ORTHOGONAL TRANSFORMATIONS WITH DERIVE:

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Milestones: Competences

- Generic competences
- Specific competences

Meta-Competence

- Engineering meta-competence
- Mathematics in Engineering

Generic Competences

- Self-learning
- Critical thinking
- Teamwork
- Problem solving
- Use of technology

Specific Competences

- The use of Linear Algebra concepts to solve Engineering problems.

The experience

- Use of technology for enhancing some Linear Algebra concepts.

The topic

- Orthogonal transformations (rotations and reflections) in the plane and space
- Prerequisites: Eigenvalues and eigenvectors
- Formal lectures for introducing the contents, like other Linear Algebra topics
- No special time devoted to DERIVE files

Learning Goals

- Self-learning. (There is no specific lectures)
- To enhance the apprenticeship
- Autonomous work

Description of the experience

- Tutorials are provided

- Optional work
- Students (working in group of 2-3 people) solve the proposed problems
- A survey is proposed for evaluation purposes

Tutorials and exercises

- 5 tutorials: 2 rotations and 3 reflections (in the plane and in the space)
- Around 20 exercises (approximately 4 exercises in each tutorial)

Results

- 12 groups (around 30 people)
- Good marks (the best students of the classroom)

Satisfaction Survey

Average of results

1= NO, 2=POOR, 3= QUITE 4= VERY MUCH

ITEMS	D1: Rot2	D2: Ref2	D3: Rot3	D4: Ref1-3	D5: Rfe23
Easy to work with the files	3.7	3.7	3.3	3.5	3.4
Useful of defined functions	3.9	3.9	3.7	3.9	3.8
Useful for understanding concepts	3.6	3.5	3.3	3.2	3.4
The exercises are affordable	3.5	3.4	2.8	3	3.2
Useful for solving problems	3.6	3.6	3.2	3.5	3.5
Suitable for exams	3.1	3.2	3.1	3.1	3.2
Improving the competence Self-learning	3.3	3.5	3.6	3.5	3.5
Improving the competence Teamwork	3.6	3.6	3.5	3.5	3.6

2. The competition

- A work is proposed (addressed to best students)
- Topic: Problems or phenomena related with orthogonal transformations.
- Prize: Participation in ACA.

- The winner work

Optimal and automatic process for container unloading

ABSTRACT

Design and implement a tool to automatically unload a container ship.

The program will be based on the routine of a crane whose movements will be defined thanks to the orthogonal transformations with Derive.

The key goal wil be the the reduction of distance thanks to a rational patterns

GOALS

- Reduce time through an autonomous process
- Suppress human intervention
- Improve security; both personal and maritime

