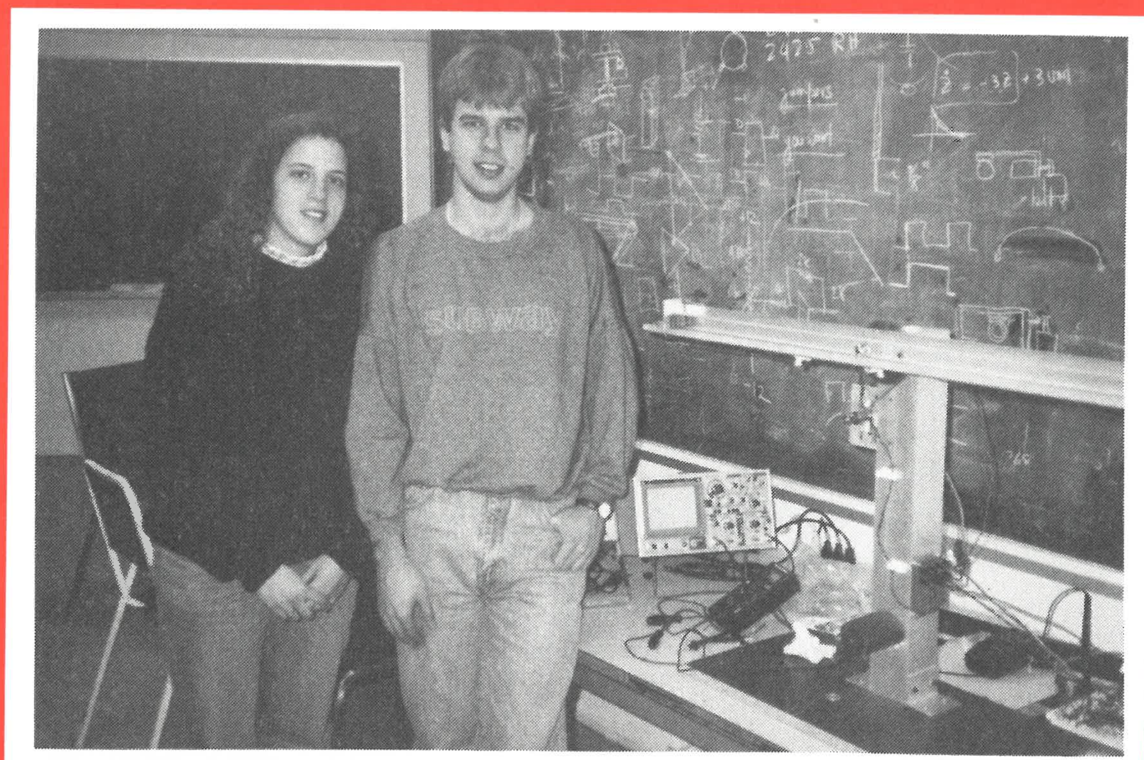
QUEEN'S MATHEMATICAL COMMUNICATOR

SUMMER 1995



A Snapshot From Our Control-Robotics Laboratory

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Kingston, Ontario K7L 3N6

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Queen's Mathematical Communicator
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THE ROOTS OF FEEDBACK CONTROL

The Coleman-Ellis Lecture given in March 1995 by Ron Hirschorn

Personal Data: Ron Hirschorn joined the department in 1973. He works in the area of nonlinear control theory and together with Jon Davis runs the Control-Robotics Lab at Queen's. He lives with his wife Linda and three children on a farm near Napanee, where he tries to apply control theory to the uncontrollable.

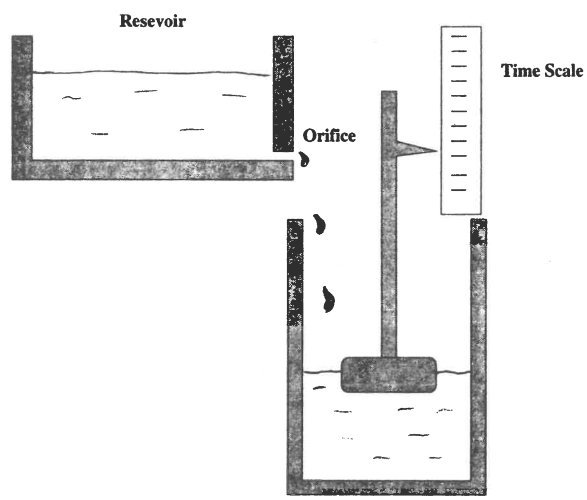
Mathematics and Engineering Control-Robotics Lab

This spring marks the first anniversary of our new Mathematics and Engineering Control-Robotics Laboratory. The lab is located in the *interesting* space which backs onto the three large lecture theaters on the first floor of Jeffery Hall. With financial help and encouragement from our own department, the Dean of Applied Science, the undergraduate engineering students' Better Equipment Development Fund, and a gift from a generous alumnus we have developed a unique set of control experiments to complement our third year course in classical control. I am happy to report the these labs were well received by our third year students and three of our fourth year Mathematics and Engineering Projects involved work in our lab. This summer we are building higher order linear motion devices and designing a series of experiments to add a practical dimension to our two fourth year/graduate courses in modern control theory.

Control Theory is a relatively new discipline. Before the Second World War the design of control systems was an art involving a trial-and-error approach. During the war a number of challenging problems (e.g. the automatic control of anti-aircraft artillery) called for a more mathematical approach to system design. From the early 1940's until 1960 *classical control theory*, based on concepts from complex analysis and differential equations, flourished in s-space ($s \in \mathcal{C}$). This theory has had many successful applications but is not well suited to systems with several inputs and outputs or with parameters which change with time (e.g. satellites, aircraft, robotic manipulators, economic models, biological systems). In *Modern Control Theory* systems are studied in the time domain. This theory dates from 1960 and is well suited to computer implementation. With the introduction of low cost digital computers in the 1980's the exciting theoretical developments in state space control could be applied to many practical problems. This use of digital computers to perform real time control is well illustrated in our control lab where 486 DX-66 computers interface with DC Servo motors to apply control force and with optical encoders to sense positional data. This approach to control requires many thousands of computations to be performed each second. At first glance this seems far removed from the early devices used to regulate water clocks, control temperature in furnaces, and regulate the speed of windmills and steam engines. Nonetheless, in early designs many mathematical constructions are present in an interesting physical form. What follows is a brief history of feedback.

