious reason. "After all," I asked myself nervously while taking the short walk to UW Parking Services/Police, "what would anyone possibly want with a 1991 Chrysler Dynasty, when there are all of those nice, shiny Volvos around, just ripe for the taking?" (My apologies to a particular colleague for such an un-Christian thought.)

According to that fine young UW police officer who handled my case (as he was driving me on a tour of B lot, just to rule out any possibility of professorial absent-mindedness), the endangered Dynasty species is high on the hit list for robbery. First, it's a nice looking and comfortable car. (Oh, how soothing to a troubled soul. After all, my car was in mint condition.) Even more important, however, is that such old cars are a cinch to break into. Newer cars (e.g., those shiny Volvos) have alarm systems. (Sound of ego being crushed.)

By 5:00 p.m., the theft was reported to Waterloo Regional Police. There is so much more to this story that I could share. I'll only mention that the situation could have been much worse. Fortunately, I took my beloved graphite-shafted King Cobras (yes, they are also "vintage") out of the trunk the night before.

I was quite paranoid over the weekend because in the car were to be found, as usual, the vehicle registration papers (with our home address) as well as a remote garage door opener. What a lovely invitation for "sharing"! (Do you want to know what the sight of a slow-moving van on your street does to you after you've been robbed? Needless to say, I recorded a lot of license plate numbers that weekend.)

My car was found by the police on Monday morning on Lodge Street in Waterloo. Thankfully, the only damage was a hole under the driver's door latch (roughly the size of a quarter) plus a popped-out ignition lock (the plastic ring was shattered). Since only a few kilometres were put on the car that weekend, it appears that the perpetrator(s) simply needed some wheels for a quick ride, as opposed to a Burt Reynolds-style weekend of entertainment. I should mention that the repair bill for this "minimal damage" was a whopping $1300! This, along with the four-day fee for a rental car, was "covered by insurance." (My question to our economists: Are such expenses still considered as contributions toward the GNP?)

My purpose in recounting this story is twofold. First, I would like to express my appreciation to UW Police for a very efficient and professional handling of the case. Second, the story is meant to be a sober wake-up call to all. My car is not the first to have been stolen from this campus and it most probably won't be the last. And, of course, robbery is not restricted to automobiles. Perhaps it would be of interest to the UW community to know the frequency of various crimes that have been committed on campus over the past few years.

In the meantime, be on guard and don't leave any valuables in your vehicles. *ERV*

HOW IS AN EMBRYO FORMED?

by G. Wayne Brodland
Department of Civil Engineering

Although the question of how an embryo is formed has intrigued people for several thousand years, its answer has remained elusive. As new techniques of inquiry become available, they shed new light on this question and explain why previous attempts to answer it were not entirely successful. Can a definitive answer be found now, or perhaps in our lifetimes? Only time will tell. However, it is clear that the answer will require a highly multidisciplinary approach, drawing on input from biochemistry, micro-morphology, mechanics, and other fields. If research history is any indication, there will be many more surprises during the quest for answers to this question.

In order to form organs and other critical structures, thin, fragile embryonic tissues must undergo precise, self-driven changes of shape. It is generally accepted that the cytoskeleton and other sub-cellular structural components drive these movements. However, no morphogenetic process has been investigated with sufficient rigor that its medical outcomes can be predicted. This is tragic because, every year, nearly half a million babies enter the world (three thousand in Canada, alone) with a serious birth defect such as a cleft lip or palate, a cardiac septum defect or a neural tube defect due to a tissue malformation. It is essential to develop strategies to prevent these serious, often debilitating defects because, even with surgery, the prognosis for these infants can be very poor.

Two Complementary Approaches

To gain an understanding of how sub-cellular forces drive particular morphogenetic movements is difficult because the driving forces are invisible and their mechanical interactions complex. The problem is further complicated by the small size of the embryo (whole, early-stage animal embryos are typically 3mm or less in diameter) and the need to use unconventional methods to measure forces and to test hypotheses.

A typical embryonic tissue (Fig. 1) is made of an organised collection of cells. Various structural elements, called cytoskeletal components, are present in these cells, and they have the capacity to generate and carry tensile and compressive forces. These components are constructed and controlled by complex sequences of biochemical events that are ultimately regulated by the genes.

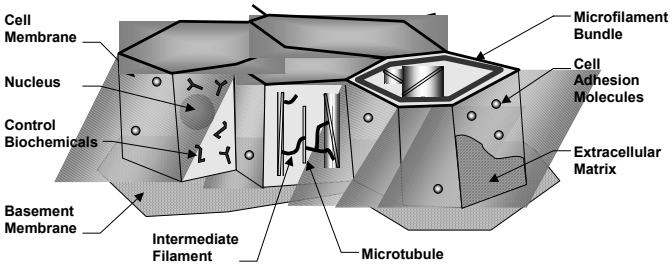


Fig. 1. A schematic illustration of an epithelium hints at the complex geometry of its structural components and the plethora of biochemical factors present. These interact together, under genetic control, to produce mechanical forces with the potential to reshape the tissue. The changes of shape that occur in any particular tissue depend also on its mechanical and biochemical interactions with adjacent tissues.

In order to investigate morphogenetic movements, our research team has followed two main approaches. The first of these uses a unique robotic microscope (Fig. 2) to collect images from different viewing angles over the surface of a live embryo and original software to make three-dimensional reconstructions (Fig. 3) of it. The basic concept is that if a particular point on the embryo can be seen from two different viewing angles, its three-dimensional location must lie at the intersection of those two lines of sight. To overcome error, data from at least three views are used for the reconstruction of each point, and sophisticated software is used to account for errors in camera positioning. This approach allows us to determine the precise shape of real embryos, and to calculate important geometric details such as surface curvatures at any time and location, and rates of in-plane and out-of-plane deformation with time. Although this

information is important to know, it alone does not provide sufficient information to determine which of the many structural elements present actually drive a particular pattern of movements.

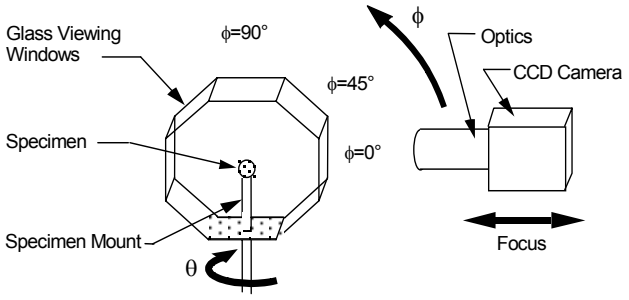


Fig. 2. The Robotic Microscope System collects images from different viewing angles over the surface of a live embryo. Custom software that we have written allows us to make three-dimensional reconstructions of live embryos from this data, and to follow the motions of the cells and tissues on their surfaces.

