POINT NORMAL TRIANGLES

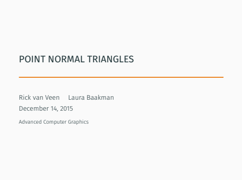
Rick van Veen   Laura Baakman

December 14, 2015

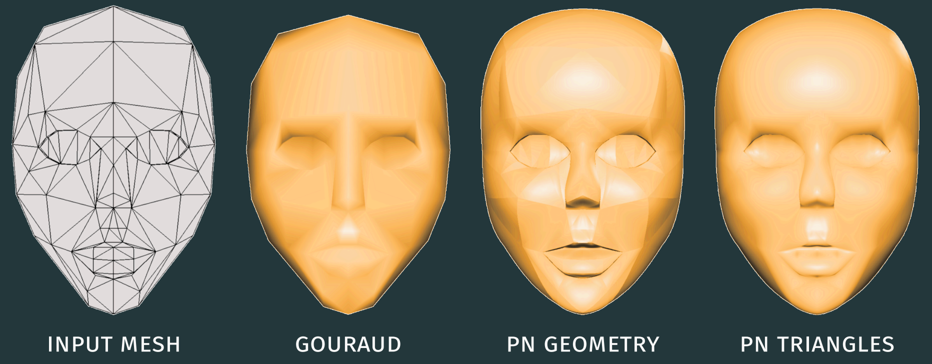
Advanced Computer Graphics

2015-12-09

Point Normal triangles

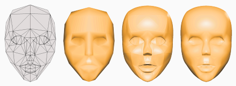


[Rick] Welcome everybody. Tell people that PN means Point Normal triangles.



2015-12-09

Point Normal triangles



[Name] Why PN triangles? Look at the nice result it gives :-) and we will see that it easy to extend it to the 'existing' pipeline.

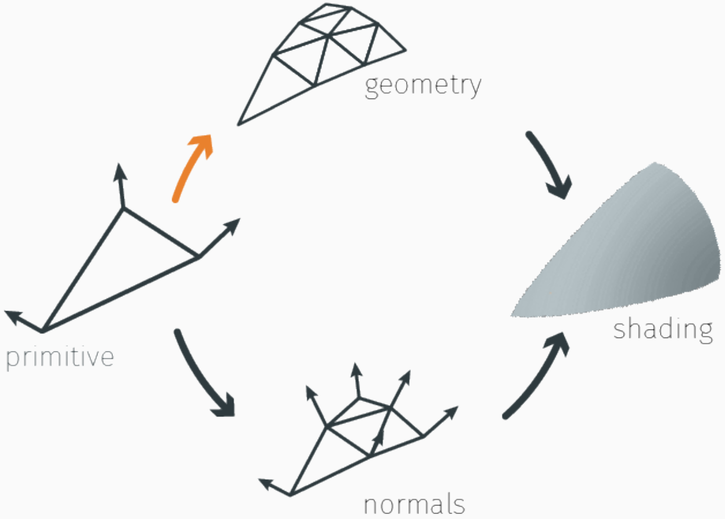
SINGLE PN TRIANGLE

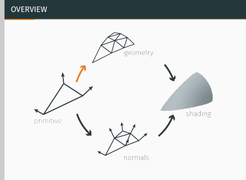
SINGLE PN TRIANGLE

[Name] How does one construct a single PN triangle?

Overview on the next slide

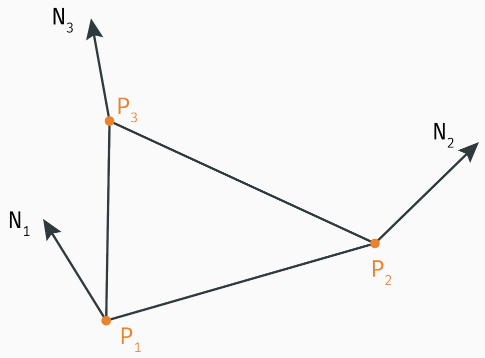
OVERVIEW



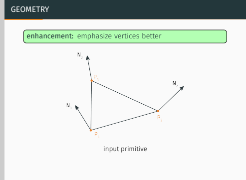


[Name] Why PN triangles? Look at the nice result it gives :-) and we will see that it easy to extend it to the 'existing' pipeline. Story about Bezier patches...

