Development of automated school timetabling in Hong Kong

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Agenda

❖ Steps of school timetabling process

❖ Status of automated timetabling for secondary schools in Hong Kong (with data collected from two surveys)

 ➢ October 1995 (Kwok et. al., 1997)

 ➢ March 1999 (unpublished)

❖ Desirable features of a timetabling system

❖ Timetabling systems used in Hong Kong

❖ Education Department's initiative in school timetabling

School timetabling process (1/2)

❖ Timetable planning (usually prepared by a senior staff member)

  ➢ Identify resources, i.e., teachers, rooms, and classes, needed for conducting a lesson

  ➢ Identify any resource constraints, e.g., resources availability

  ➢ Identify other timetabling constraints/preferences, e.g., no Physical Education lessons immediately after lunch

  ➢ Prepare teaching duties assignment

School timetabling process (2/2)

- ❖ Timetable scheduling (usually prepared by a group of staff members led by a senior staff member)
  - ➢ Assign all lessons to the school master timetable such that all constraints and as many preferences as possible are satisfied
  - ➢ Even when computers are used to aid the process, manual effort is usually unavoidable
  - ➢ Not unusual to take more than 100 man hours to complete according to some survey results

Birth of TESS

❖ In the second half of 1995, Education Department launched its first automated school timetabling system called TESS as a part of SAMS

  ➢ TESS was spawned from a M.Phil. research project conducted in 1992

  ➢ TESS was designed as a decision support system for timetabling experts use rather than a fully automated school timetabling system

Survey on timetabling in HK secondary schools by Kwok, et. al.

❖ Conducted by Kwok, Kong and Kam in October 1995

❖ Aimed to understand the timetabling problems

❖ 480 questionnaires sent out and 173 were completed and returned

❖ 163 of the respondents are grammar schools

Major findings of the survey conducted by Kwok, et. al. (1/4)

❖ Problem size
  ➢ Number of teachers in a school
    ● Mean is 52.53 and mode is 55
  ➢ Numbers of classrooms and special rooms
    ● Number of classrooms: mean is 25.46
    ● Number of special rooms: mean is 12.96
  ➢ Number of classes
    ● Mean is 28.81 and mode is 30
  ➢ Number of timeslots in a teaching cycle
    ● Mean is 46.96

Major findings of the survey conducted by Kwok, et. al. (2/4)

❖ Problem complexity
  ➢ Number of split lessons
    ● Mean is 229.43, i.e., about 4.9 per timeslot
    ☞ A split lesson needs at least 2 rooms and 2 teachers
  ➢ Existence of 2-period and 3-period lessons

Major findings of the survey conducted by Kwok, et. al. (3/4)

- ❖ Timetabling efforts
  - ➢ Average number of hours per school to complete the task was 160.5 hours or about 20 days
- ❖ Degree of automation
  - ➢ Manual timetabling: ~22%
  - ➢ Computerized timetabling
    - Conflict checking only (manual scheduling): ~35%
    - Automated generation followed by manual completion: ~35%
    - Fully automated: ~9%
  - ☞ **About 57% schools generated their timetables manually**

Major findings of the survey conducted by Kwok, et. al. (4/4)

- ❖ Among schools that generated timetables with the aid of computers
  - ➢ Mean completion rate: ~67%
    - On average, about 450 periods of lessons left to be handled manually
  - ➢ Source of timetabling system:
    - Purchased from the market: 66%
    - Self-developed systems: 14%
    - TESS (just launched then): 14%
    - Tailor-made package: 6%

Survey on timetabling in HK secondary schools by Kwan (1/2)

❖ Conducted by Kwan in March 1999

❖ Aimed to study

  ➢ School timetabling requirements and whether they were supported by timetabling systems available at that time

  ➢ Whether automated timetabling

    • Had received more attention since the survey conducted by Kwok et. al.

    • Had helped school reduce timetabling effort

Survey on timetabling in HK secondary schools by Kwan (2/2)

