Leading Flying Objects

Stephen M. Watt
Western University

J. W. Graham Medal Seminar
13 June 2012, University of Waterloo

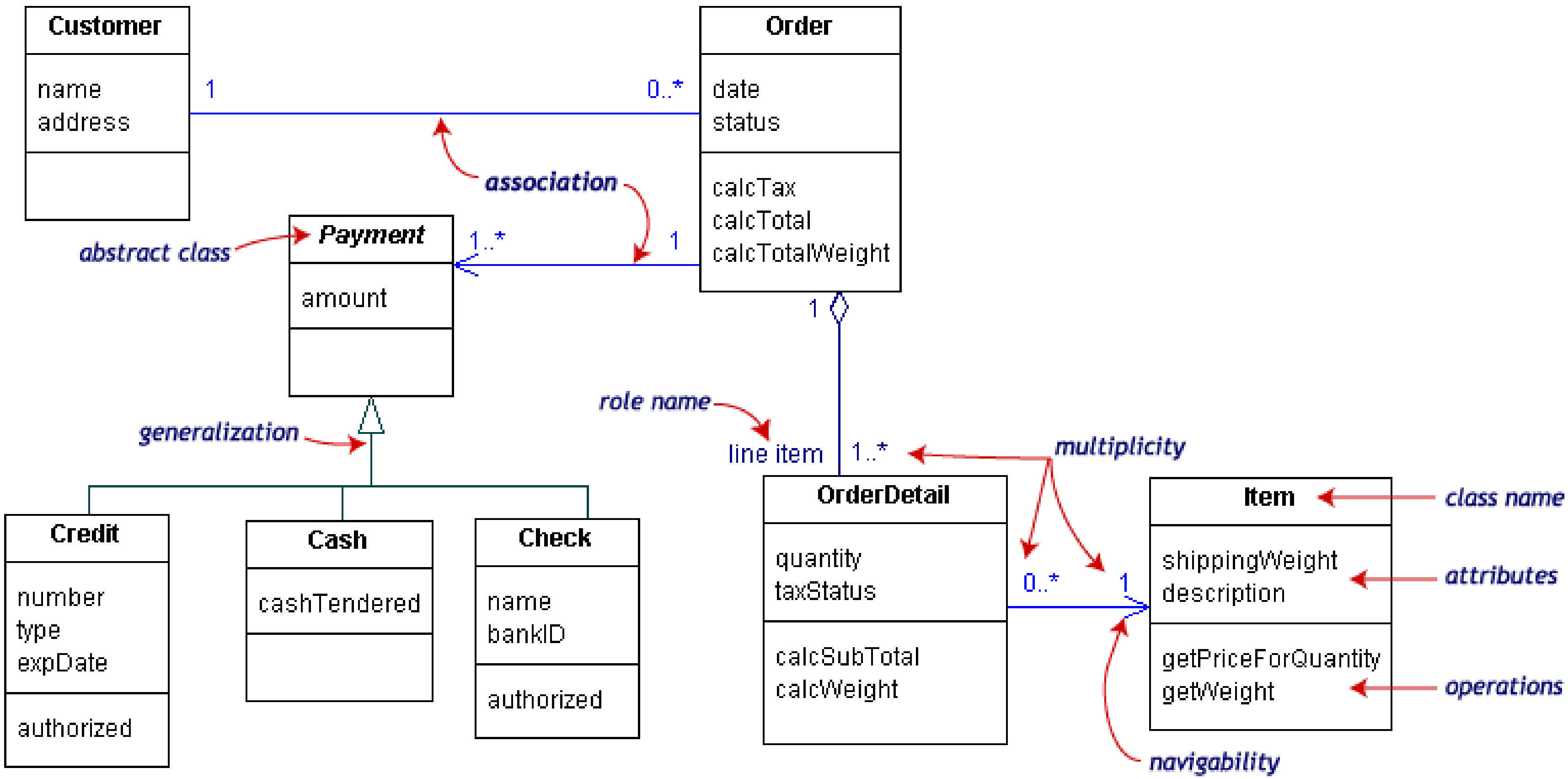
Leading

adj.

1. guiding, directing or influencing
2. of greatest importance or degree

Flying

Objects



Customer
name
address
1
0..*
Order
date
status
calcTax
calcTotal
calcTotalWeight
association
abstract class
Payment
1..*
1
amount
1
generalization
role name
line item
1..*
multiplicity
Credit
number
type
expDate
authorized
Cash
cashTendered
Check
name
bankID
authorized
OrderDetail
quantity
taxStatus
calcSubTotal
calcWeight
0..*
1
Item
shippingWeight
description
getPriceForQuantity
getWeight
class name
attributes
operations
navigability

Leading Flying Objects

Lewiston Evening Journal
October 12, 1955

Aiming Ahead of Your Target Important in Wing Shooting

Henry P. Davis

In any form of wing shooting, whether the targets be upland game birds, waterfowl or trap or skeet shooting "clay saucers," a prime requisite for good marksmanship is the ability to determine instantly the proper lead for each individual shot.

