Systems Thinking and Dynamic Modeling – 2010 Conference for K-12 Education

HAIG DYNAMICS
A System Dynamics Club at Earl Haig Secondary School, Toronto, Canada

A Dream in the Making... From the Bottom Up

By Yannick Ngana

systemdynamics@earlhaig.ca
Sunday, June 27th, 2010
OUTLINE

- Brief Presentation of Earl Haig Secondary School
- Setting the Context: Balancing and Sustaining “well rounded” High Academic Achievement with Excellent Extra Curricula Life
- Brief Overview of System Dynamics
- Haig Dynamics: for Balanced and Sustained high academic achievement and extra curricula Life at Earl Haig Secondary School.
- Haig Dynamics in its first year
- Haig Dynamics: more than a Club at Earl Haig?
Earl Haig Secondary School, a school in the Toronto District School Board, is comprised of a student population of more than 2,000 and serves a diverse population in North York area of Toronto.

Earl Haig Secondary School has 156 Teaching staff members mapped to 20 departments, each led by a Curriculum Leader; and has 4 Senior Administration Staff members (1 Principal and 3 Vice-Principals).
Enrichment program in core subjects (Math, Science, English, History, Geography...) with extended opportunities for students with a special interest in these subject areas.

The school's large size and professional staff ensures a very wide variety of curricular and extra-curricular opportunities for our students.

All students have opportunities to develop leadership skills through outstanding athletic, academic, and co-curricular activities (e.g. Student Activity Council, Leadership Council and Clubs).
# Earl Haig Secondary School Department

<table>
<thead>
<tr>
<th>Department</th>
<th>Teachers</th>
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<tbody>
<tr>
<td>Business Education</td>
<td>10 Teachers</td>
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<tr>
<td>English as a Second Language</td>
<td>8 Teachers</td>
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<tr>
<td>Modern Languages</td>
<td>6 Teachers</td>
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<tr>
<td>Technology</td>
<td>5 Teachers</td>
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<tr>
<td>Computer Studies</td>
<td>3 Teachers</td>
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<tr>
<td>Guidance</td>
<td>6 Teachers</td>
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<td>Physical Education</td>
<td>6 Teachers</td>
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<tr>
<td>Special Education/Student Success</td>
<td>7/3 Teachers</td>
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<td>Cooperative Education</td>
<td>3 Teachers</td>
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<tr>
<td>Library</td>
<td>4 Teachers</td>
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<tr>
<td>Science</td>
<td>16 Teachers</td>
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<tr>
<td>Dance/Drama/Music/Screen Arts/Visual Arts</td>
<td>6/6 Teachers</td>
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<tr>
<td>English</td>
<td>15 Teachers</td>
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<tr>
<td>Mathematics</td>
<td>19 Teachers</td>
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<tr>
<td>Social Science</td>
<td>20 Teachers</td>
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<td><a href="http://www.earlhaig.ca">www.earlhaig.ca</a></td>
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## Setting the Context

| Overcrowded and very broad curriculum and expectation for high student achievement and success in life | No frame of reference for making facts provided to students (learners) relevant to the complexities of life |
| Static snapshots of the real world taught to students; and expecting pressures for an increase of additional science, humanities, and social studies | Real world’s problems are dynamic and interrelated |
| Subjects or knowledge areas are taught in a fragmented way | Society becomes more complex, crowded, and tightly interconnected |
| Math, science, social studies are taught as if they were inherently different from one another | Behaviour in Math, science, social studies rests on the same underlying concepts. |
“Students’ Ideal”: High Academic Achievement and Excellent Extra Curricula Life

Key Questions:

- How can a student balance and sustain “well rounded” High Academic Achievement with Excellent Extra Curricula Life, toward success in life?

- How can math, science (physics, chemistry, and biology), literature and the social sciences, which are traditionally separated knowledge areas, be interrelated in order to make it easier for learners (e.g. Earl Haig students) to master their underlining concepts...?
“System dynamics is a discipline with the scope of science, education, law, engineering, or medicine”

Jay W. Forrester
Founder of System Dynamics
Sloan School of Management
Massachusetts Institute of Technology
**System Dynamics**

- *System dynamics deals with how things change through time, which covers most of human concerns.*

- *System dynamics uses computer simulation to reveal how the structure and policies in a system act to create its behaviour.*