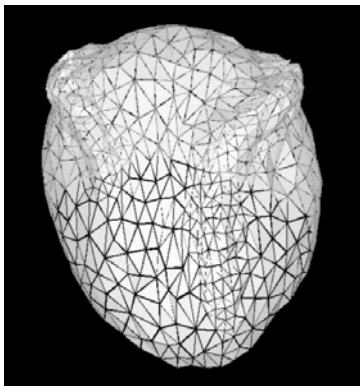


Fig. 3. The reconstructed surface of an amphibian (axolotl) embryo is represented in this computer rendering using approximately 1000 triangles.

The second approach we use attempts to answer this fundamental question using finite element software that we wrote to model cells and tissues. The software is based on state-of-the-art finite element methods such as those used to analyse complex engineered structures such as automotive systems and tall buildings. Our software, however, has been optimised to handle the unusual mechanical properties of sub-cellular biological components – negative mechanical stiffness, for instance. A negative stiffness arises in microfilament bundles because of their filamentous structure. As a bundle of microfilaments contract, the actin filaments of which they are composed intercalate with each other. As a result, the diameter of the bundle increases. Since the force generated in the bundle is proportional to its current cross-sectional area, its tensile force increases as it shortens. This is exactly opposite to common materials like a rubber band, in which the tensile force increases as it is extended. Negative component stiffnesses pose special modelling difficulties because they tend to make the system unstable.

The essence of the finite element method is that the object of interest is broken into small pieces, each of which is sufficiently simple that its behaviour can be approximated mathematically (Fig. 4). The pieces are then "re-assembled", producing a large system of simultaneous equations. In a mechanics problem, the solution of these equations gives the displacements that occur at each node in the structure. From this information, all of the internal and external forces and deformations can be calculated. In the case of an embryo study, the deformations are assumed to occur incrementally over time. The forces and deformations calculated during each time increment are used to update cell shapes and forces in preparation for the next step. Millions of calculations must be carried out for each time step and several hundred time steps may be needed to model a typical morphogenetic movement. Our computers typically have to run for many hours in order to calculate the complex sequence of deformations that occur during neurulation, the process by which the precursors of the spinal cord and brain are formed.

The idea of a computational model is that it takes as input the detailed geometry of an embryo and the subcellular morphology and mechanical properties of its tissues at a certain stage of development. It then uses established methods of mechanics to calculate how a mechanical system defined by that input would deform with time. A computational model is important because the forces that drive these motions are invisible and their effects often counterintuitive. If the predicted motions do not agree with those that occur in real embryos, one is forced to conclude that the current understanding is insufficient to explain the motions that occur. Unfortunately, the converse is not true. Nonetheless, differences between model and real embryos can be used to pinpoint regions where differences in mechanical properties or gene expression may be present. Model validation is an important part of the research process, and our model is currently being validated against neurulation-stage amphibian (axolotl) embryos because their tissues exemplify all possible changes of shape, including in-

plane reshaping, out-of-plane bending, thickening, and combinations of these.

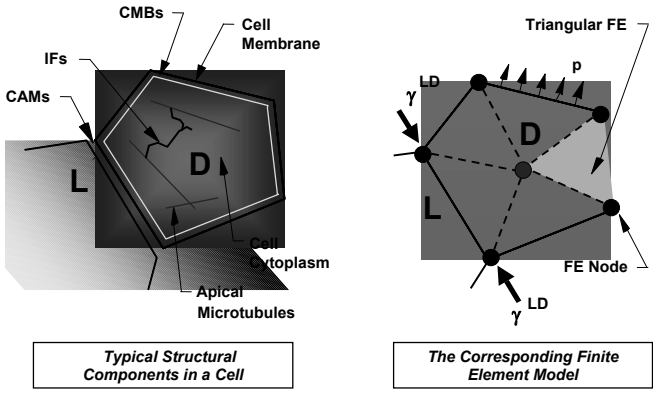


Fig. 4. The cells in an epithelium appear as polygons when viewed in plan. In a cell-level computational model, multiple finite elements can be used to represent each cell. This allows the mechanical properties and deformations of each cell to be modelled independently.

What Have We Learned?

When we used our finite element software to investigate neurulation (Fig. 5), it was able to predict the changes of shape that various combinations of driving forces would produce in the neural plate. These are found to be highly sensitive to the forces that act; if the strength or nature of the driving forces is changed, a visibly different sequence of morphogenetic movements results. This finding is consistent with studies in which drugs are used to disable specific force-generating components in real embryos. Our software made possible an unbiased test of any of the 50 hypotheses that had been offered in the literature to explain this critical developmental process. Our calculations showed that only one theory - contraction of apical microfilaments coupled with axial elongation of the embryo - could produce the requisite changes of shape. The simulations also revealed an interesting interaction between the current shape of the embryo and the effect of a fixed set of forces. As the geometry of the embryo changed, a single fixed set of driving forces was able to produce ridges at the edges of the neural plate, followed by narrowing of the plate and, finally, rolling up of the plate.

We then used our software to investigate the self-sorting of embryonic tissues (Fig. 6). In the course of this work, we made the unexpected discovery that the Differential Adhesion Hypothesis, which had been almost universally accepted for forty years, was mechanically untenable. This led to a new theory based on differential interfacial tensions to explain cell sorting and a family of related phenomena.