The average novice gunner when first confronted with this problem, usually weighs his own lack of knowledge and experience and considers the task almost impossible of accomplishment. However, after he makes a few hits, this feeling of incompetence passes to some degree and the first cardinal rule in shooting efficiency begins to soak in. This simple self-evidence speaks for itself 'You can't hit 'em if you shoot behind em.'

Given the speed of the target, the angle of flight and the velocity of the shot charge, one well versed in mathematics can figure out the exact lead necessary to center the target. But by the time his mental slide-rule has dished up the answer, the target has usually flown on to safer bounds. So the good shot learns, by experience to instinctively apply the proper lead. This necessarily, is done very quickly, and very often unconsciously, in the swing-through that is so important in good shotgun marksmanship.

Here's How

This is all I can tell you about leading a flying object.

1. Start your swing behind it. Don't hold your gun still and wait for it to come to you.

2. Swing with it, following its flight.

3. Pass it and pull the trigger.

No one can tell you how far to pass it. That you must figure out by trial and error. When you hit, you are right. When you miss, the odds are that you didn't pass it far enough. Remember how the ones you hit looked to you over the sights. Do it again the same way!

Why can't anyone tell you how far to pass it?

Because it takes different humans different lengths of time to pull a trigger.

When your eye says "Shoot," the message has to travel through a set of nerves to tell a set of muscles to pull the trigger and the muscles have to pull it. Some folks have twice as long as others to get the job done. Don't ask me why. It has been proved.

Follow and Pass Target

When you start your swing behind an object, then follow in the object's path until you pass it, the speed of your gun movement is faster than that of the moving object—you are overtaking it. As your line of sight goes by it, the line of sight is moving ahead of the object all during the time it takes you to pull the trigger after your eye says "Shoot." In that space of time, you are building up a lead which you don't even know about. It isn't being recorded on your conscious mind. But you are leading the object more than you think you are. How much? No one can tell you that; you find it out for yourself. You find the distance which you should pass the object in order to score a hit, that's the right amount for you. You alone can solve the problem.

How do you allow for different speeds and different angles? The time which it takes you to pull a trigger, helps you do it. The more acute the angle, the faster the speed; the more your gun swings ahead of the object when you pass it, the faster the object goes, the faster your gun will be going when it passes the target. So in the Reaction Interval the time it takes you to get the trigger pulled, your lead is increasing more on a fast, acute angle shot than on a slower one at a lesser angle. Your swing is furnishing compensation for the speed and angle of the shot without your even realizing it.

A load of shot is about 15 feet long as it flies through the air. If you are a little too far ahead of the object, some of the tail-end shot may bite it down, but if you are behind the object, there isn't any doubt about your missing it. If you have hunted many ducks, you have no doubt had the experience of aiming at the lead duck of a string flying across in front of you and killing one of the rear ducks.

The Trigger Pull

It takes you longer to get the trigger pulled than it does for the load of shot to travel 40 yards. An average reaction interval takes .20 of a second to get the load out of the gun after your eye says "shoot" as against roughly .15 of a second for the shot to travel 40 yards. Some people are slower and some are faster; small shot are slower, big shot are faster, but the two figures add up to about one-third of a second from the time your eye says "shoot" until the shot travels 40 yards.

A bird winging 60 miles an hour at right angles to your gun is doing 88 feet per second. So, if you held your gun still, pointing at a spot the bird is going to cross, your eye would have to say "Shoot" while the bird was about 30 feet from the crossing point of the bird and the shot in order for both to arrive at the same time. Now no one could even accurately judge a distance of 30 feet at 40 yards on an object doing a mile a minute. I sometimes wonder how we ever hit anything! Yet, thousands of clay targets have been run without a miss in both trapshooting and skeet. It is only because we start behind the object and swing through it that we are able to develop any accuracy in tossing the shot where the object is going.

The mile a minute bird will only travel about 13 feet while the shot travels its 40 yards. If you swing fast and pull a slow trigger, you will not consciously have to lead as much as the person who doesn't swing so fast and pulls a quick trigger. I have the old time hunters tell me that they never led game at all. At first I thought they were lying, but some of them with a slow reaction interval probably didn't consciously lead their game much, if any. They just swung through and the lead took care of itself. I repeat, that no charts, diagrams or tables of figures will give you the remotest idea of how to hit a flying object which is flying differently on every shot.

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A Few Stories

- Maple
- Axiom & Aldor
- Symbolic-Numeric Algorithms for Polynomials
- MathML
- Descartes
- Symbolic Exponents
- Mathematical Handwriting Recognition
- Directions in Teaching