❖ 311 questionnaires sent out and 120 were completed and returned

❖ 163 of the respondents are grammar schools

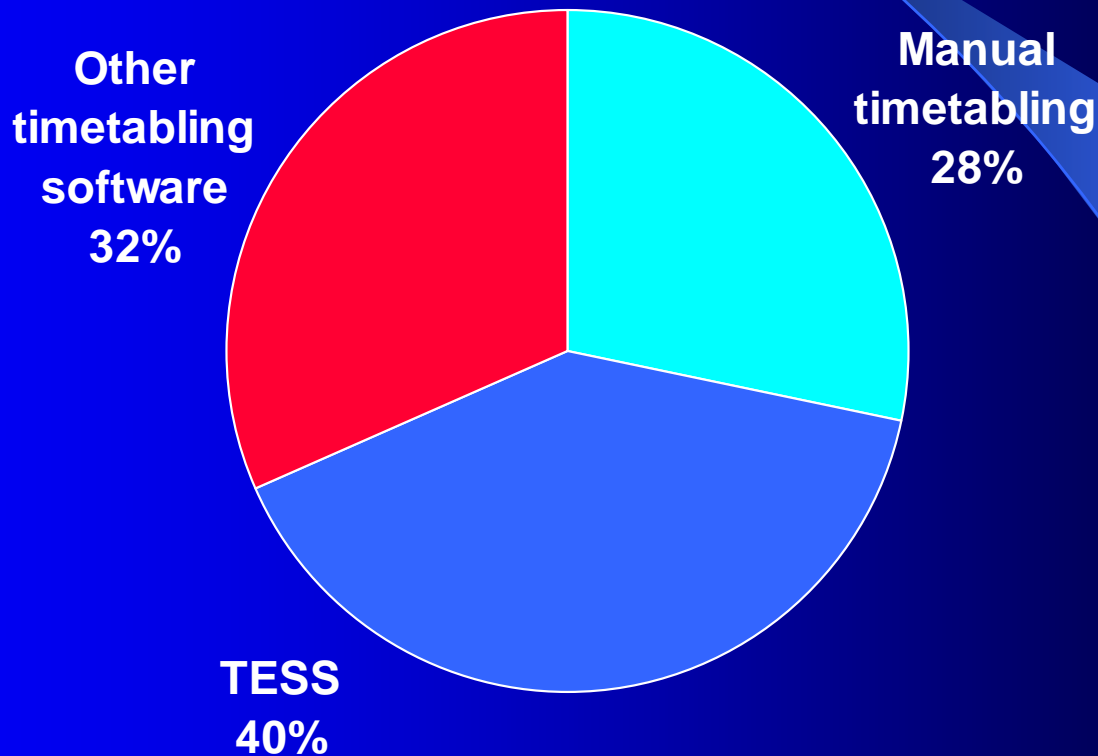# Major findings of the survey conducted by Kwan (1/4)

❖ Problem size

  ➤ Results were in line with the survey results conducted by Kwok et. al.

❖ Problem complexity

  ➤ 70% of the schools has floating classes

  ➤ 78% of the schools may need to go to other classes' homerooms for lessons due to floating classes and split lessons

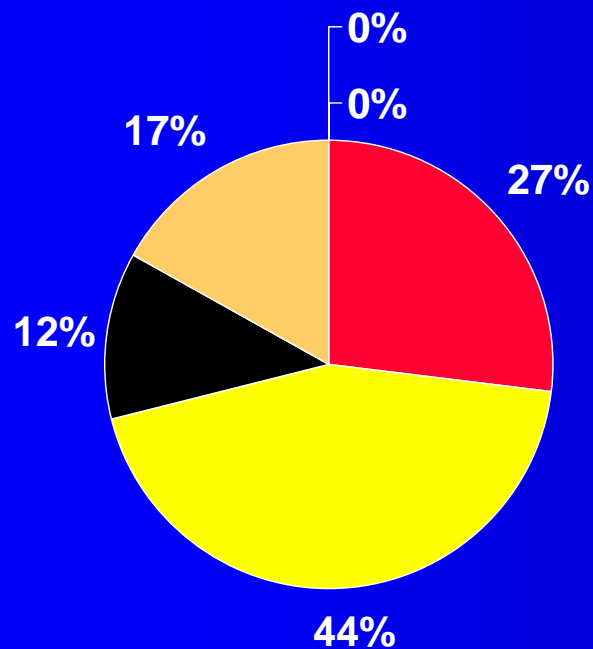 ➤ Complicated timetabling requirements were involved (and we will see some of them later on)