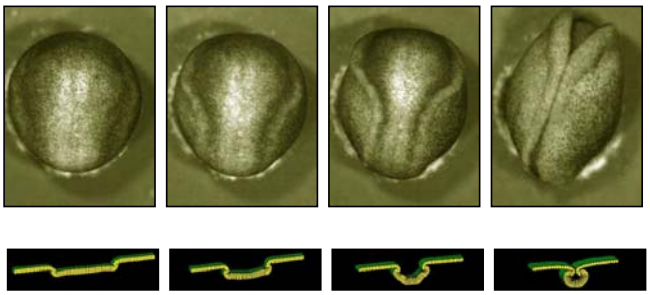
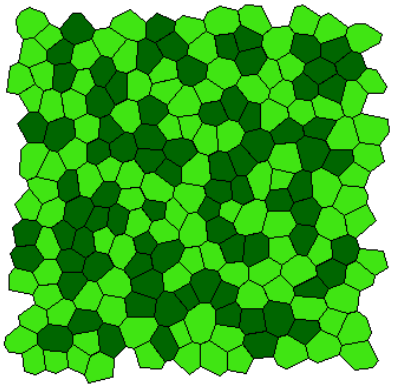
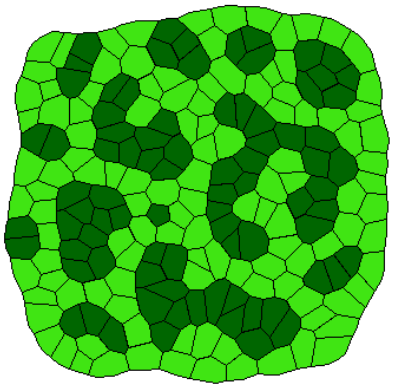


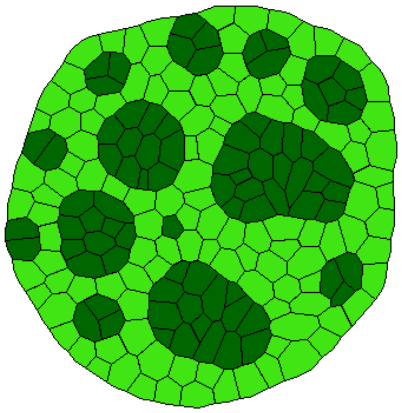
Fig. 5. The upper set of four figures illustrates changes of shape that an amphibian embryo undergoes during neurulation, the process by which the precursor of the spinal cord and brain are formed. During this process, neural ridges are formed, the plate between them narrows, the plate starts to roll up and, finally, forms a closed tube. The lower figures show corresponding predictions from computer modelling of a typical embryo cross-section. The modelling was carried out in collaboration with David Clausi, now of Systems Design Engineering.



(a) Initial Configuration ($\tau = 0$)



(b) At a Time of $\tau = 4$



(c) At a Time of $\tau = 70$

Fig. 6. Model cells have been randomly assigned one of two colours and then given different interfacial tensions according to their colours. When given suitable properties, the cells sort spontaneously. The time parameter τ is dimensionless. The process of sorting involves smoothing of the interfaces between like cells, the formation of long chains, shortening of those chains, and annealing of the cells in the resulting masses. The conditions for sorting and the identifiable stages seen here agree with experimental findings.

From a philosophical perspective, I am impressed with the elegance of embryo design. One morphogenetic movement sets up the geometry for the next, with each following so smoothly that it may be difficult to define a point of transition. Often, as in neurulation, the means by which a sequence of movements is driven is deceptively simple. Since many hundreds of precise morphogenetic movements are required to produce a normal embryo, one has to wonder that embryos, including human ones, are ever normal.

Towards the Future

We are endeavouring to integrate together the various technologies used in our laboratory so that three-dimensional computational models of whole embryos can be constructed (Fig. 7) and the morphogenetic movements predicted by them compared with those that occur in real embryos.

Since our computational model will make it possible to investigate the effects of changes in embryo geometry, mechanical properties and gene expression on morphogenetic movements and their medical outcomes, it will provide a powerful tool to identify possible causes of malformation defects and test potential defect prevention strategies. Other recent computational models have provided keys to dramatic advances in drug discovery, orthopaedics and cardiovascular fluid mechanics. Based on the successes of these other specialised models, we are optimistic that our model may be able to make an important contribution to the study of embryogenesis.

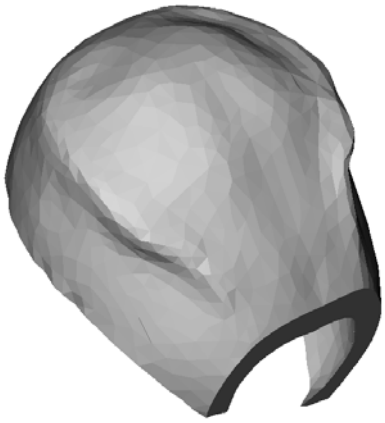


Fig. 7. When the surface geometry obtained from a three-dimensional reconstruction of a live embryo is combined with cross-sectional data from serial sections, a volumetric model results. The volumetric model provides a starting configuration for a computational (finite element) model. For purposes of illustration, the model has been truncated by two planes and all interior tissues have been removed.

The structure of our model is such that it can be applied to studies of other morphogenetic movements, such as those that form the heart, face and eye - structures that are the sites of common malformation defects in humans. To date we have directed our efforts towards studies of human neurulation, since the most common of these defects, spina bifida, occurs during that process. Clearly, data from which human models can be constructed are sparser, and experiments on live embryos are not possible. Thus it is important, first, to validate our model and perfect our supporting techniques using animals.

We look forward to a time when computational models of embryos become sufficiently comprehensive that they can be treated as virtual embryos. They could then serve as a basis for virtual experiments. If reliable models of human embryos can be developed, they could be used to investigate possible causes of malformation defects in humans and to evaluate potential prevention strategies. A virtual embryo model would also provide a useful teaching tool in medicine and science. Until that

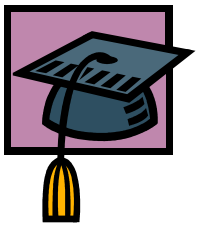
time, we will continue to improve and validate our computational models using animal systems, and savour the unique fusion now occurring between science, medicine and engineering.

Animations of embryo development and selected computer simulations can be viewed at www.civil.uwaterloo.ca/brodland.

G. Wayne Brodland (Ph.D., U. Manitoba) has held a faculty appointment in Civil Engineering at the University of Waterloo since 1988. His research team includes research assistant Jim Veldhuis, graduate students Colin Wiebe, Greg Bootsma, Caleb Van Sligtenhorst (co-supervised with Duane Cronin), Shannon Puddister (co-supervised with David Clausi) and UCEP student Nicky Hesch. His research has received funding from NSERC, the Spina Bifida and Hydrocephalus Association of Canada (SBHAC) and the Easter Seals Research Institute (ESRI) of Ontario. Some of the teaching innovations with which Wayne has been involved can be viewed at his web site.

CONGRATULATIONS!