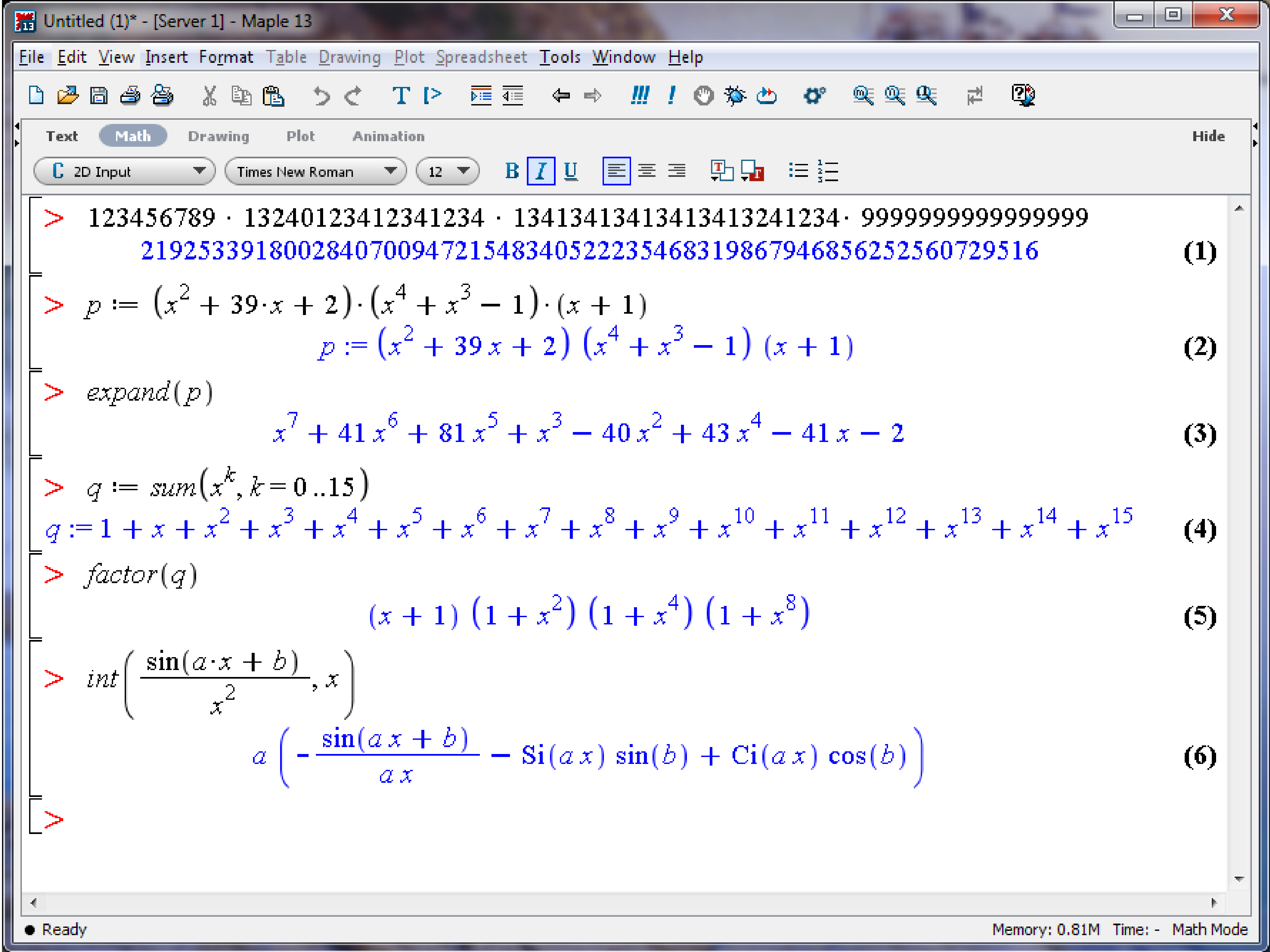
Maple

- Software for symbolic mathematical computing.

$$diff(\sin(\exp(a \cdot x) + x), x)$$

$$\cos\left(e^{a\,x} + x\right)\left(a\,e^{a\,x} + 1\right)$$

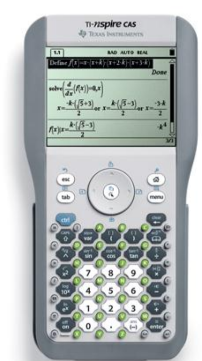
- Geddes and Gonnet, U Waterloo Dec 1980.
- Joined as NSERC student Jan 1981.
- Maplesoft founded 1988.


Untitled (1)* - [Server 1] - Maple 13
File Edit View Insert Format Table Drawing Plot Spreadsheet Tools Window Help
Text Math Drawing Plot Animation Hide
2D Input Times New Roman 12
> $123456789 \cdot 132401234123412341234 \cdot 1341341341341341324 1234 \cdot 9999999999999999$
$2192533918002840700947215483405222354683198679468562525607295 16$ (1)
> $p := (x^2 + 39 \cdot x + 2) \cdot (x^4 + x^3 - 1) \cdot (x + 1)$
$p := (x^2 + 39\,x + 2)\,(x^4 + x^3 - 1)\,(x + 1)$ (2)
> $expand(p)$
$x^7 + 41\,x^6 + 81\,x^5 + x^3 - 40\,x^2 + 43\,x^4 - 41\,x - 2$ (3)
> $q := sum(x^k, k = 0..15)$
$q := 1 + x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7 + x^8 + x^9 + x^{10} + x^{11} + x^{12} + x^{13} + x^{14} + x^{15}$ (4)
> $factor(q)$
$(x + 1)\,(1 + x^2)\,(1 + x^4)\,(1 + x^8)$ (5)
> $int\left(\frac{\sin(a \cdot x + b)}{x^2}, x\right)$
$a\left(-\frac{\sin(a\,x + b)}{a\,x} - \mathrm{Si}(a\,x)\sin(b) + \mathrm{Ci}(a\,x)\cos(b)\right)$ (6)
>
Ready
Memory: 0.81M Time: - Math Mode