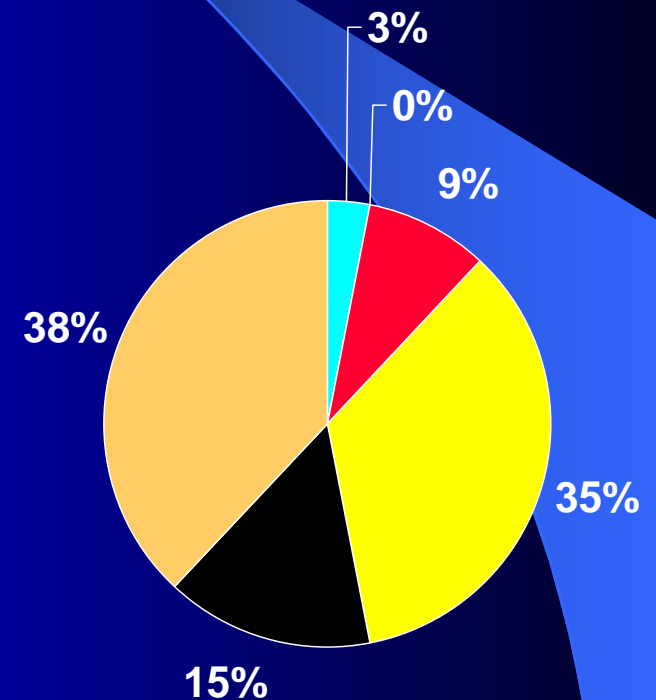# Major findings of the survey conducted by Kwan (2/4)

Means of timetabling

Other timetabling software 32%

Manual timetabling 28%

TESS 40%

Major findings of the survey conducted by Kwan (3/4)

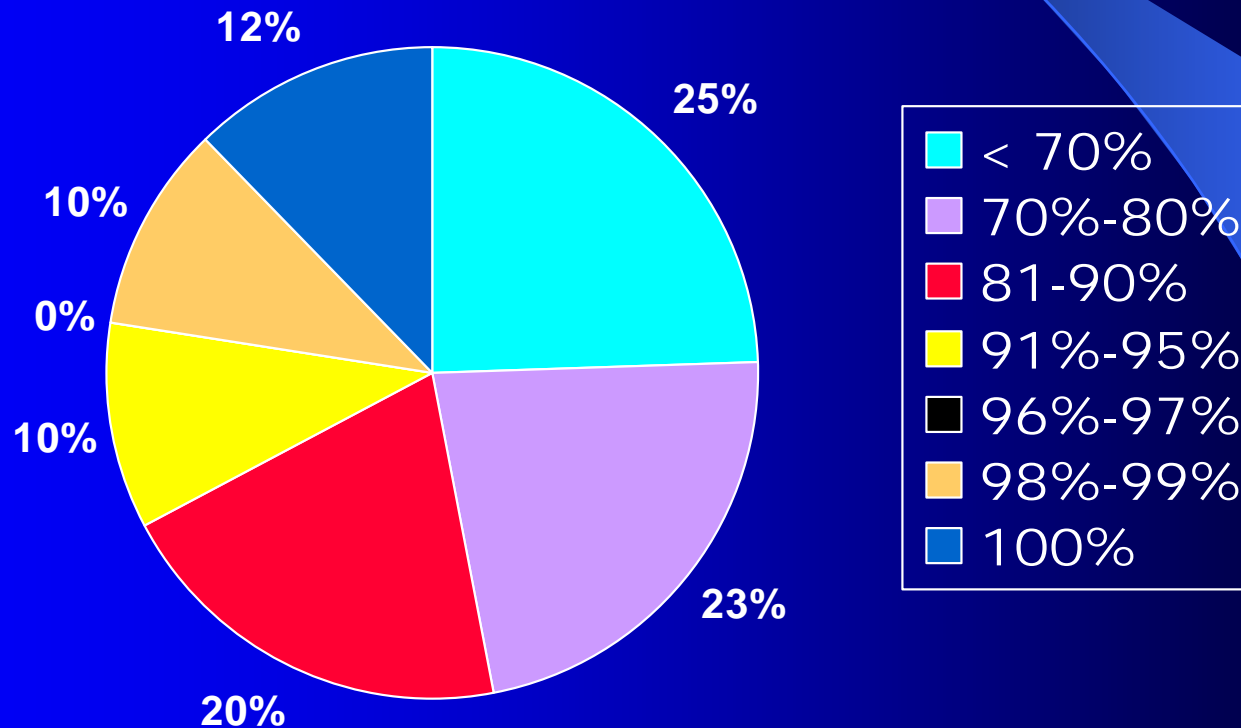**Man-days needed to complete timetabling tasks with TESS**

Man-days needed to complete the timetabling tasks manually

Legend:
- ☐ < 1 man-day
- ☐ 1-2 man-days
- ☐ 3-5 man-days
- ☐ 6-10 man-days
- ☐ 11-15 man-days
- ☐ >15 man-days

Major findings of the survey conducted by Kwan (3/4)

Timetable completion rate achieved by TESS (48 schools)

Legend:
- < 70%
- 70%-80%
- 81-90%
- 91%-95%
- 96%-97%
- 98%-99%
- 100%

Pie chart values: 12%, 25%, 23%, 20%, 10%, 0%, 10%

Desirable features of a timetabling system (1/10)