The Faculty Association congratulates the following faculty members from St. Jerome's University who were awarded tenure and/or promotion this year:



Promoted to Professor effective March 11, 2002
Gabriel Niccoli, Italian Studies

Awarded tenure and promoted to Associate Professor effective July 1, 2003
Christopher Burris, Psychology
Conrad Hewitt, Mathematics
Christina Vanin, Religious Studies

EYE SURGERY INSTEAD OF GLASSES – IS IT EFFECTIVE?

by T. David Williams
School of Optometry

People have been using spectacles to correct vision problems for 700 years. Over that time, techniques have been developed to permit accurate determination of the power of corrective lenses and to design appropriate frames to hold them in place. If a person is capable of excellent vision, spectacles or contact lenses can provide it.

This method of helping people who have trouble seeing either distant or close objects clearly has been proven to be safe and effective. In the event that spectacles or contact lenses are not doing their job properly, they can be adjusted and/or the lenses replaced easily.

The concept of altering the shape of the cornea surgically in order to lessen a person's dependence on spectacles is not a new one. Early attempts involved removing the central cornea, freezing it, using a lathe to change its curvature, thawing it, and suturing it back in place. More recent approaches involve lifting a flap of the epithelial surface of the cornea and using a laser to reshape the underlying cornea, then putting the flap back down. Some surgeons are also beginning to advocate placing lenses inside the eye (in addition to the naturally-occurring lens which is already there) in order to accomplish the same goal.

All of these surgical procedures are founded on the premise that spectacles or contact lenses are somehow not acceptable to the patient. This reminds me of the tactic of simply positing that a particular regime is bad or wrong, in order to support the idea that a new regime is required.

Studies which are cited by refractive surgeons as supporting the safety and efficacy of refractive surgery[1, 2, 3] show that the success rate is considerably less than that accomplished by the use of spectacles and contact lenses. In these studies on refractive surgery, the unaided vision of people who have had their corneas reshaped is equal to or better than 20/25 in only 50% of cases. This number varies from study to study, up to a reported 66.5 % of treated cases with uncorrected visual acuity of 20/20 or better. In this latter study, there is still a third of operated patients who have uncorrected visual acuity less than 20/20. In some cases, the cornea is altered to the point where the person cannot regain the presurgical sharpness of vision by any means.

One of the major difficulties for the refractive surgeon is that, prior to the surgery, he/she must make assumptions about the healing ability of the cornea, in order to decide how much to alter the shape of the cornea. It is not possible to know how the cornea will respond to the surgery until after it is done.

A further consideration that many members of the public overlook is the fact that, firstly, they will probably need to wear glasses after the surgery in order to compensate for any errors in the surgical procedure and, secondly, they will eventually need to wear a lens to help with their reading once they reach the 40-50-year age group. So the refractive surgery is not going to allow them to 'throw away their glasses'.

The equipment used for refractive surgery is largely under the control of proprietary computer software. The nature of the surgery is capable of almost infinite variation: How large is the diameter of the corneal area which is treated? How is the shape of this area blended into that of the surrounding cornea? What energy levels are used by the laser; how many sweeps of the cornea are used to make the changes? What wavelength of laser is used? ... In this way, the proponents of refractive surgery can offer a new technique almost indefinitely.

Thus, the public is being offered a procedure which is experimental and whose outcome is still to a significant extent unpredictable. This method is being offered as an alternative to a method whose safety and efficacy have been established for centuries.

I do not have any difficulty in making a choice between these alternatives.

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[1] Fiander D.C., Tayfour F., "Excimer laser in situ keratomileusis in 124 myopic eyes", *J Refract Surg,* Volume: 11, Issue: 3 suppl (1995), pp. S234-S238.

[2] Hersh P.S., Stulting R.D., Steinert R.F., et al. "Results of phase III excimer laser photorefractive keratectomy for myopia; the Summit PRK Study Group", *Ophthalmology*, Volume: 104, (1997), pp. 1535-1553.

[3] Waring G.O. III, O'Connell M.A., Maloney R.K., et al. "Photorefractive keratectomy for myopia using a 4.5-millimeter ablation zone", *J Refract Surg*, Volume: 11, (1995), pp. 170-180.

LETTERS TO THE EDITOR

Conspiracy of grumbles

Talk to almost anyone on the University of Waterloo (UW) campus who teaches, schedules courses or administers student files and you will find cynicism, disregard, frustration and even anger related to the Student Information System Program (SISP), informally known as the PeopleSoft database. What has amazed me is how all the complaints and protests over the new system have remained so muted among the general UW community, essentially a disenchanted grumble, confined largely to administrator offices and meetings, hallway conversations and the occasional memorandum. Personally, I have been told to bite the bullet and accept the new system as it is being implemented to benefit the students, and that in time most system problems will be worked out.

I am writing this letter to express my deep concern that UW has embarked on a path that increases the burden on faculty with no compensating consideration, will unavoidably continue to frustrate staff working with the database, and insidiously cheats students of educational opportunities. I am afraid that UW policies and procedures are being dictated by a software program, not by academic considerations.

In short, the problem with the current implementation of SISP for Engineering is that it is based on a course credit paradigm, not a core program paradigm. This paradigm change for Engineering is a "square peg in a round hole" situation.

A fundamental concern of mine is that the philosophy governing SISP does not benefit students. In Engineering the course scheduling philosophy used to be one of watching out for students and accommodation. The new philosophy imposed by SISP is one of student flexibility and control. On the surface the new philosophy may seem defendable, but for Engineering this change can be disastrous for students. A prime reason for departmental approval of course selections in Engineering was to look out for the student by ensuring that their selected courses would not prevent graduation after eight terms of study. A second reason was that it provided direct feedback to a department about course scheduling problems. The new philosophy of SISP has students, not departments, responsible for dealing with course scheduling conflicts. This means that it is now extremely difficult to impossible to accommodate student interests that require removing conflicts. Not only does this shortchange current students, but the SISP philosophy also encourages a stagnant course schedule that, in general, will not adapt to the changing interests of future students as the feedback pressure to do so has been removed.

By encouraging a stagnant course schedule, SISP will bias more faculty towards teaching particular courses for the non-academic reason of time-slot desirability, as opposed to the currently favoured reason of faculty interest and ability. As this happens, the quality of the student educational experience will decrease.

From a teaching faculty perspective, I am concerned that SISP increases the burden on our faculty with young children. In the past, courses could often be moved to accommodate child care drop off and pick-up times. With SISP and "fixed" schedules, the needs of faculty become secondary. Specifically, I was told by one individual working with SISP that faculty have been "hired to teach" and that considerations such as child care "are not the university's concern" when it comes to course scheduling. I do not believe the individual would have said this had it not been for extreme frustration over problems created by SISP. Nevertheless, my point about faculty needs being secondary is made.