STAGES

- Define the ship and the storage area

- Create the automatic movements for the crane

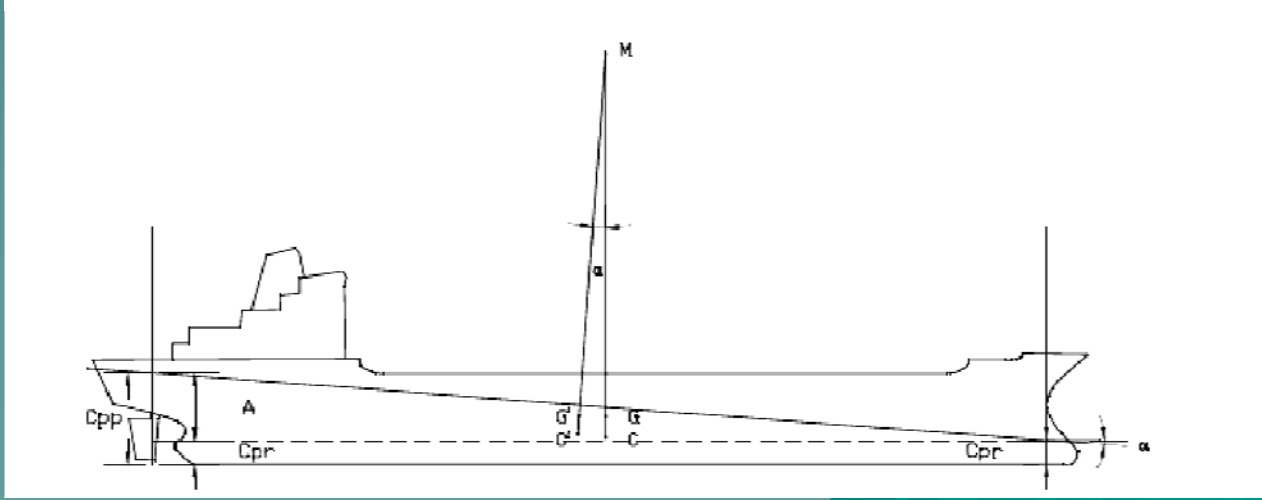
- Optimize the unloading proccess

STABILITY

Affected by the change in the centre of mass during the unloading proccess.

The angle of heel is related to the centre of mass and the metacentric height.

$$TAN(\alpha) = GG' / MG$$



Stage 1: Ship & Storage area

The containers and its precise location are defined using matrices.