- *System Dynamics builds two-way communication between mental models and simulation models*
<table>
<thead>
<tr>
<th>System Dynamics</th>
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</thead>
<tbody>
<tr>
<td><strong>Overcrowded and very broad curriculum and expectation for high student achievement and success in life</strong></td>
<td>will help in providing</td>
<td>Frame of reference for making facts provided to students (learners) relevant to the complexities of life</td>
</tr>
<tr>
<td><strong>Static snapshots of the real world taught to students; and expecting pressures for an increase of additional science, humanities, and social studies</strong></td>
<td>will help in viewing</td>
<td>World’s problems as dynamic and interrelated</td>
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<tr>
<td><strong>Subjects or knowledge areas are taught in a fragmented way</strong></td>
<td>will help in improving understanding of</td>
<td>Society as it becomes more complex, crowded, and tightly interconnected</td>
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</tbody>
</table>
| **Math, science, social studies are taught as if they were inherently different from one another** | will help in learning the underlying concepts from the | Behaviour in Math, science, and social studies.
HAIG DYNAMICS: A CATALYST TOWARDS EARL HAIG SECONDARY STUDENTS’ IDEAL

**Mandate:** to contribute to Earl Haig students’ academic success using System Dynamics.

**Goal:**
- To create a platform that will expose Earl Haig students to the enrichment System Dynamics can bring to them
- To provide Earl Haig students with System Dynamics tools that will contribute to sustainable learning of math, science, language and social sciences
- To provide Earl Haig students with System Dynamics tools to support a well-founded confidence for managing their lives (e.g. academic life) and the situations they encounter.
How Did I Learn System Dynamics?
Self-Learning
GETTING STARTED SELF LEARNING

Using:
- System Dynamics in K-12 Education by Jay Forrester
- Road Maps by Jay Forrester
- Guided Study in System Dynamics by Jay Forrester
- Education for 21st Century by Jay Forrester
- STELLA by ISEE SYSTEM
HAIG DYNAMICS IN ITS FIRST YEAR - SETTING UP

Set-up tentative Milestones
- Staff Advisor
- Getting Club Approved
- Meeting Dates and Rooms
- Advertising
- Introduction Meeting
- Regular Meetings
  - Workshop
  - Interactive
<table>
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<tr>
<th>Activities</th>
<th>Timeline</th>
<th>Deliverables</th>
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<tbody>
<tr>
<td>Establish Haig Dynamics as an official club</td>
<td>September 8th to 23rd</td>
<td>• staff advisor identified</td>
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<td>• club approved by Student Activity Council (SAC)</td>
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<td>• meeting room/dates identified</td>
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<tr>
<td>Advertise Club</td>
<td>September 24th to October 5th</td>
<td>• kick off Haig Dynamics advertisement</td>
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<td>• announcements being played on Haig Radio</td>
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<td>• posters up in hallways</td>
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<td>Introduction Meetings</td>
<td>October 5th to 30th</td>
<td>• “General Meeting”</td>
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<td>• System Dynamics introduced (history, main aspects etc.)</td>
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<td>• tone set for Haig Dynamics</td>
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<td>• members emails, names, phone numbers acquired</td>
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<td>• meetings once every two weeks confirmed</td>
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<td>• important concepts taught i.e. using STELLA</td>
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<td>• examples of applications taught i.e. simulation models</td>
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<td>• System Dynamics usefulness in our daily lives (e.g. academic life) established</td>
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**Meetings will rotate from Interactive Meetings to Workshops**
| Meetings            | November 1\textsuperscript{st} to December 10\textsuperscript{th} | • System Dynamics’s application in:  
|                     |                                                              | Mathematics  
|                     |                                                              | Chemistry  
|                     |                                                              | Physics  
|                     |                                                              | • Workshop on the use of System Dynamics tools and their meaning to the successful academic life (i.e. good score in math, physics and chemistry) |
| Meetings...        | January to June                                               | • System Dynamics’s application in:  
| continued          |                                                              | Biology  
|                     |                                                              | History  
|                     |                                                              | Literature  
|                     |                                                              | Economics  
|                     |                                                              | Psychology  
|                     |                                                              | Philosophy  
|                     |                                                              | • Workshop on the use of System Dynamics tools and their meaning to the successful academic life (i.e. good score in biology, history, literature, economics, psychology, philosophy) |
KICK-OFF MEETING

- Introduce System Dynamics
- Layout of Future Meetings
- Introduce STELLA
- Benefits of System Dynamics
  - Math
  - Physics
  - Chemistry
  - Biology
  - Social Science etc.