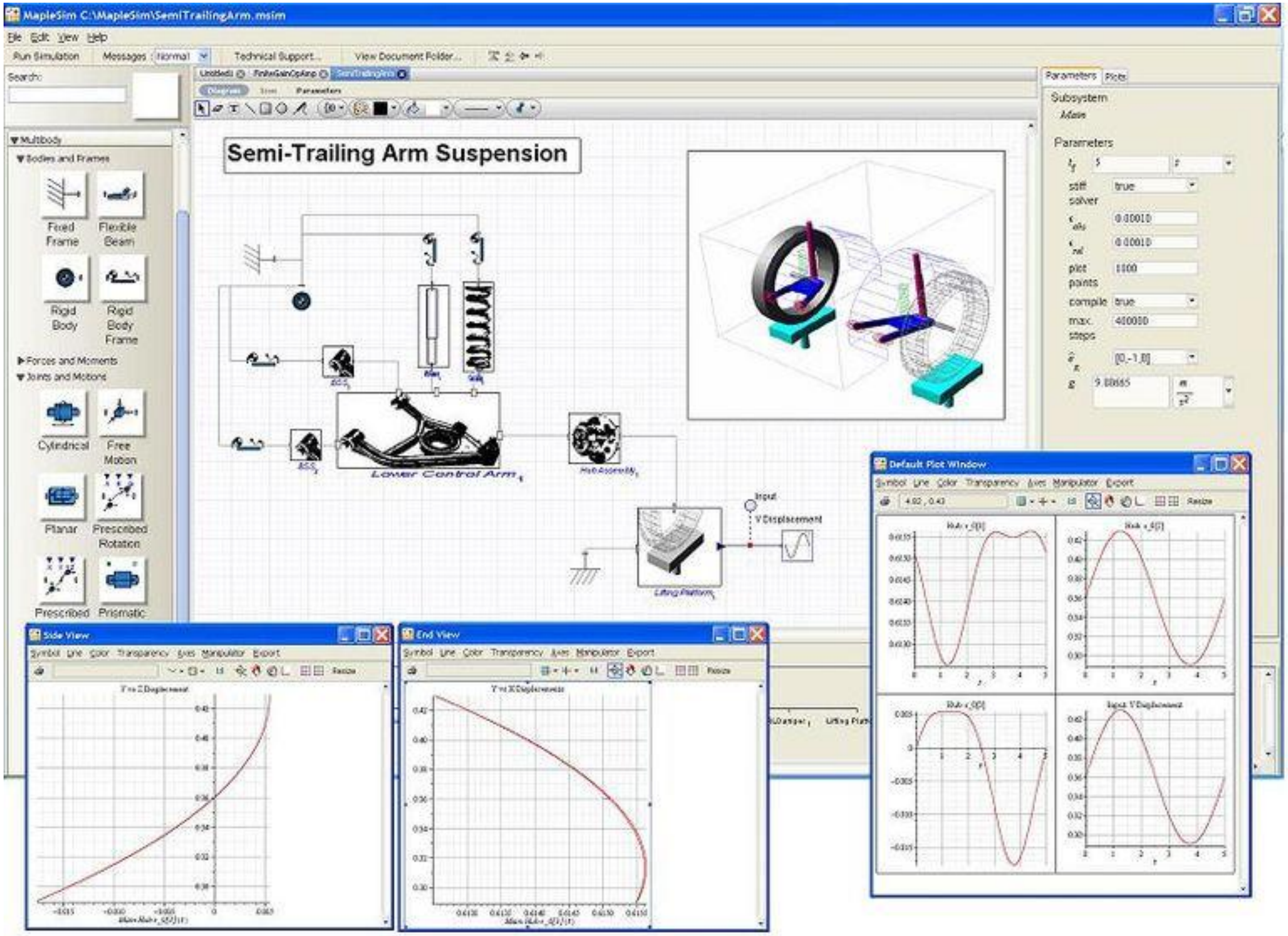
Maple

- Lightweight design, based on compiled kernel and interpreted library.
- Run a dozen students on a TSS.
- Run a single user on a personal computer.
- Do more in smaller places.



MapleSim for CAE



Axiom & Aldor

- “A Language for Computational Algebra”
  Jenks and Trager, 1981.
- Proposed a strongly typed language for generic algorithms.   Type system based on modern algebra.

- Similar direction to own developing thoughts.
- Met group at “Computers in Math” at Courant Institute.
- Joined team in 1984.

Axiom & Aldor

- Ambitious system, “Scratchpad II”
- Type categories, run-time generics.

- Shoehorned into 24 bit shared address space.
- Dial in dedicated research TSS brought to knees.