In my investigation into why faculty do not seem to be rising up in arms about SISP, I discovered that they are adapting. Survival instincts, you might call it. For example, faculty are moving courses once the term starts without informing the university, and often without informing the department. Furthermore, I have been informed that it is "official unofficial" policy that changes to course scheduling are permissible outside SISP because it is often too difficult to make the changes within SISP. In effect, there is an underground of course movement that disregards SISP and prevents, through the lack of records, feedback into the course scheduling system. Without such feedback, the SISP system will institutionalize correctable problems. Should there be a crackdown on the unofficial movement of courses, then SISP's software based constraints will surely be felt by many faculty.

Finally, from the perspective of my role as a Board Member of The Sandford Fleming Foundation (SFF) and my role as the Chair of the Academics Requirements Committee (ARC) at Professional Engineers Ontario (PEO), SISP has been a disgrace. PEO is the legislated professional body that licenses Professional Engineers in Ontario. ARC is responsible for evaluating the academic qualifications of PEO applicants.

If you attended the Engineering Class of 2002 Convocation, UW failed to recognize its academically distinguished students. Specifically, those on the Dean's Honour List and the winners of SFF awards for academic and Co-op workterm excellence were not recognized! The reason was simple: SISP could not identify the winners. Excellence in

our students is critical to UW's long term vitality. I hope that this never happens again. It saddens me, as it does colleagues of mine, that we did not acknowledge our limitations and apologize to the Class of 2002. Perhaps I should have called this article a "Conspiracy of Silence" instead of a "Conspiracy of Grumbles" as such a title is appropriate for the Convocation blunder. If we cannot respect our students at Convocation, then I feel we have failed in welcoming our alumni to the UW community.

At an ARC meeting earlier this year a UW graduate student applied for a Professional Engineering license. A problem arose, however, when the ARC member evaluating this student's transcript could not comprehend the meaning of much of the information communicated in the SISP generated transcript. This is not the type of message we wish to send to our alumni.

I have only touched a few of the problems I know exist with SISP. Nevertheless, I believe that my observations when combined with those of others on campus provide sufficient evidence to justify having UW seriously consider planning for a new student information and course scheduling system. Personally, I favour a "Made in Waterloo" solution that recognizes the academic needs of each UW Faculty.

I know there are those who will argue that changing directions now would not be cost effective; that eventually the SISP system should work (an unfortunate impossibility unless faculties allow their academic policies and procedures to be dictated by a software program primarily designed for US universities); that the system benefits the students; and that a "Made in Waterloo" solution would be more trouble than it is worth. To these and other such defenses of SISP my current reaction is to say, "Where is the proof?"

The SISP system has had plenty of time to demonstrate its capabilities and shortcomings. Unfortunately, the shortcomings appear to be winning. UW is on a path of institutionalizing a student information system that I believe will negatively affect the quality of employment and the student experience at UW for many years to come. I would encourage others who concur with me to assist in focusing our collective grumble to a roar that promotes a Waterloo compatible system. For those who disagree with my prediction, I would encourage these people to calm the grumble by clearly communicating to the UW community why the SISP system is the best approach for Waterloo.

My parting thought comes from an important engineering design rule: "Prove through testing that a design works before committing to it."

Roydon Fraser
Department of Mechanical Engineering

Mandatory retirement at 65

In my current copy of the Memorandum of Agreement, Article 11.3 bluntly informs us that at 65 we have to retire. As a younger individual, this little matter seemed far off enough to have only theoretical importance. Time unfortunately catches up, and with merely eight years to go for me, the idea of mandatory retirement is coming into focus. I do not yet know whether I will look forward to the day when the University will boot me out. What is clear to me is that mandatory retirement at 65 is a violation of our rights as workers. Some years ago the Supreme Court decreed that it is an acceptable violation as far as Canadian standards are concerned. That should not be good enough for us at Waterloo. The time has come for the Faculty Association in conjunction with the University to re-examine Article 11.3.

As proof of the intrinsic nastiness of mandatory retirement at 65, I offer the simple observation that those who were here at the start, and drafted the current policy, were careful to leave themselves out of its clutches with a generous grandfather clause that lets them hang on until they are 68. They smelled the rat and deftly finessed their way around it. In the USA most jurisdictions prohibit mandatory retirement. I think it is like that in Québec and maybe in some other Canadian jurisdictions. I doubt we know something that these other places don't know.

As we get older and time wears us down, we have to let go sooner or later. However, the age at which we can no longer be effective workers need not be 65. For instance, our forefathers thought that for them 68 would be a better age. As a civilized community we are bound to seek that elusive state of fairness. The current retirement policy does not come close enough to it.

There is the argument that, as we age, our capacity to contribute diminishes. According to the argument, if we did not have a mandatory retirement age, then we would be obliged to have de-tenuring committees whose job would be to eject those of us who can no longer perform but are unwilling to face reality. Such an exercise would be seen as a cruel thing to do to a beloved senior colleague, so why don't we make a standard rule that all will go at 65. The trouble with the argument is that mandatory retirement at 65 is cruel too, but to make it worse its cruelty is blind. I am afraid that the cruelty we are trying to avoid is that which administrators and committees would have to bear in persuading or possibly forcing someone to let go.

Some people cannot appreciate why anyone would even dream of wanting to continue beyond 65. After all, think of the freedom and peace of mind. I would caution those who feel this way to refrain from ascribing their priorities into the minds of others. There could be superb reasons for an

individual to seek a later retirement. For instance, some people don't get hired on a permanent basis until they are well over 30.

If these people are forced out at 65, they do not have enough time to accumulate the full 35 years of pension credits. By retiring them at 65 we force them into a serious financial squeeze. Some at 65 still support dependents, and their pension is not enough. Some just love to work and be paid for it. They do not seek a life of leisure or volunteerism or another career. Why should a primary raison d'être be snatched from them, if they are still good at their job and they want to do it?

Then there is the argument that mandatory retirement at 65 creates employment. When an old coot is hanging on, there goes a job that cannot be filled by an energetic youngster. The old guy or gal have had their kick at the can, so let them make way for fresh blood. The problem with this argument is that everybody who has a job is probably keeping somebody from getting that job. Mandatory retirement does not create jobs, it merely changes workers more briskly. To single out the older faculty for dismissal, instead of say the incompetent at any age, is blatant age discrimination.