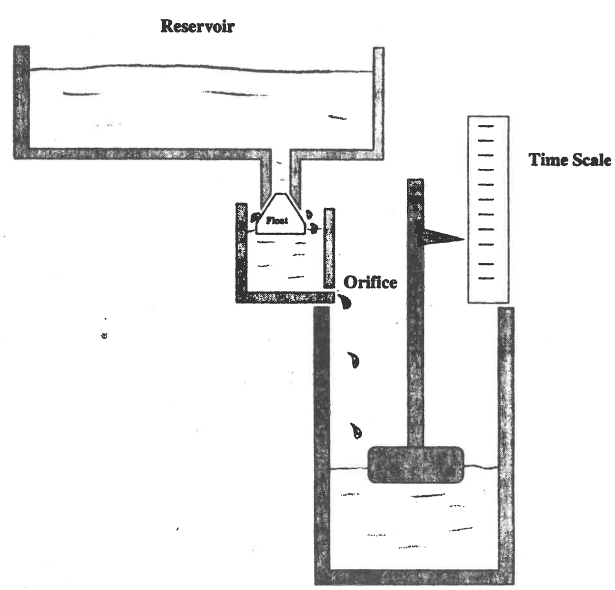
A Brief History of Feedback Control

Control theory is essentially a subject based on a single idea, that of the feedback loop. The earliest recorded example of feedback control is the waterclock of Ktesibious. Ktesibious was a contemporary of Euclid and Archimedes. In ancient times he was considered to be the equal of Archimedes and is credited with the invention of several catapults, the force pump and the waterclock. In a simple waterclock, as shown below, water from a reservoir flows through an orifice and falls into a column.



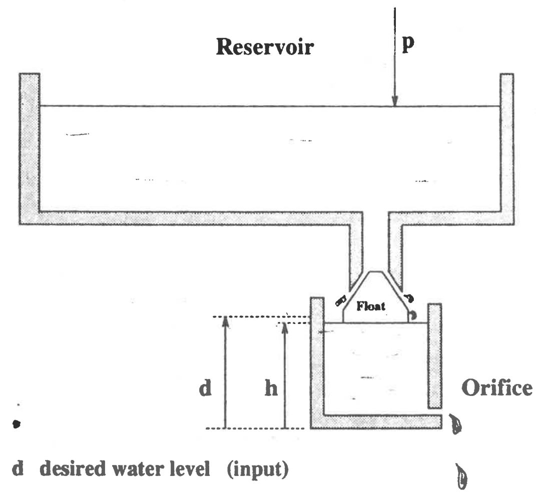
WATER CLOCK

A float in the column rises at a rate proportional to the rate at which water leaves the orifice. Thus to keep good time the rate of flow of water from the orifice should be as constant as possible. This rate of flow depends on the water pressure in the reservoir at the orifice. This pressure is proportional to the height of water in the reservoir. One way to try to achieve a constant pressure therefore is to have a reservoir with a huge surface area so that the level of the reservoir changes very slowly with time. Several obvious drawbacks come to mind immediately. The next figure shows the solution to this problem devised by Ktesibious.



WATER CLOCK of KTESIBIOS

In Ktesibious' design the float senses the level of water in the small secondary chamber and performs the control action which admits water from the reservoir.



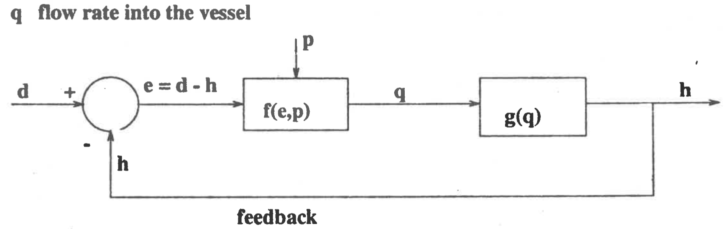
d **desired water level (input)**

h **actual water level (output)**

e **valve opening (tracking error)**

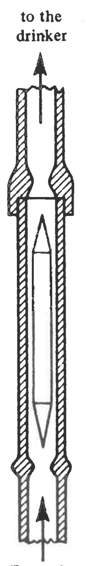
p **water supply pressure**

q **flow rate into the vessel**



This regulator illustrates the use of feedback. We wish to regulate h, the height of the water in the small tank so that h equals d, the desired height. We call h the *output* of our system. The output is sensed by the float. The valve cone on the top of the float performs the control action - the amount of water admitted is proportional to the *tracking error* $e(t) = d(t) - h(t)$. Working out a few scenarios quickly convinces us that this control scheme will make $e(t)$ tend to zero so that $h(t) \to d(t)$. This device clearly utilizes feedback - the quantity to be controlled is measured and the control action taken is based on this information. It is interesting to note that the float plays a dual role - as a float it senses the output h and as a valve cone it controls the amount of water which enters the small tank.

Over the next 2000 years many interesting clocks and regulators were designed. The device shown below was used in the south eastern part of China in the 12th century AD to regulate wine consumption at festive gatherings. The two foot long bamboo tube was passed from drinker to drinker and its regulating properties are evident. A similar device was patented in Europe in 1841. On the whole these clever devices little impact on society, but this changed dramatically in 1789 with the introduction of the Boulton-Watt steam engine.