Axiom & Aldor

- Move to Unix ca 1987.
- Re-invented language based on dependent types.
- C-implementation of stand-alone compiler.

- Release via NAG Ltd (UK) as Axiom and Aldor (early 90s)
- Failed commercially.   Limited open source use.

- Too early.
- Influential.   Views, C++, Magma, Sage, MatheMagix,…

Symbolic-Numeric Algorithms for Polynomials

- What is a polynomial GCD?

$$p = x^2 + 2x + 1$$

$$q = x^2 - 1$$

Symbolic-Numeric Algorithms for Polynomials

- What is a polynomial GCD?

$$p = (x+1)(x+1)$$

$$q = (x+1)(x-1)$$

$$g = \gcd(p, q) = x+1$$

- Compute using Euclidean algorithm.

Symbolic-Numeric Algorithms for Polynomials

- Slightly different coefficients....

$$p = x^2 + 2x + 1.0000001$$

$$q = x^2 - 1$$

$$g = \gcd(p, q) = 1$$

Symbolic-Numeric Algorithms for Polynomials

- How to find that the second problem is “close to” the first problem and there is a non-trivial answer?

- ≤1995, state of the art was

  “Run the Euclidean algorithm with a fuzzy zero test.”

- What does this mean???

Symbolic-Numeric Algorithms for Polynomials

- With Corless, Gianni, Trager (1995) proposed to use ideas from backward error analysis.

Symbolic-Numeric Algorithms for Polynomials

Given $p, q \in \mathrm{R}[x]$ of degrees d_p, d_q

and $\epsilon > 0$,

do there exist $\Delta p, \Delta q \in \mathrm{R}[x]$ of degrees $\leq d_p, d_q$

with $||\Delta p||, ||\Delta q|| \leq \epsilon$

such that $\gcd(p + \Delta p, q + \Delta q)$ is nontrivial?

If so, find them.

Symbolic-Numeric Algorithms for Polynomials

- Well defined question.
- Can answer using any approach.

- Then polynomial decomposition, factorization, etc.

Symbolic-Numeric Algorithms for Polynomials

MathML

<math>

$$\int_{c} \mathrm{d}\,\omega \;=\; \int_{\partial c} \omega$$

$$\left(\frac{p}{q}\right)\left(\frac{q}{p}\right) \;=\; (-1)^{\frac{p-1}{2}\cdot\frac{q-1}{2}}$$

$$G(E/F) \;=\; G(K/F)\;/\;G(K/E)$$

$$\nabla^{\mu}\nabla_{\mu}A^{\nu} - \nabla^{\nu}\nabla_{\mu}A^{\mu} = j^{\nu}$$

$$\partial_{n-1}\partial_{n}\,c \;=\; 0$$

</math>

MathML

- OpenMath effort initiated 1993 for data exchange.
- Unfulfilled <math> element in HTML 3.2 Jan 1997.

- Initial, unchartered Math WG defining microsyntax for <math>.
- Internecine rivalry between syntax and semantics camps coming from TeX, Mathematica and SGML.

MathML

- Convened “HTML-native” math group to form unified proposal.

- XML proposed recommendation December 1997.
- MathML proposed recommendation February 1998.

- Supported in major browsers, computer algebra systems, incorporated in HTML 5.

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Descartes

NASDAQ:DSGX   TSE:DSG

- Global leader in on-demand software-as-a-service solutions for logistics-intensive businesses.

- More than 35,000 trading partners networked.

- Solutions to route, schedule, track and measure delivery resources;   plan, allocate and execute shipments; rate, audit and pay transportation invoices;
file customs and security documents for imports and exports.

Descartes

- Re-use data for multiple purposes,
  e.g. warehousing, routing, customs

- Multiple transportation partners on network enable end-to-end treatment of goods.

- Internet of things on the move.

Descartes

- Board member since 2001. Chairman 2003-2007.
- Turn-around needed.
- Appointed Art Mesher President/CEO in Nov 2004.
- Fired customers, reduced staff, focused.
- Strategic acquisitions. One example….

Supply Chain Security

C-TPAT Eligibility

In April of 2002, Customs and Border Protection initiated the Customs Trade Partnership Against Terrorism (C-TPAT) voluntary program to combat potential terrorists threats that was open to enrollment by Importers only. In the years that have followed, CBP has expanded the scope of the program to include additional business entities within the international supply chain. At the present time, there are over 14,000 companies actively involved with the C-TPAT process. CPB Agents have participated in over 4000 Validation reviews and have met with C-TPAT Partners in over 50 countries.

To be eligible to participate in this vital security program you must be one of the following business entities:

Are YOU Eligible for C-TPAT Certification? Click the Link for C-TPAT Eligibility!