How about the argument that old profs are expensive, while new ones come cheap? According to this argument, mandatory retirement at 65 saves money. I do not believe that it makes a big difference any more. From my observations of late, new people no longer come cheap. When I started exactly at the floor, the senior faculty were making 2.5 times as much money as I was. I'll bet that now most senior faculty make only 1.5 times more than the majority of new faculty (thanks to our rapidly disintegrating salary structure). Without mandatory retirement, I would be surprised if at any given time there would be more than 50 faculty still working beyond 65. The amount of their salary over that of a newly hired person might be 35 thousand dollars. The extra burden on the budget would come in at well below 2 million a year. This is a manageable amount of money. To compensate, these older workers would be still off the pension plan, thereby saving the plan a lot more than 2 million per year. Notwithstanding these crude estimates, I don't think the budget argument should receive any consideration whatsoever. Everything we do, administration, teaching, computer support, research, fixing the buildings is a burden on the budget. Why single out senior faculty salaries as a primary burden?

How could we do better?

Probably the simplest thing might be to attenuate the current unjust policy by giving the grandfather clause to all university workers, and let those who so desire continue until 68. This policy has been operating in many grandfathered cases for a long time now. It does not look to me like the sky has fallen. A change to 68 would still be flawed in principle, but thanks to the corrective effects of old age, the harm of mandatory retirement would be significantly reduced. The forefathers who gave us the current policy knew that, didn't they?

Another approach might be to move to a system of definite term appointments after 65. Under this system, an individual would have the right to seek a renewed contract for a few years subject to certification of the quality of their work. Under this approach, painful judgements would have to be made. Yet we make tough judgements now when we deny tenure, seek to de-tenure, entice people into early retirement, or deny a raise or promotion. Fairness demands that we have the courage to make judgements collegially. If this process of deciding who could go on for a while beyond 65 is done some years in advance of age 65, it need not be so unkind. Possibly the panels that would decide on reappointments after 65 could work at first in an advisory role. Incumbents in their early 60's, who might be thinking of staying on, could ask to have their competence reviewed. If the panel had doubts, the candidate would be advised to retire at 65. If push came to shove, the process could be run along the lines of the current tenure process. I know that it sounds like a lot of work, but that is what fairness demands sometimes.

We could look into some half-time appointments after 65. The other half of the salary could come from the pension plan. However, I fear that something like that might be legally complicated.

Probably the most correct thing is to have no mandatory retirement policy. This, of course, could be difficult to cope with in some individual cases. De-tenuring committees would have to be struck on occasion, when an individual who is no longer effective refuses to see the light of day. I don't know if we currently have the courage to go this far.

A perfect retirement policy does not exist, but I am convinced that we can do better. I hope that I am not alone in perceiving injustice with the current Article 11.3. I invite the Faculty Association to open up this file, to seek the views of its members, to explore what is being done elsewhere in the country, and, in conjunction with the Pension and Benefits Committee, to plan for improvements. Even if a large majority looks forward to letting go at 65 or sooner, the rights of a minority of any size matter. On some issues the Association has gone to bat even for a minority of one. The time has come to forget the excuses, get off the dime, and seek to improve our mandatory retirement policy.

Frank Zorzitto
Department of Pure Mathematics

Humanities and social sciences education

Prof. Heppler posed some stimulating questions in the last issue of the *Forum*, questions relating to the role and impact of the Humanities and Social Sciences (HSS) at universities today. I would like to suggest some ideas that may serve as a response to his queries. Since Prof. Heppler employed only a little in terms of numbers relevant to the matter and since I have no hard and fast statistics before me (if statistics in this area are ever hard and fast rather than soft and loose), what I say will be comprised of armchair insights.

Why is it that politicians, the majority of whom have a background in HSS, do not support HSS by their political activity whereas engineering alumni support the furtherance of their technical discipline by financial support to their respective almae matres (pardon my Latin)? I suggest the reason is ultimately monetary. Politicians look around and see that they are far less wealthy than most of the people they deal with day by day (bankers, lawyers, CEO's, business people, etc.). Of course, there is the odd (or not so odd) politician who is corrupt and is enriched by illegitimate dealings. Many politicians probably realize that their humanities' training did not give them the practical skill to make mountains of money and so they have little incentive to do something for HSS which they perceive did little for them. After all, the "real" world runs on power and money. On the other hand, engineers have probably done well by their training – if they were able to land a job – and hence are in a good position to make a monetary return to their institution of learning. Consultants may get high pay for advice about civic designs, electrical projects, chemical plants, etc. but not for an analysis of ideas about tragedy or the historical influence of ancient historians.

Why is their not a better balance between scientific/mathematical training and HSS in student programs? Good question. There should be now (just as there was at sometimes in the past), a better balance between the two, even though the strength of current science is greater than past science and therefore might justifiably claim more attention. Given the world in which we live where so many current moral and social issues are being defined by scientific advances, HSS students surely need to know more about developments in science. Alternatively, science students need to form a world view in contact with HSS. I should note, however, that the influence of the Humanities themselves have become weak vis-à-vis other current academic enterprises. Even the use of the expression "Humanities and Social Sciences" (HSS) is not the same as the one behind the abbreviation dictated by one of Canada's great funding agencies, the SSHRC where "Social Sciences" occupy first place. That those in such disciplines emulate the title of "science" for their inquiries shows how narrowly the domain of mind has come to be envisioned: one's discipline should be called a science or it may be considered nothing worthwhile. Yet, the need for the insights from the Humanities seems pressing. At this point in world history, notice how little politicians know about the histories of other civilizations which, some would argue, are now in open conflict with one another.

Prof. Heppler asks, "Was Pogo correct?" Pogo appears to me to be an entity with many insights and positions, so it is really hard for me to answer that.

Joseph A. Novak
Department of Philosophy

Thoughts on the Sokal hoax

The discussion of the "Sokal Hoax" in the *FAUW Forum* (June 2002) was fascinating to me. I do not know if publishing a paper, devoid of content as far as the author is concerned, in an unrefereed journal says much about the publishing game, but it is certainly great fun to observe. Listening to the various "scientific evidence" that salmon fish farms in BC or tuna fish farms in Australia do or do not damage the environment significantly leads me to believe that a similar hoax has probably been played in some other scientific journal. It seems that the Sokal hoax has resulted in some finger-pointing. Hopefully Catherine Schryer's comments on Aristotle's "Rhetoric" (*Forum*, October 2001) will suggest a way to reduce such tensions even between very different camps.