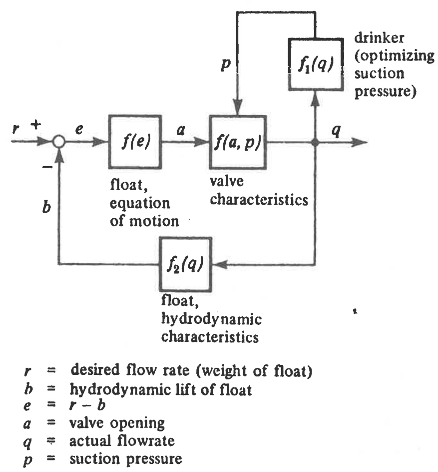
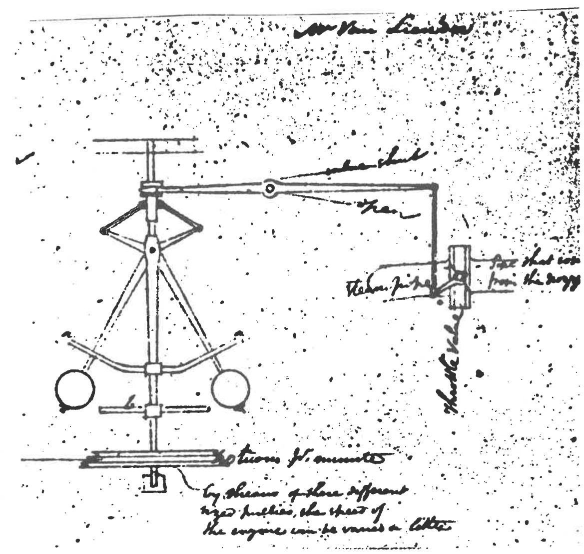


Figure 37 Drinking-straw regulator, block diagram.

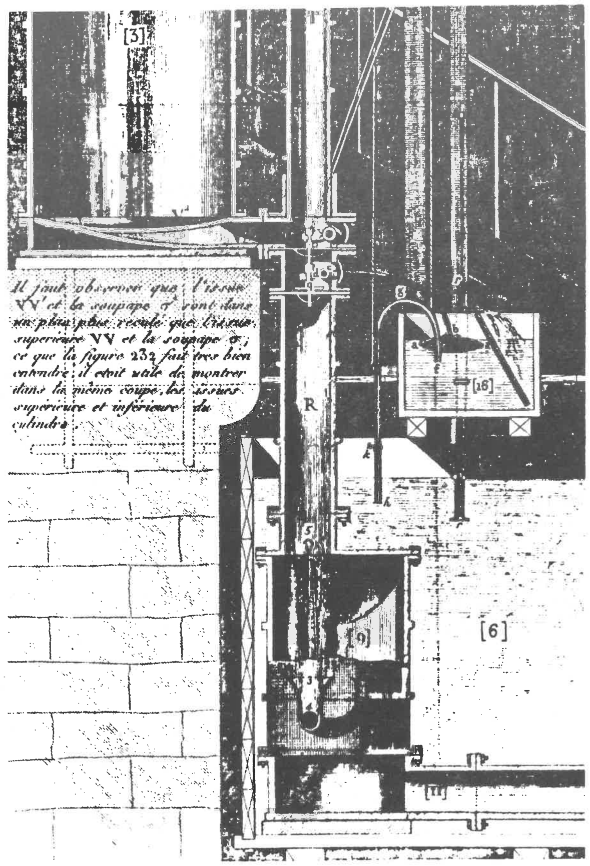
Figure 36 Drinking-straw regulator.



Centrifugal governor, design sketch, Boulton & Watt, 1798.

The governor is connected to the rotating output shaft of the steam engine. When the angular velocity of the engine shaft increases the flyballs spin faster and centrifugal force causes the balls to separate. This motion causes a steam valve to close and reduce the amount of steam which reaches the piston. The engine then slows down, the balls fall, the steam valve opens,and the engine speeds up. At first Boulton and Watt tried to protect their governor by keeping its operation secret. Buyers of the engine had to promise to keep the governor mechanism out of sight. Of course the secret was discovered and the devise was copied by a competitor in 1793. The steam engine then spread rapidly over Europe, the flyball governor providing a graphic example of feedback control in action. It is interesting to note that this governor was not invented by Watt. It was first patented in Britain in 1787 as a speed regulator for windmills. Grist mills require a constant speed of rotation of the grindstones to produce high quality flour. Thomas Mead's speed regulator maintains a constant speed in the face of varying wind speed and load by maintaining an equilibrium between a spring and the centrifugal force on a pair of rotating flyballs as shown below. When the wind picks up the mill's drive shaft rotates faster, the flyballs go out and and compress the spring and causes the sail to furl up a bit and reduce the area which the wind hits. This actually worked and was used on mills into the 1820's.

Of course steam power rapidly replaced wind power in industrial applications and speed control became an important issue. The flywheel governor was not the only device used for speed regulation. In 1790 the Perier Brothers installed their first steam engine in Paris to run a grist mill. They had a unique and interesting approach to speed control.



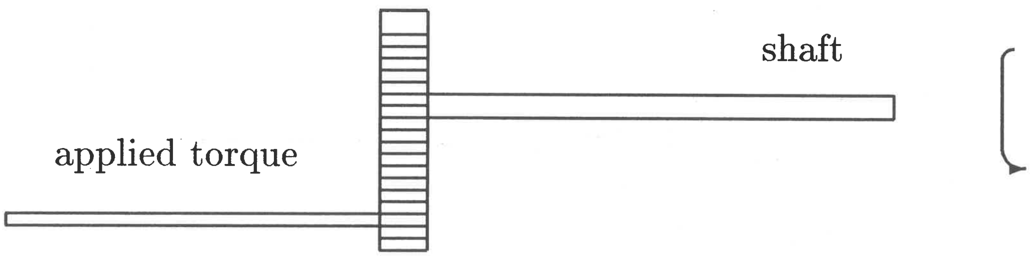
Speed regulation of Périer steam engine.

Each stroke of the engine pumps water into a storage tank. The speed of the engine is thus measuring by the **rate at which water enters the tank**. A float in the tank controls a steam valve which shut off the flow of steam as the level of water in the tank rises. At the same time a siphon removes water from the tank. Here the desired speed of the engine is expressed as the **rate at which water leaves the tank**. The control effort in the Periers' arrangement is proportional to the level of water in the tank. This level is the integral of (the flow rate into the tank)-(the flow rate out of the tank) which is equivalent to (actual speed) - (desired speed). Thus their controller adjusts the steam flow using a control which is proportional to the **integral of the tracking error**. This integral controller was found to be sluggish and unreliable and was soon replaced by the flyball governor where the control is proportional to the tracking error. In the 20th century the integral controller was red is covered and is widely used today.