- 3PL - Third Party Logistics Provider
- Air Carriers
- Air Freight Consolidators, Ocean Transportation Intermediaries (OTI) and Non-Vessel

Descartes

- ***Acquired***

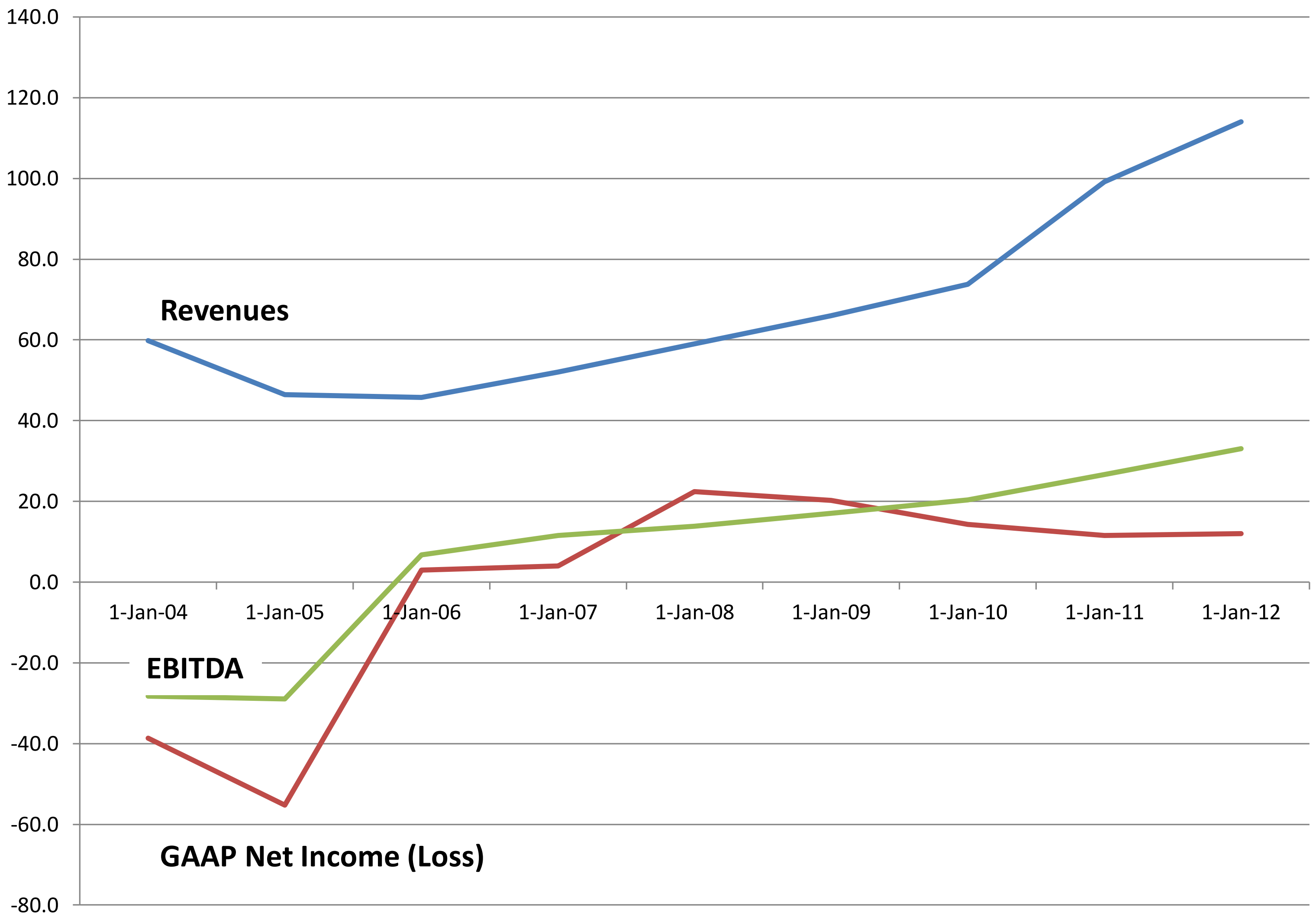
  Flagship Customs Services (US)
  USD 29mm June 2006

  ViaSafe (Canada)
  USD 9mm Apr 2006

- ***Mandatory criteria***

  $\Rightarrow$ **Sold out**

Descartes



140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09
1-Jan-10
1-Jan-11
1-Jan-12
Revenues
EBITDA
GAAP Net Income (Loss)

Symbolic Exponents

- "Computer Algebra's Dirty Little Secret"

$$\frac{(k - k^n)}{k}$$

$$\frac{k - k^n}{k}$$

$simplify(\%)$

$$-\frac{-k + k^n}{k}$$

Symbolic Exponents

- CAS do not handle symbolic degrees, dimensions, characteristics, etc.