- Math, science (physics, chemistry, and biology), literature and social sciences as a whole is more than (math + science + literature + social sciences)
- Making it easier for learners (e.g. Earl Haig students) to master the underlying concepts of math, science, literature and social sciences

WHAT: The kick-off meeting of Haig Dynamics

WHY: System Dynamics @ Earl Haig - a driver of success (e.g. academic success)

Haig Dynamics in brief:

Mandate: to contribute to Earl Haig students’ academic success using System Dynamics

Goal:
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- To provide Earl Haig students with System Dynamics tools to support a well-founded confidence for managing their lives (e.g. academic life) and the situations they encounter

WHEN: Monday, October 5th, 2009
8:30 PM
WHERE: Room 296

R.S.V.P.
Yannick Ngana
President
HAIG DYNAMICS
systemdynamics@earlhaig.ca

2009
HAIG DYNAMICS EXECUTIVE TEAM

- President .......... Yannick N.
- Head of Workshop Meetings for each of the following:
  - Mathematics/Physics....... Yannick N.
  - Chemistry.........................Carlos M.
  - Biology............................Taylor K.
  - Economics.........................Brandon L.
  - History/Literature..........Thomas C.

- Secretary for:....................Arthur Y.
  - Meeting Minutes
  - Attendance
FUNDRAISER

- Sold pizza slices for $2.00 to raise money in order:
  - To buy
    - STELLA v9.1.3 and move away from Trial version
    - Lessons in Mathematics: A Dynamic Approach
    - Introduction to Systems Thinking with STELLA
HAIG DYNAMICS IN ITS FIRST YEAR – SELECTED WORKSHOPS
Balloons Problem

- Started to Apply Dynamic Modelling

  Here’s a classic related rates problem for you:
  The situation is this: A balloon is released from the ground, about 150 meters away from a stationary observer. The balloon rises at a rate of, say, 50 m per second. How fast is the balloon receding from the observer, when it is roughly 300 meters away from the observer?

- Conducted experiments to learn more about this simple system
The Balloon Problem
A Simple Model of Related Rates

- Distance between observer and balloon
- Rate at which balloon recedes $\frac{ds}{dt}$
- Vertical velocity of balloon
- Height of Balloon
- Initial distance between balloon and observer
School Reform Model

- Discussed Factors Affecting
  - School Performance
  - Student Performance

- Anchor River Simulation

- Discussed Dynamic Model
  - Cause and Effect of each Action
  - How to Simulate the Ideal School
LESSONS IN MATHEMATICS: A DYNAMIC APPROACH

- Gave a model in which to teach
  - Physics
  - Math

- Students Fully Understood the use of System Dynamics in Learning
  - Linear Systems
  - Quadratic Systems
  - Exponential Systems
HAIG DYNAMICS: more than a Club at Earl Haig? MEETING WITH EARL HAIG PRINCIPAL

- Met With me (one on one)
  - Wanted to know the basics of System Dynamics
  - How can System Dynamics be incorporated into School System both Educational and Management?

- Very Interested in System Dynamics
  - Wants to know how it can be applied to the School System
  - Costs Involved
  - Equipment Needed

- Attended a Haig Dynamics Meeting
STUDENTS’ THOUGHTS

“System Dynamics has really helped with my performance in school. I used to study at subjects separately but now when studying I try to bridge it with other subjects, saving me time to do the things I enjoy doing.”

“System Dynamics has improved my overall understanding in different subject areas. I look at things now as interrelated and not separate.”
HAIG DYNAMICS IN ITS FIRST YEAR – OVERALL FEEDBACK

- Excellent Experimental Year
- Positive
  - Interactive/Workshop Meetings
  - Increasing Interest among students, teaching staff members and Senior School Administration

- Negative
  - Didn’t cover all subject areas
  - Limited System Dynamics resources
HAIG DYNAMICS IN ITS SECOND YEAR @ EARL HAIG SECONDARY SCHOOL (2010/11)

- Improve my Teaching style based on the first year experience
- Organize a Conference on System Dynamics in Education at Earl Haig and invite a well-known System Dynamicist.
- Prepare succession plan as this will be my last year at Earl Haig Secondary School, through:
  - Involvement of more Departments
  - Involvement of more junior students (grade 9 and 10).
  - Partnership with Student Leadership Council.
THANK YOU
ANY QUESTIONS?