By the 19th century many sophisticated governors were in use but they all experienced a common problem: when an increase in load occurred the new equilibrium speed was below the equilibrium speed prior to the load increase. Efforts to improve this failing often led to instability. In 1868 J. C. Maxwell delivered his paper *on Governors* to the Royal Society of London.

" ... in the case of a governor constructed by Mr. Flemming Jenkin, with adjustments, by which the regulating power of the governor could be altered. By altering these adjustments the regulation could be made more and more rapid, till at last a dancing motion of the governor, accompanied with a jerking motion of the main shaft, showed that *an alteration had taken place among the impossible roots of the equation.*
... the mathematical investigation may be rendered practically useful by pointing out the remedy for these disturbances. "

To illustrate Maxwell's ideas we can consider the motion of an engine shaft when a torque is applied.

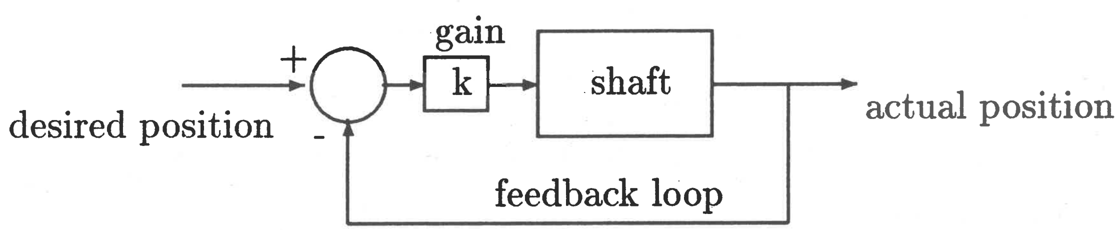


Let $\theta(t)$ represent the shaft's position as a function of time t, $\theta(t)'$ the shaft's velocity, and $\theta(t)''$ the shaft's acceleration. Using $F = MA$ in rotating coordinates we find that

$$\tau - \beta\theta' = J\theta''.$$

Here the *input* to our system is τ and the *output* is θ. Our task is to choose τ to make $\theta(t) \rightarrow \theta_d(t)$

One Solution is to imitate the simple feedback loops used in early devices so that the applied torque τ is proportional to the tracking error $e(t) = \theta_d(t) - \theta(t)$.



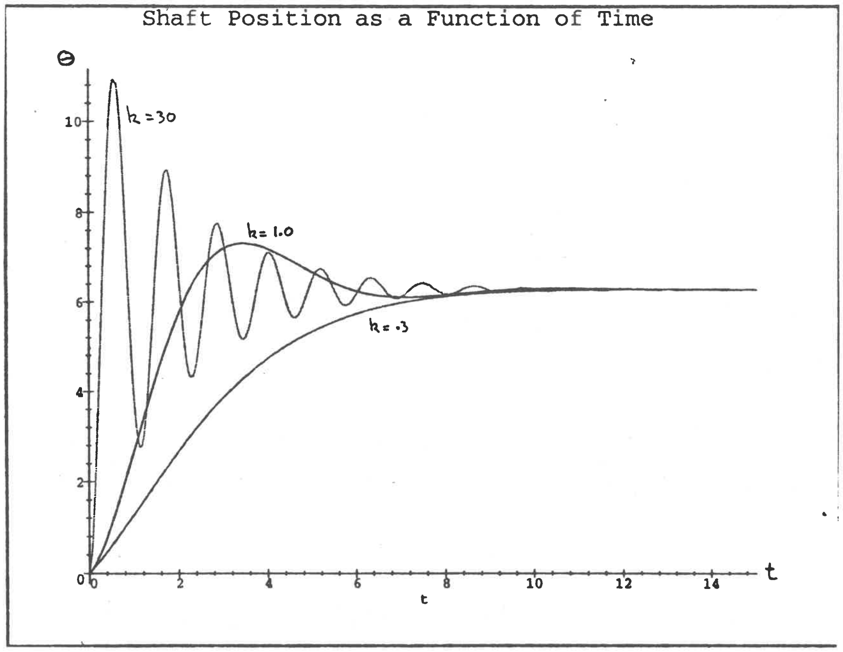
With this control strategy we have

$$J\theta'' + \beta\theta' = \tau$$

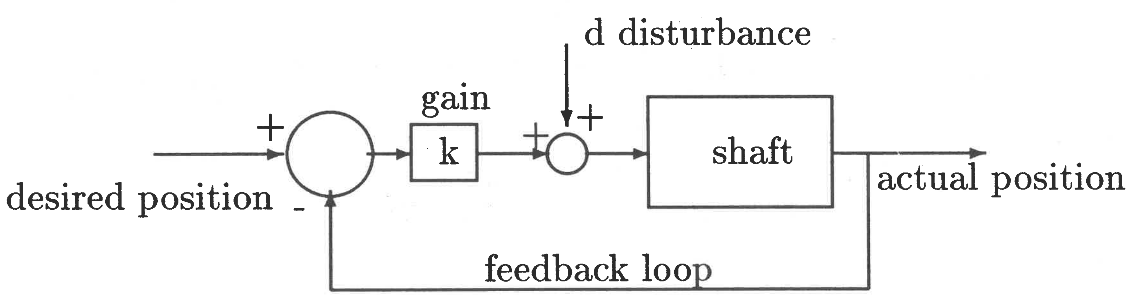
$$J\theta'' + \beta\theta' = k(\theta_d - \theta)$$

$$J\theta'' + \beta\theta' + k\theta = k\theta_d,$$

the same differential equation used to model a spring-mass-damper system where the spring constant is k. Thus our *proportional controller* represents a simple control strategy: **add a spring with spring constant k.** Of course too strong a spring (large values of k) results in wild oscillations which are undesirable so one is tempted to settle for moderate values of k. Unfortunately



this is not always wise because external disturbances (or unmodelled effects-stiction, lags, etc) act on our system. To see this consider the following situation:



Here

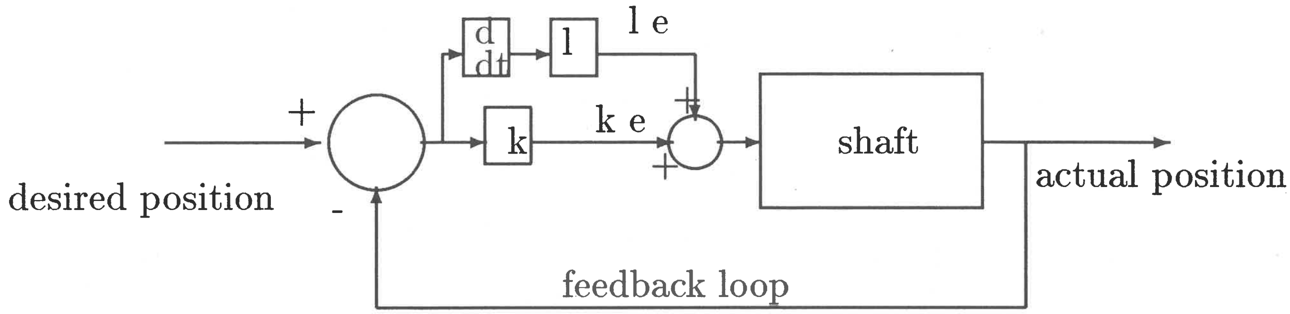
$$J\theta'' + \beta\theta' = k(\theta_d - \theta) + d$$

and in the steady state ($\theta' = 0, \theta'' = 0$) we have

$$k(\theta_d - \theta) + d = 0$$

$$\theta_d - \theta = -d/k.$$

In particular should the load increase then d could be large and our speed regulation would be off by the amount $-d/k$. To isolate our system from these disturbances it is clearly wise to make k rather large. To compensate for the resulting oscillations (instability) we could try adding some more damping to our system (that is, add in a torque which is proportional to the velocity of the tracking error).



In this situation

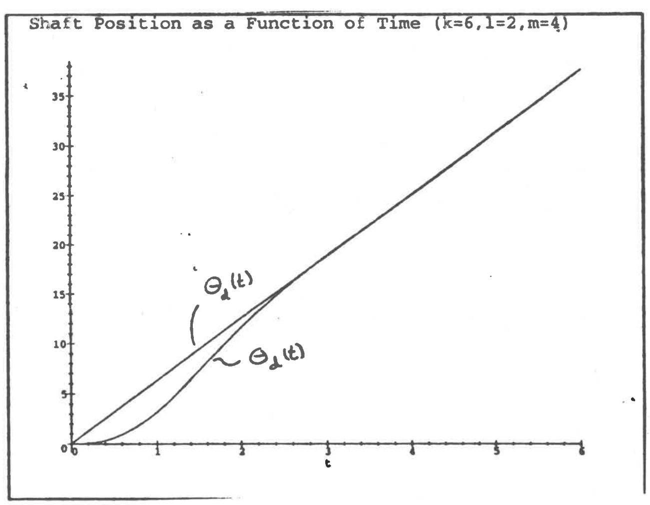
$$J\theta'' + \beta\theta' = k(\theta_d - \theta) + l(\theta_d' - \theta')$$
$$J\theta'' + (\beta + l)\theta' + k\theta = k\theta_d + l\theta_d'$$

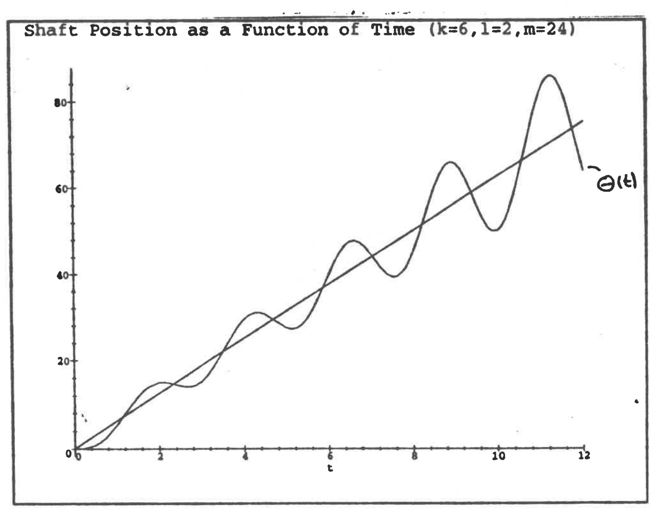
and we have a fast response and reasonable accuracy. We also have a steady state error when trying to follow a ramp.

The solution is add some torque proportional to the integral of the tracking error, the strategy used in the Periers' steam engine!

$$\tau(t) = ke(t) + le'(t) + m\int_0^t e(\sigma)d\sigma$$

This results in the PID controller which first appeared in the 1920's and yields fast response,+ small overshoot, and small steady state error.





But with this controller our model can show a new behaviour: instability. To see why this is happening we will plug our controller τ into our differential equation

$$J\theta'' + \beta\theta' = \tau(t)$$

$$J\theta'' + \beta\theta' = ke(t) + le'(t) + m\int_0^t e(\sigma)d\sigma$$

$$J\theta''' + \beta\theta'' = ke(t)' + le''(t) + me$$

$$J\theta''' + (\beta + l)\theta'' + k\theta' + m\theta = k\theta_d' + l\theta_d'' + m\theta_d.$$

If $\theta(t)$ is constant we can guess the solution $\theta = e^{\lambda t}$ and our equation becomes $(J\lambda^3 + (\beta + l)\lambda^2 + k\lambda + m)e^{\lambda t} = 0$. Thus if $p(\lambda) \stackrel{\text{def}}{=} J\lambda^3 + (\beta + l)\lambda^2 + k\lambda + m)$ we require that $p(\lambda)e^{\lambda t} \equiv 0$ and λ must be a root of $p(\lambda)$.