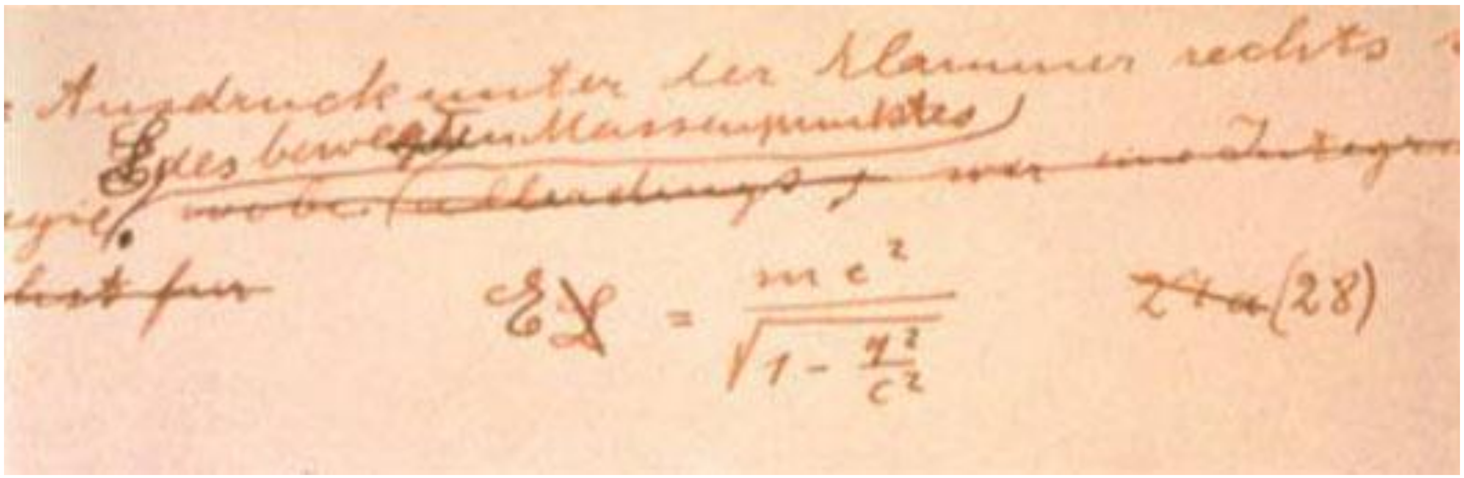
$$x^{2n} - y^{2m} = (x^n + y^m)(x^n - y^m)$$

$$x^{n^2+3n} - y^{2m} = \left(x^{n(n+3)/2} + y^m\right)\left(x^{n(n+3)/2} - y^m\right)$$

$$16^n - 81^m = (2^n - 3^m)(2^n + 3^m)(2^{2n} + 3^{2m})$$

- Algorithms for gcd, factorization, fn decomposition, etc.

Mathematical Handwriting Recognition



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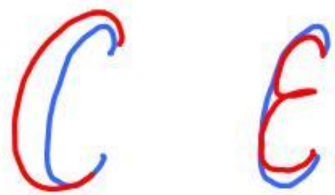
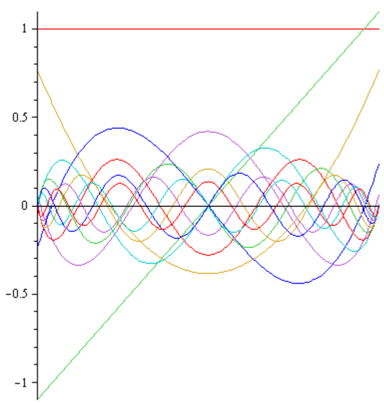
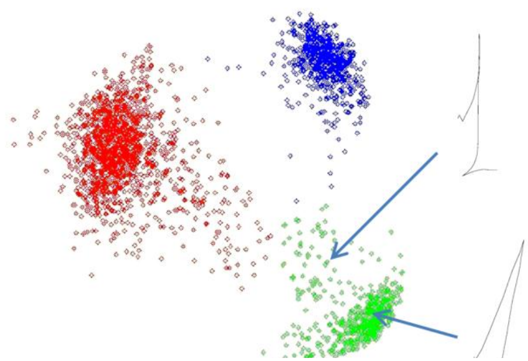
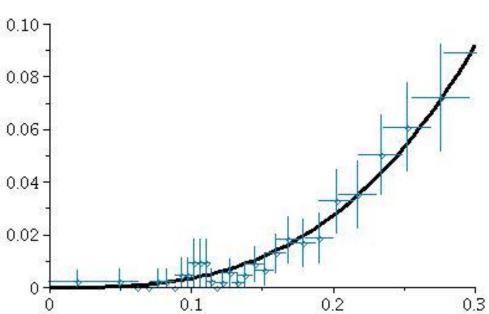
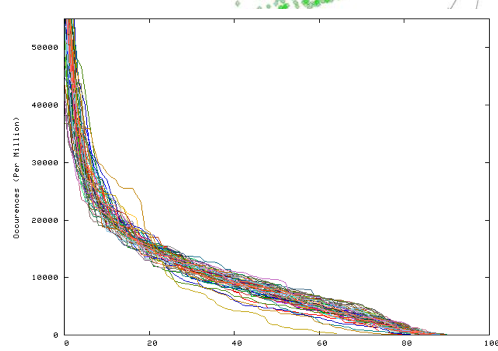