Bertrand Russell defined mysticism as the "feeling that all things are connected." I will certainly not find out the effect, if any at all, that describing my research as mysticism has on my next NSERC grant application. Nevertheless, it's certainly very natural to find connections between seemingly different disciplines. Surely Alan Sokal did not intend to criticize T. Stoppard for using scientific terms in his plays. Is it not possible that a concept like "randomness" arises in the Greek tragedies, the Book of Job, the novels *Gravity's Rainbow* and *White Noise,* quantum mechanics and the game of BINGO? No one would claim that the randomness is the same in all cases, but is not something of interest common to them? Bohr and Sokal will be remembered for their physics long after Bohr's insights into the connection between sociology and quantum mechanics and Sokal's hoax are forgotten. I'll bet dollars to doughnuts on this, assuming that this is still giving odds.

In closing, I think that topics such as the Sokal hoax are perfect for discussion in the *Forum.*

Bruce Richmond
Department of Combinatorics & Optimization

Debate on global warming begins

Christopher Essex's anti-global-warming article, "Scientific Confusion" (*FAUW Forum*, September 2002) indulges in some of the same tactics it decries.

Essex dismisses a statement acknowledging that global warming is a reality signed by 100 Nobel laureates, arguing that most of those didn't have expertise to know what they were signing. Maybe he's right. But then he turns around and favorably cites the "Oregon Petition", where only a small fraction of the signers are specialists in environmental science.

Essex writes that "One fashionable claim in the pro-Kyoto activist community is that 'Ginger Spice' is a name on [the Oregon petition]. It isn't."

But Essex doesn't tell us the whole story. In fact, the name "Geri Halliwell, PhD", *was* indeed a signer at one time, as forthrightly admitted on the Oregon petition project's home page:

http://www.oism.org/pproject/s33p357.htm

This page says her name was "eliminated". A name cannot be "eliminated" from a petition unless it was once attached to that petition.

More to the point, the page also admits that approximately 10% of the signatures have not been independently verified.

It's true that climate is a difficult scientific problem. Is there proof of global warming? Not in a mathematical sense. Perhaps Essex, who resides in a mathematics department, forgets that in science we never have proof. Instead, we have hypotheses and evidence.

There are legitimate scientists who doubt global warming. But then, there are legitimate scientists who doubt evolution, relativity, continental drift, ozone depletion by CFC's, and a dozen other theories that have been confirmed beyond reasonable doubt.

Nevertheless, the vast majority of environmental scientists do believe that the preponderance of evidence indicates that global warming is real, that it is human-caused, and that it will lead to significant problems in the coming century. To claim otherwise is seriously misleading.

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FAUW FORUM

The FAUW Forum is a service for the UW faculty sponsored by the Association. It seeks to promote the exchange of ideas, foster open debate on issues, publish a wide and balanced spectrum of views, and inform members about current Association matters.

Opinions expressed in the Forum are those of the authors, and ought not to be perceived as representing the views of the Association, its Board of Directors, or of the Editorial Board of the Forum, unless so specified. Members are invited to submit letters, news items and brief articles.

If you do not wish to receive the Forum, please contact the Faculty Association Office and your name will be removed from the mailing list.

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COUNCIL OF REPRESENTATIVES

The fall meeting of the Council of Representatives will be held on Thursday, November 14 at 4:30 in DC 1568. Please contact your representative if you have questions or concerns that you would like to have discussed. If your department or school does not have a representative, please consider helping out in this capacity. The Council has two regular meetings each year.

Accountancy ..... *(vacancy)*
Anthropology ..... *(vacancy)*
Applied Mathematics ..... Kevin Lamb
Architecture ..... Michael Elmitt
Biology ..... Marilyn Griffith
Chemical Engineering ..... Bill Anderson
Chemistry ..... Peter Chieh
Civil Engineering ..... Eric Soulis
Classical Studies ..... George Robertson
Combinatorics & Optimization ..... Bruce Richmond
Computer Science ..... Kenneth Salem
Drama & Speech Communication ..... Bill Chesney
Earth Sciences ..... *(vacancy)*
Economics ..... Ken Stollery
Electrical & Computer Engineering ..... Jim Barby
English ..... Victoria Lamont
Environment & Resource Studies ..... Greg Michalenko
Fine Arts ..... *(vacancy)*
French Studies ..... Delbert Russell
Geography ..... Peter Deadman
Germanic & Slavic Studies ..... Paul Malone
Health Studies & Gerontology ..... Steve McColl
History ..... *(vacancy)*
Kinesiology ..... *(vacancy)*
Management Sciences ..... *(vacancy)*
Mechanical Engineering ..... Roydon Fraser
Optometry ..... David Williams
Philosophy ..... *(vacancy)*
Physics ..... Paul Wesson
Planning ..... Mark Seasons
Political Science ..... *(vacancy)*
Psychology ..... John Michela
Pure Mathematics ..... Pl. Kannappan
Recreation & Leisure Studies ..... *(vacancy)*
Sociology ..... *(vacancy)*
Spanish & Latin American Studies ..... Maria Sillato
Statistics & Actuarial Science ..... Jerry Lawless
Systems Design Engineering ..... (*vacancy*)
St. Jerome's University ..... Conrad Hewitt
Library ..... Shabiran Rahman

2002 HAGEY LECTURE

ENVIRONMENTAL ECHOES: IMMUNOLOGICAL LEARNING FROM THE ENVIRONMENT
Dr. John Stanford
Professor, Department of Medical Microbiology, University College, London, UK
Thursday, November 21, 2002, 8:00 P.M.
Humanities Theatre, Hagey Hall

Dr. John Stanford is Professor and Head of the Department of Medical Microbiology at the Windeyer Institute of Medical Sciences, University College, London. His life work concerns the role of the immune system in the control of infection, and the interactions between bacteria and human physiology.

He did his primary medical studies at Guy's Hospital Medical School, University of London, from 1957 to 1962. Eight years later, he earned his Doctor of Medicine degree with a thesis on classification of mycobacteria, the infectious agents responsible for diseases such as tuberculosis and leprosy. His framework remains in common use. A series of academic appointments at Guy's Hospital Medical School and Middlesex Hospital Medical School followed. He joined University College, London as a Reader in Microbiology in 1988. He has published more than 150 papers in refereed journals and has over 100 publications in other forums.