Suppose that $\lambda = a + ib$ is an *impossible (complex) root* of $p(\lambda)$. Then

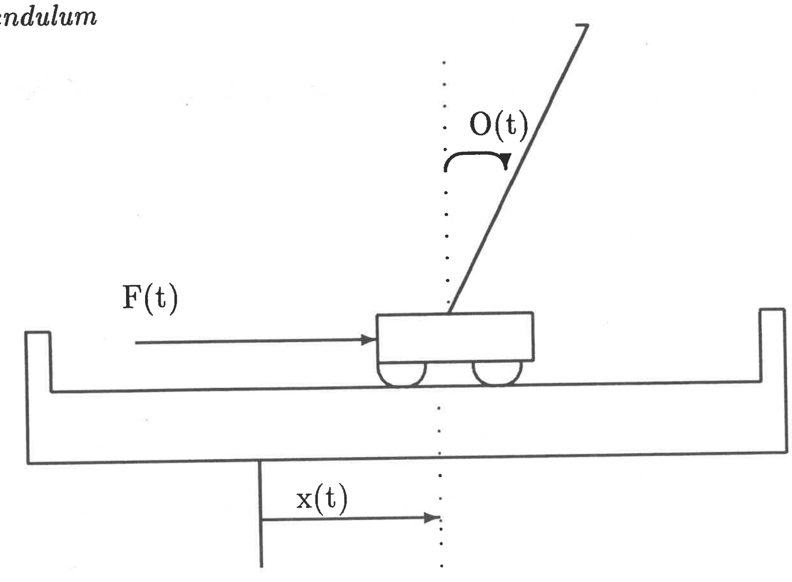
$$\begin{aligned} \theta(t) &= e^{\lambda t} \\ &= e^{(a+ib)t} \\ &= e^{at}e^{ibt} \\ &= e^{at}(cosbt + isinbt) \end{aligned}$$

and if $\lambda = a + ib$ and $\lambda = a - ib$ are roots of $p(\lambda)$ then

$$\begin{aligned} \theta(t) &= e^{(a+ib)t} + e^{(a-ib)t} \\ &= e^{at}(cosbt + isinbt) + e^{at}(cosbt - isinbt) \\ &= 2e^{at}cosbt. \end{aligned}$$

Thus if the *impossible (complex) root* λ lies in the right half complex plane $(a > 0)$ then $e^{at} \to \infty$ and the mystery of the instability is cleared up. This was Maxwell's contribution to the design of simple regulators.

In our new control-robotics lab we have more complicated control devices such as our *inverted pendulum*



Here we need to specify F to control x and θ simultaneously. The equations of motion are very nonlinear

$$\theta'' = \frac{mgsin\theta - cos\theta[F + m_p l\theta'^2 sin\theta]}{(4/3)ml - m_p lcos^2\theta}$$

$$x'' = \frac{F + m_p l[\theta'^2 sin\theta - \theta'' cos\theta]}{m}$$

and the control problem is more mathematically challenging. Ideas from differential geometry and Lie theory provide the mathematical basis for the understanding and control of such systems.

EXCERPTS FROM THE LETTERS RECEIVED BY THE COMMUNICATOR FROM FORMER GRADUATES

Hans Kummer, Editor of the Communicator

In the last edition of the Communicator (Summer 1994) I published an invitation to our former graduates to describe to the readers of the Communicator their professional career, and in particular how their degree in Mathematics or Statistics helped them to get started. Eight graduates responded to my invitation. On the following pages I present excerpts from their letters, ordered by the year in which each respective graduate obtained his/her degree from Queen's. These letters should be of great interest to our present undergraduates, who love mathematics but are worried that studying their favourite subject will not be very helpful from the point of view of their future careers. Accordingly, I have reprinted that part of each letter which communicates, most clearly, the sense that to start off one's career with a degree in Mathematics or Statistics is quite advantageous in today's society. This is even true if you engage in a career as a lawyer as Ken Learn's letter so amusingly conveys. I freely made use of italics in order to bring to the attention of the reader those parts of the letters which stress the usefulness of a mathematics background.

1) *George C. Bush*, a graduate in mathematics of 1961 has been a professor of mathematics and a missionary in the middle east. He writes: "I have enjoyed the opportunity to pursue an academic career and a missionary career in parallel. It is not quite correct to say that my mathematical background opened the way for me to be a missionary, but it did open up places for me to pursue that second career".

2) I reprint the following letter by *Gordon Hall*, a mathematics graduate of Queen's of 1963 in its entirety. It shows what a creative person can achieve with an Honours degree in Mathematics. Gordon writes: "I am responding belatedly to your request in the Summer 1994 publication.
Briefly:

- I graduated in 1963 with an Honours degree in Mathematics (minor in physics).
- I completed the examination of the Society of Actuaries in the spring 1971 and was admitted as
    1. a Fellow of the Society of Actuaries and
    2. a Fellow of the Canadian Institute of Actuaries.

- I worked from 1963 to 1971 as an actuarial student for the Crown Life Insurance Company and have been employed as a consulting actuary with William M. Mercer Limited from 1973. In terms of management responsibilities, I hold the position of Vice-Chairman of the Board of the Canadian company and am a Managing Director of the worldwide firm, William M. Mercer Companies, Inc. In terms of professional responsibilities, I specialize in the pension practice and provide counsel to a few very large pension funds on a wide range of design, administration, funding, investment and communication matters. As well, I am a member of the Canadian firm's national pension practice group and am the editor of *The Mercer Bulletin.*

- In terms of external involvment in community and business affairs:

  1. I have been elected recently to the Board of Trustees of Queen's University.
  2. I am a Director of the Institute of Corporate Directors and
  3. I have just completed a three-year term as President of the Thorncrest Homes Association Inc. (a planned community).

  I trust that the above outline of my career will be of interest to you and help to illustrate that a *solid training in mathematics/statistics and physics can provide a platform for future professional growth and participation in a variety of forums*".

3) *Ms. X*, who requested that her name not be published, graduated from Queen's in 1969 with an Honours degree in Mathematics. She concludes her description of a very varied career by writing: "Generally I would say that a mathematical background has *opened doors.* It has made studying other subjects very easy because there is so much mathematics in so many subjects these days that I think it is preferable to study the math first and then study other subjects later. I took physics in my second year at Queen's and never had to study because it was all math. When I see the pain people without math background have trying to learn financial analysis, economics or even programming, I am very glad for that math I took so long ago. *It has allowed me to be a real generalist*".