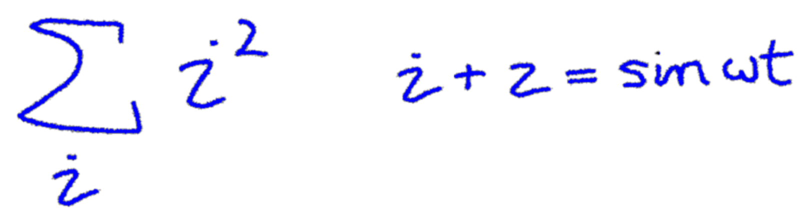
$$\langle f, g\rangle = \int_{-1}^{1} f(t)g(t)\mathrm{d}t + \mu_1 \int_{-1}^{1} f'(t)g'(t)\mathrm{d}t + \mu_2 \int_{-1}^{1} f''(t)g''(t)\mathrm{d}t + \cdots$$











Directions in Teaching

- Joint program in Computing and Law BSc/LLB

- Western 1st year Faculty of Science 2011-12

  400 BSc, 1000 BMSc

  $\Rightarrow$ Entry-level course in “Medical Computing”

Scorecard

- Just right: Maple, SNAP, MathML, Descartes
- Too early: Axiom/Aldor
- Too late: ??

- Jury out: $x^{n(n+1)/2}$, Math HR, Joint programs

Aiming Ahead of Your Target Important in Wing Shooting

Henry P. Davis

In any form of wing shooting, whether the targets be upland game birds, waterfowl or trap or skeet shooting "clay saucers," a prime requisite for good marksmanship is the ability to determine instantly the proper lead for each individual shot.

The average novice gunner when first confronted with this problem, usually weighs his own lack of knowledge and experience and considers the task almost impossible of accomplishment. However, after he makes a few hits, this feeling of incompetence passes to some degree and the first cardinal rule in shooting efficiency begins to soak in. This simple self-evidence speaks for itself 'You can't hit 'em if you shoot behind em.'

Given the speed of the target, the angle of flight and the velocity of the shot charge, one well versed in mathematics can figure out the exact lead necessary to center the target. But by the time his mental slide-rule has dished up the answer, the target has usually flown on to safer bounds. So the good shot learns, by experience to instinctively apply the proper lead. This necessarily, is done very quickly, and very often unconsciously, in the swing-through that is so important in good shotgun marksmanship.

Here's How

This is all I can tell you about leading a flying object.

1. Start your swing behind it. Don't hold your gun still and wait for it to come to you.
2. Swing with it, following its flight.
3. Pass it and pull the trigger.

No one can tell you how far to pass it. That you must figure out by trial and error. When you hit, you are right. When you miss, the odds are that you didn't pass it far enough. Remember how the ones you hit looked to you over the sights. Do it again the same way!

Why can't anyone tell you how far to pass it?

Because it takes different humans different lengths of time to pull a trigger.

When your eye says "Shoot," the message has to travel through a set of nerves to tell a set of muscles to pull the trigger and the muscles have to pull it. Some folks have twice as long as others to get the job done. Don't ask me why. It has been proved.

Follow and Pass Target

When you start your swing behind an object, then follow in the object's path until you pass it, the speed of your gun movement is faster than that of the moving object—you are overtaking it. As your line of sight goes by it, the line of sight is moving ahead of the object all during the time it takes you to pull the trigger after your eye says "Shoot." In that space of time, you are building up a lead which you don't even know about. It isn't being recorded on your conscious mind. But you are leading the object more than you think you are. How much? No one can tell you that; you find it out for yourself. You find the distance which you should pass the object in order to score a hit, that's the right amount for you. You alone can solve the problem.

How do you allow for different speeds and different angles? The time which it takes you to pull a trigger, helps you do it. The more acute the angle, the faster the speed; the more your gun swings ahead of the object when you pass it, the faster the object goes, the faster your gun will be going when it passes the target. So in the Reaction Interval the time it takes you to get the trigger pulled, your lead is increasing more on a fast, acute angle shot than on a slower one at a lesser angle. Your swing is furnishing compensation for the speed and angle of the shot without your even realizing it.

A load of shot is about 15 feet long as it flies through the air. If you are a little too far ahead of the object, some of the tail-end shot may bite it down, but if you are behind the object, there isn't any doubt about your missing it. If you have hunted many ducks, you have no doubt had the experience of aiming at the lead duck of a string flying across in front of you and killing one of the rear ducks.

The Trigger Pull

It takes you longer to get the trigger pulled than it does for the load of shot to travel 40 yards. An average reaction interval takes .20 of a second to get the load out of the gun after your eye says "shoot" as against roughly .15 of a second for the shot to travel 40 yards. Some people are slower and some are faster; small shot are slower, big shot are faster, but the two figures add up to about one-third of a second from the time your eye says "shoot" until the shot travels 40 yards.

A bird winging 60 miles an hour at right angles to your gun is doing 88 feet per second. So, if you held your gun still, pointing at a spot the bird is going to cross, your eye would have to say "Shoot" while the bird was about 30 feet from the crossing point of the bird and the shot in order for both to arrive at the same time. Now no one could even accurately judge a distance of 30 feet at 40 yards on an object doing a mile a minute. I sometimes wonder how we ever hit anything! Yet, thousands of clay targets have been run without a miss in both trapshooting and skeet. It is only because we start behind the object and swing through it that we are able to develop any accuracy in tossing the shot where the object is going.

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