❖ Timetable structure requirements

➢ Number of days in a teaching cycle can be adjusted

➢ Number of teaching periods in each day can be adjusted (so as to support the notion of *special day*)

➢ Breaks may be introduced between blocks of successive teaching periods in a day

➢ A break is said to be *soft* if it allows a multi-period lesson scheduled across it; otherwise, it is *hard*

  ● Recesses may be classified as soft breaks whereas lunch sessions may be classified as hard breaks

Desirable features of a timetabling system (2/10)

❖ Teacher related requirements

➢ A teacher may not be available at all periods

➢ Each teacher has a maximum number of periods of lessons that s/he can teach for each day

Desirable features of a timetabling system (3/10)

❖ Room (or teaching venue) related requirements

  ➢ A room may not be available at all periods

  ➢ Each room can be assigned with a capacity that indicates the number of classes that can be accommodated in the room, e.g., a playground may be allowed to accommodate two classes of students to have physical education lessons simultaneously

  ➢ Each teaching venue is assigned a priority for accommodating a floating class

  ➢ Each teaching venue is associated with an area zone to order to support *location reasoning*

Desirable features of a timetabling system (4/10)

❖ Class related requirements

  ➢ A class may not be available at all periods

  ➢ A class may be of floating or non-floating type

  ➢ Each class must be associated with one or more class teachers

Desirable features of a timetabling system (5/10)

❖ Location reasoning requirement

➢ Successive lessons of a floating class should be allocated teaching venues that are of closest proximity to one another, e.g., within the same zone

Desirable features of a timetabling system (6/10)

- ❖ Subject related requirements
  - ➤ Certain subject must not be taught in some periods, e.g., physical education lessons must not be held in the period immediately after lunch session
  - ➤ Certain subject lessons are to be held at special teaching venues
  - ➤ For some classes, some subjects must not be held in the same day and we call such a group of subjects *exclusive subject group*, e.g., English dictation and Chinese dictation should not be held at the same day

Desirable features of a timetabling system (7/10)

❖ Subject related requirements (continued)

➢ Notion of subject needs to be defined at class level

● For example, Class 4A's PE and 4B's PE need to be defined as different subjects because students of 4A may need to take a public examination on PE whereas students of 4B may take PE as a non-examinable subject only

➢ For each subject, a class may take one lesson of arbitrary length or up to two single-period lessons in any single day

Desirable features of a timetabling system (8/10)

❖ Lesson related requirements

➢ A lesson may be held at two different teaching venues in alternate week/cycles

➢ Two or more subjects may be taught in alternate teaching cycles

➢ Some lessons need split class and split subject support, e.g., two classes may be split into three groups, with each group taking a different subject taught by separate teachers at three venues

Desirable features of a timetabling system (9/10)

❖ Lesson related requirements (continued)

➢ Co-teaching in some lessons is needed

➢ Some subject lesson may only be suitable to be held at certain periods. For example, one period of English lessons may be allocated for watching Education TV programme. Due to the restriction of the broadcast time, the specified lesson can only be held at certain feasible periods. Note that other English lessons do not share the same restriction.

Desirable features of a timetabling system (10/10)

- ❖ Other requirements
  - ➢ Multi-period lessons must not be scheduled across a break unless otherwise specified
  - ➢ Lessons of a subject should be scheduled evenly in each class timetable

Other timetabling systems (1/3)

❖ Titus

  ➢ A DOS-based system (introduced in late 80s?) which seems to be no longer available on the market

❖ APT

  ➢ Introduced in 2000 as a locally developed web-based application written in Java

  ➢ Reasonable performance in automated timetable generation but lack of tools to aid manual timetable tuning

  ➢ No long available on the market

Other timetabling systems (2/3)

- ❖ A timetabling system developed by Lau at Ju Ching Chu Secondary School (Tuen Mun)
  - ➢ Started as a M.Sc. Project at Hong Kong Polytechnic University
  - ➢ Has a web interface for data capture
  - ➢ Timetabling engine was written in FoxPro
  - ➢ Has offered timetabling service at a nominal cost to schools for the past few years

Other timetabling systems (3/3)

❖ iTimetable21

  ➢ Launched as timetabling service instead of timetabling software in July 2001

  ➢ A Chinese version of an overseas developed Windows based timetabling software called **aSc Timetables**

☞None of the above systems can cater for all the timetabling requirements mentioned earlier

Education Department's initiative in school timetabling

❖ Education Department will launch a new school administration system called Web-SAMS next year

❖ TESS will be replaced by a new timetabling module

❖ Unlike TESS, the new module will be a fully automated timetabling system and is designed for average users instead of timetabling experts

❖ TESS will still be supported by Education Department