4) *Ken Learn*, graduated from Queen's in 1969 with an Honours degree in Mathematics and subsequently engaged in a career in *law*! In fact he, together with two other lawyers, founded the law firm "Campbell Learn & Zenk" in Halifax, Nova Scotia. His letter is praising a mathematical education in quite amusing ways. He writes: "The song says: "Mamas, don't let your babies grow up to be cowboys." Tell them to study mathematics instead. In 1969, I graduated with an Honours degree in mathematics and chemistry. After teaching high school for a year I entered law school and have been a courtroom lawyer ever since.

If you think that Lebesque Integration requires logical analysis, you should be on the receiving end of a judge's questions while making submissions at the conclusion of a trial. I apply the processes of analytical thought that I spent hours learning in Arts 69 on a daily basis in my courtroom life.

No employer ever told me they were going to hire me because I had a math degree. On the other hand, no employer ever said they would not hire me because a math degree was an unusual background for a lawyer.

In the law business you live by your wits and it is of daily assistance to me that I had the opportunity to learn the analysis of complex issues in a mathematics class room...."

5) *Richard T. Burnett* received a B.Sc. in mathematics from Queen's in 1977, a M.Sc. in Mathematics and Statistics in 1978 and a Ph.D. in Statistics from Queen's in 1982. Here is an excerpt

from his letter: "In 1983 I accepted a position as a consulting statistician at Health & Welfare Canada in Ottawa and have held a number of positions in this department.

My main interests are in biostatistics and epidemiology. I received a sound training in both mathematics and statistics at Queen's. The combination of a strong background in theory and applied work was ideal to pursue my career aspirations.

From 1988 to 1992, I held the position of *Head, Statistics Section* in the Environmental Health Directorate. I also had the opportunity to conduct my own research into developing statistical methods for the analysis of longitudinal data, and as such obtained the position of research scientist. In 1994, I was named *Head, Air Quality Health Effects Research Section*, a multidisciplinary research group examining the health effects of ambient air pollution in Canada. This position permitted me to broaden my experience into other scientific disciplines and it also *demonstrates the opportunities available to individuals with a mathematics background.*

Clearly, my education in mathematics and statistics at Queen's has provided me with the opportunity to pursue a fascinating and rewarding career in science and research. The technological issues we face today require multidisciplinary solutions, *with mathematics playing a major role.* One of the most rewarding aspects of my work is integrating mathematics and statistics with other disciplines and in particular, being part of a dynamic team".

6) *Paul Tseng*, is an example of a graduate of the famous program for *Mathematics and Engineering* at Queen's. After his graduation in 1981 he spent the next five years at MIT in order to obtain a Ph.D. in Operations Research (in the area of optimisation). Then he spent one year as an "urf" (University Research Fellow) in the Management Science Division of U.B.C. After having spent another three years at MIT, this time as a research associate in the Laboratory for Information and Decision Systems, he joined the Department of Mathematics of the University of Washington in Seattle, where at present he is teaching applied mathematics. In his letter he first describes the initial segment of his career just outlined, and then he writes: "I joined my current department four years ago. So was my mathematical training useful for the path I took? Not unexpectedly, the answer is a resounding "yes"".

7) *Raymond Grinnell* who obtained his PHD in Mathematics from Queen's in August 1991 and now is a professor of Mathematics at the University of the West Indies has quite a few flattering words to say about the Mathematics Department at Queen's. He writes: "At no mathematics department of which I have been a staff member so far, has the amount of mathematical expertise, activity, or resources *even come close to those I found at Queen's.* Much of the good fortune following my degree is due to these facts alone. Whenever I have visited the department I can not help but remark what an outstanding opportunity it is to be a mathematics student there and what a fine collection of people are a part of it all. Perhaps one can only realize this fully by spending several years as a student, graduating, and then moving on. I have a similar feeling about Canada. In ways that I could only know by leaving Canada and living elsewhere did I more completely see what a marvellous country ours is..."

8) *David Harris* graduated from Queen's in 1992 with a BSCH in Mathematics and presently is working as an *Actuarial Consultant* at Alexander & Alexander. He writes: "When I was interviewed at A & A they were impressed with my strong math background, and the fact that I went to Queen's, as they held the school in high regard. The majority of my work involves estimating loss reserves and forecasting losses. I use a lot of computer models (e.g. to fit severity curves), and my knowledge of probability distributions really helps. While these were covered on my actuarial exams, the fundamentals I learned in some of my Queen's courses have proven to be essential. *I still use some of my old textbooks for reference every now and then.*

Currently I am studying for part 7 of the exams (there are 10 in all). When I am finished I will have the designations FCAS and FCIA (Fellow of the Casualty Actuarial Society, Fellow of the Canadian Institute of Actuaries)".

NEWS OF GRADUATES

Andrew Granville, who received his Ph.D. from Queen's in 1987 under the supervision of Paulo Ribenboim has been named in 1994 a *Presidential Faculty Fellow.* Now at the University of Georgia, Andrew is one of fifteen scientists so honoured by President Clinton. Each award carries a grant from the National Science Foundation (NSF) of $100,000 per year for up to five years.

PROBLEMS

Peter Taylor

Here's two nice little probability problems.

1. I have an urn which contains 100 balls, each one either black or white. If you draw two balls at random from the urn, then the probability that they are the same colour is exactly 1/2. How many balls of each colour were there in the urn?

2. A flips a fair coin 100 times, and B flips a fair coin 101 times. What is the probability that B gets more heads than A?

PROBLEM FROM LAST ISSUE

Peter Taylor

I have to fly from A to B, at some distance due south, and back again. Assuming a fixed air speed, rank order the following options according to total time of transit.

(a) no wind
(b) A north wind of 5 knots
(c) A west wind of 5 knots
(d) An east wind of 7 knots.

SOLUTION

Peter Taylor

First of all it doesn't matter how far apart A and B are – the time for the trip under any of the schemes will be proportional to the distance. It's convenient to let them be 1/2 nautical mile apart. I let v denote the air speed of the plane. We calculate the time T for the trip under each option.

(a) No wind. $T = dist/speed = 1/v$.