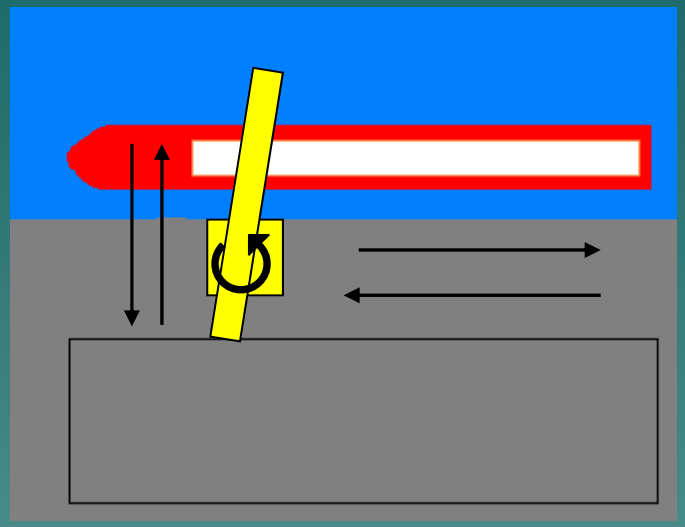
Nº of containers in each position

3	2	1	1	2	3
3	3	2	2	3	3
2	3	3	3	3	2

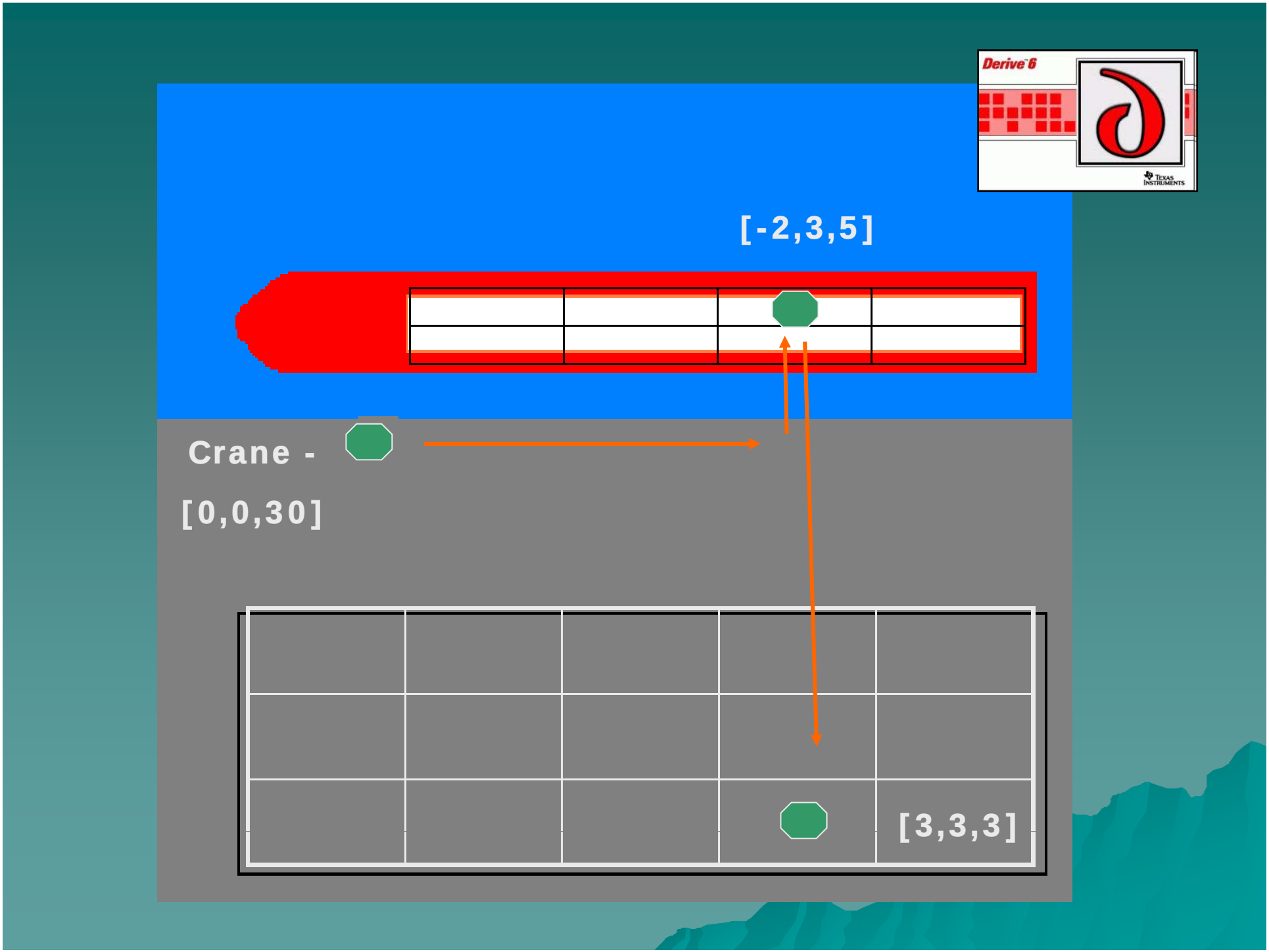
Stage 2: Crane

- Goal: Unload container without human intervention
- Proccess applied with orthogonal transformations through the affine space.
- Movements: reflections, rotations and translations.

Crane movements



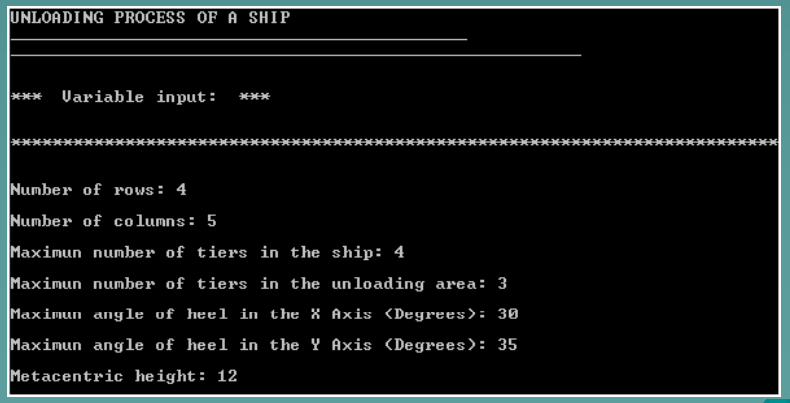
- Adjust X & Y axis: Reflection matrices
- Adjust angle: Rotation matrices
- Lift container: Translation matrices


Derive 6
Texas Instruments
[-2,3,5]
Crane -
[0,0,30]
[3,3,3]

Stage 3: Unloading proccess

C+ program based on:

- Movements of the crane
- Stability of the ship
- Patterns of unloading

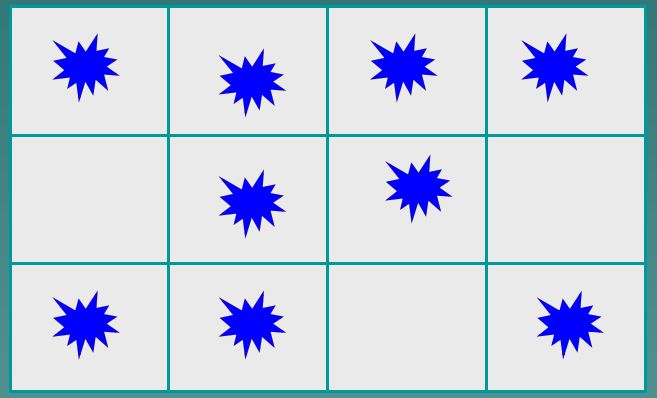


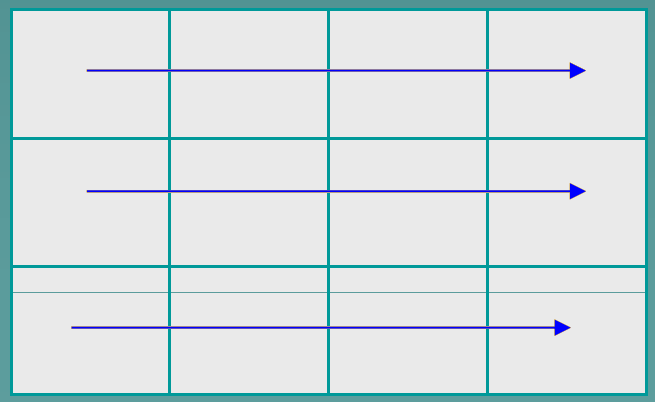
The unloading proccess is calculated following three patterns taking into account the stability of the ship:

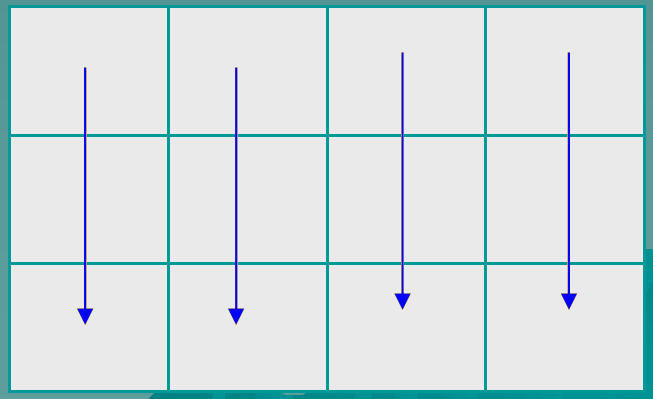
Random

Columns

Rows







RESULTS

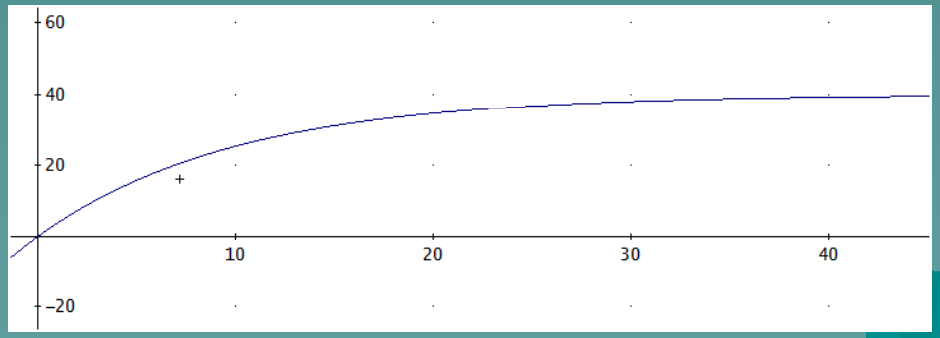
The results obtained after running the program with different ships with and a differnt amount of cargo is the following:

- Size of the ship: <3x3 – No significant improvement

- Size of the ship: >3x3 - Reduction of distance with columns pattern up to 40%

Difference between the rows and columns pattern

(%)



Size of the ship

IMPROVEMENTS

- Uniformity between the parts intervening in the proccess.
- Save time and as a consequence money.

  (Up to 40%)
- Guarantee the security at all time.
- Link the proccess to rational concepts rather than to human decissions.

Conclusions

- Good “feeling” for students
- Useful material
- The same method for other topics.

THANK YOU