Applied mycobacteriology involves extensive fieldwork, on which Dr. Stanford was usually accompanied by his wife and collaborator, Cynthia, and their children. Through research programmes spanning three decades and four continents, he has gained an understanding of not only the harmful effects of bacteria, but also of their potential benefits. His work on the mechanisms behind the BCG vaccine for tuberculosis (whose efficacy appeared to vary with geography) led him to identify an innocuous mycobacterium, M. vaccae, in soil samples from the shores of Lake Kyoga in Uganda. This organism, because of its similarity to more virulent mycobacteria, can help the human immune system to respond to them. This led to the development of an effective vaccine for leprosy, and a treatment that healed the autoimmune systems of leprosy sufferers free of bacterial infection.

Together with his colleague Graham Rook, he has formed Stanford Rook Ltd., a public company to develop and investigate applications of vaccines derived from M. vaccae. He believes that the modern rise of allergic diseases such as asthma may be linked to the disappearance of mycobacteria from living environments because of modern hygiene, and that benign organisms such as M. vaccae may even offer hope in the treatment of cancer and HIV/AIDS.

The Hagey Lecture series is co-sponsored by the Faculty Association and the University of Waterloo.

There is no charge for admission to the lecture, but tickets are required. Tickets will be available in early November from:

- *the UW Box Office (x4908)*
- *the Faculty Association Office (x3787)*
- *Hagey Lecture Committee members:*
  - *Heather Carnaghan, Applied Health Studies (x5353)*
  - *Judy Wubnig, Arts (x3548)*
  - *Garry Rempel, Engineering (x2702)*
  - *Laura Johnson, Environmental Studies (x6635)*
  - *Prabhakar Ragde, Mathematics (x4660)*
  - *Paul Wesson, Science (x2939)*
  - *Conrad Hewitt, St. Jerome's University (x228)*

Dr. Stanford will also give a student colloquium in the Faculty of Applied Health Sciences in the Clarica Auditorium of the Lyle S. Hallman Institute (LHI 1621) on Friday November 22 from 3:00 - 4:00. This talk is open to everyone, and no ticket is required. A reception will follow the colloquium.

(President's Message continued from page 16)

So how does mandatory retirement connect to the double cohort and increasing enrolments? The demand for faculty, especially experienced faculty, is growing. Universities are going to need more faculty than graduate schools can produce during the next decade or so. In particular, there will be an increasing demand for faculty with high profiles and faculty who can direct graduate students. In fact, mandatory retirement is beginning to make less and less sense.

So what can Dr. Zorzitto and other like-minded individuals do about mandatory retirement? How about becoming Faculty Association representatives for their departments? How about running for an office on the Board? How about volunteering to become a member of a subcommittee devoted to this issue? This is not just a FAUW issue; it concerns every faculty member at UW.

PRESIDENT'S MESSAGE

by Catherine Schryer
Department of English Language and Literature

Greetings and salutations!

In this letter I would like to weave together two themes: the double cohort and mandatory retirement. In interesting ways these two issues interconnect to affect many faculty here at Waterloo and at other universities across Canada.

The Double Cohort

Surprise, surprise – according to Dr. Alan King's report to the Ministry of Education, government planning has failed to account for an extra 6,300 students who will graduate from secondary schools next year and who will be seeking university entrance. In other words, no provision was made for those students, and places do not currently exist for them. Dianne Cunningham, the Minister of Training, Colleges and Universities, says that the universities will accommodate the additional students. However, the universities, according to the *National Post*, are reporting that they cannot accommodate any more students unless they receive emergency funding to cover extraordinary costs, such as expenses associated with holding classes on weekends and building portable classrooms.

Recent reports also suggest that although we will be experiencing a bulge next year, we will also experience an overall growth in undergraduate enrolment of up to 10% (or more) in the following years. At the same time, the government is also encouraging us to increase our graduate enrolments. In response to this demand some universities are planning to increase their overall numbers. Wilfrid Laurier, for example, is anticipating a 25% growth and has signed an understanding with its Faculty Association that the faculty complement will also grow by 25%.

This surge in growth has implications for all of us. First, we have to insist on maintaining academic quality and academic integrity in the face of a government that does not seem to realize that failing to provide resources means an erosion of our ability to provide quality education. Secondly, we desperately need more faculty in almost all areas of campus. Virtually every departmental review presented in Senate over the last year has noted a decline in programs or course offerings because not enough faculty were available to maintain the required depth of programming.

Mandatory Retirement

In his thoughtful and thorough letter in this issue of the *Forum*, Frank Zorzitto focuses on the issue of mandatory retirement at age 65. He asks the Faculty Association to acknowledge the injustice of requiring competent, fit faculty members to retire at the arbitrary age of 65. Many faculty members here and at other campuses support Dr. Zorzitto's point. In fact, OCUFA has just released a discussion paper asking for faculty associations' input on this issue. This paper outlines the legal history of mandatory retirement requirements in Ontario, the rest of Canada and the United States. In Ontario, our Human Rights Code provides age discrimination protection only to employees between the ages of 18 and 65. Mandatory retirement of faculty members was challenged by McKinney *et al.* from 1985-1990. The case went all the way to the Supreme Court. The court decided that mandatory retirement was in violation of the Charter but that universities were beyond the reference terms of the Charter.

In another case, Olive Dickason of the University of Alberta challenged her forced retirement as age-based discrimination. As a woman coming late into academia she had not had the opportunity to develop a good basis for her pension. Again her case went through levels of judicial review, until the Alberta Court of Appeal ruled that discrimination on the basis of age was reasonable and justified given the kinds of pension arrangements that existed at universities. The fact that as an individual Dr. Dickason could not benefit from those arrangements did seem to affect their decision.

Recently, however, there are some indications that attitudes toward mandatory retirement might be changing. In 2001, the Ontario Human Rights Commission published a paper entitled "Time for Action: Advancing Human Rights for Older Ontarians", which argues that mandatory retirement needs to be revisited as a public policy.

Also we now have the American experience to consider. Mandatory retirement has been illegal since 1987 in the United States. American universities have not suffered as they had to relinquish mandatory retirement. Instead they adopted more gradual procedures to encourage retirement. Some faculty do elect to stay on a little longer (usually until age 68), but very few faculty remain past age 70 and only in schools with large graduate programs.

The spectre of post-tenure reviews has also not come to pass. Post-tenure reviews were originally designed to remove "deadwood," faculty members who stayed beyond their time or who were not productive. In fact, according to a recent article in the *Chronicle of Higher Education*, in the last few years only one or two faculty members in 37 states have lost their positions because of post-tenure reviews.

(Continued on page 15)