(b) North wind of 5 knots. The ground speed one way is $v - 5$ and the other way is $v + 5$. The time is

$$T = \frac{1/2}{v-5} + \frac{1/2}{v+5} = \frac{v}{v^2 - 25}.$$

(c) and (d): East or West wind of k knots. A trip north of time t in a west wind will have the form given by the triangle at the right. Here the path of the plane is plotted with respect to the air–so that when the effect of the wind is included, the plane will always be found exactly north of its starting point. The situation is similar for a southward journey or for an east wind. The time t for the one-way trip must satisfy the equation:

$$(vt)^2 = (kt)^2 + (1/2)^2$$

which we can solve for t. The time for the return trip is

$$T = 2t = \frac{1}{\sqrt{(v^2 - k^2)}}. \tag{1}$$

Now we must compare these T values. First of all (a) is clearly smaller than anything else. To compare (b) with (c) and (d), we observe that (b) has the greater time when:

$$\frac{v}{v^2 - 25} > \frac{1}{\sqrt{(v^2 - k^2)}}. \tag{2}$$

Cross-multiplying and squaring (everything's positive)

$$\begin{aligned} v^2(v^2 - k^2) &> (v^2 - 25)^2 \\ (50 - k^2)v^2 &> 625. \end{aligned} \tag{3}$$

For (c) we take $k = 5$ and the condition becomes $v^2 > 25$, or $v > 5$. This will certainly hold.

For (d) we take $k = 7$ and (3) becomes $v^2 > 625$, or $v > 25$, and I presume that this will hold as well–not many airplanes are capable of flying at speeds less than 25 knots.

Finally, (c) is faster than (d) because (1) increase with k.

The conclusion is that the times T are ordered as

$$(a) < (c) > (d) < (b)$$

under the assumption $v > 25$ knots. [If we allow $v < 25$, then we must reverse (b) and (d).]

It is interesting to note that if we took k just a tad above 7 (indeed if $k > \sqrt{50}$) then a crucial sign will change in (3), and the result will change. So the problem would have been more interesting if it had included:

(e) an east wind of 8 knots.

If we set $k = 8$, the right side of (3) is negative, and (3) will never hold, so that (e) will always take longer than (b). The entire answer would be:

$$(a) < (c) < (d) < (b) < (e).$$

A solution was submitted by David Hain, correct under the assumption that I was flying a bent-wing ultralight at a speed of under 25 knots.

A YEAR IN THE LIFE OF THE DEPARTMENT

Leo Jonker

1994-95 has been another eventful year for the Department of Mathematics and Statistics. For the first time in many years we did not hold our annual party in the fall. Instead, following suggestions made by Agnes Herzberg, always one to promote style, we held our first annual Department Dinner on May 4 at the Donald Gordon Centre. It was a great occasion to honour the retirees of the past year and the winners of various honours and awards. Of course we also enjoyed a good meal followed by a short presentation by Rena Upitis, who was recently appointed Dean of the Faculty of Education, on the effects of video games on children.

This year's retirees are: Norman Pullman, Cedric Schubert, M. Wasan and Bill Woodside (who will retire in August). I am sure that many of our readers will have fond memories of courses taught by one or more of these retirees. We will miss them.

Once again, we were able to celebrate notable successes on the teaching front. Peter Taylor (as usual) outdid all of us by winning the 3M Teaching Fellowship (an award for outstanding contributions to teaching) in a nation-wide competition. You may remember that Peter had previously won a pretigious (international) teaching award from the Mathematical Association of America, as well as the Queen's ASUS Teaching Excellence Award (with the late Bill Barnes) for their course on Mathematics and Poetry. In addition to this, Peter was awarded a Golden Apple Award for his work with Engineering students. A second Golden Apple was won by Jim Whitley, another (retired) member of this Department. This is the second year in a row that two of the three Golden Apples have come to the Department of Mathematics and Statistics.

Agnes Herzberg continues to involve herself in the administrative work of both national and international organizations in her profession. This year she was honoured by election as Vice President of the International Statistical Institute.

We have been seeing a lot less of Tony Geramita this year. He has an arrangement with the University of Genova that allowed him to spend the winter term in Italy at that institution. It appears that this may turn into a permanent arrangement. Are we a little envious perhaps?

There have been three promotions this year: Dan Offin and Duncan Murdoch to Associate Professor (the latter was also granted tenure) and Eddy Campbell to Full Professor.

This year also, in our second attempt, we were able to fill the vacant position in Mathematics and Engineering. It will be filled by Fady Alajaji. Fady is an Information Theorist who did his undergraduate work at the American University of Beirut, and received his graduate degrees at the University of Maryland, where he is currently active in a postdoctoral program. We look forward to his arrival in July.

One of the newer annual events is the Department's "Gradfest". Gradfest is a day in which we bring together current and prospective graduate students. Its main purpose is to acquaint prospective students with the Department. The event consists of a sequence of short seminars followed by a party. It appears to have been a great success.

Two further changes should be noted. Leslie Roberts has come to the end of his three year term as Associate Head. He has served the Department very well in the difficult and time consuming task of managing the enormous flood of correspondence with job applicants and their referees, together with all the paper work associated with promotion, tenure and renewal decisions. I know that Leslie is eager to get back to a more balanced Professor's life. At the same time, I have come to the end of my five year term as Department Head. As I think you know from my comments in previous issues of the Communicator, I have enjoyed the job but have also found it destructive of my research efforts. I look forward to a sabbatical year at the University of Amsterdam. I am happy to be able to pass the reins to Eddy Campbell, who has agreed to be our next Department Head. I am confident that we will see good things under his inspired and energetic leadership.

Let me end these musings on a sad note. Ian McKay, a Ph.D. graduate of this Department (1993) and a very promising young research statistician, suddenly died of a heart attack this April, while on a post doctoral visit in Australia. The tradegy of his death is compounded by the fact that he had recently married, and that his wife was expecting a baby at the time of Ian's death. The statistical community in Canada and the Department joins Ian's family as we mourn the loss.

HAPPY NEWS FROM THE MCKAY FAMILY

Yvonne McKay (Ian's wife) had a baby girl Elisa Magdelina, Saturday June 3rd, 1995, 1:15 a.m., weighing 4.3 kilos. Both are doing fine.

IF UNDELIVERED RETURN TO:
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