enhancement: emphasize vertices better



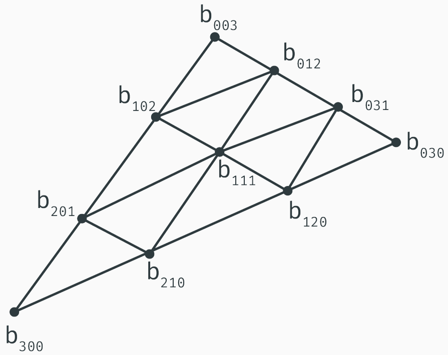
input primitive



[Name] This a standard triangle primitive, defined by its vertices and normals.

Focus on getting the different control primitives.

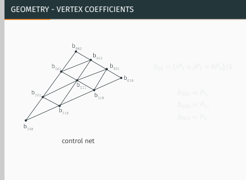
GEOMETRY - VERTEX COEFFICIENTS



control net

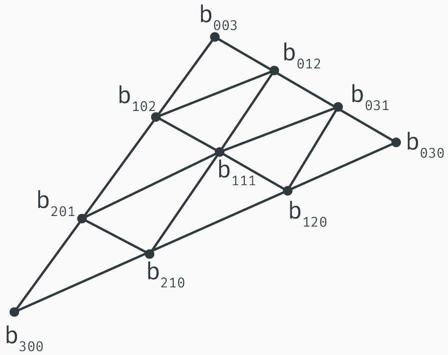
$$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$$

$$b_{300} = P_1,$$
$$b_{030} = P_2,$$
$$b_{003} = P_3$$



[Name] These are all the initial control point. Evenly divided on the triangle. -> formula

GEOMETRY - VERTEX COEFFICIENTS



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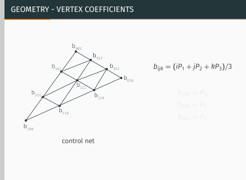
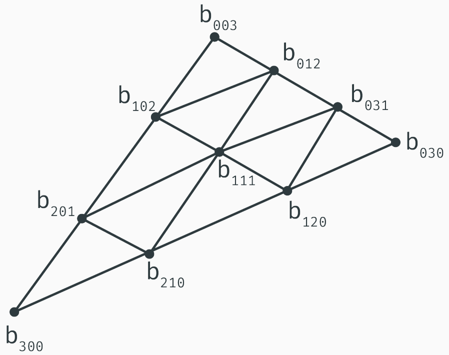


[Name] Nice formula

GEOMETRY - VERTEX COEFFICIENTS



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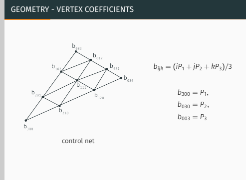
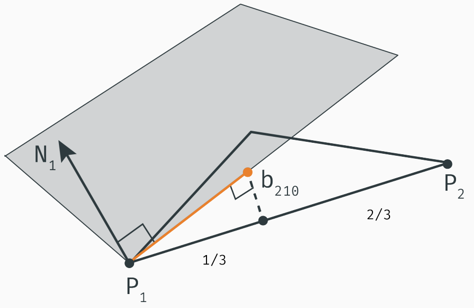


[Name] Stress that the vertex coefficients/control points are the one on the original vertices and that they do not move.



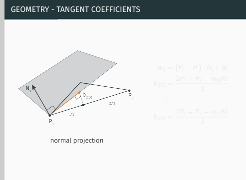
normal projection

$$w_{ij} = (P_j - P_i) \cdot N_i \in \mathbb{R}$$

$$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$$

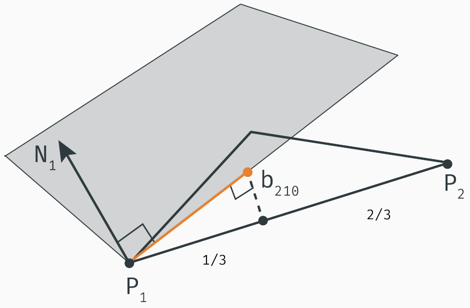
$$\vdots$$

$$b_{201} = \frac{2P_1 + P_3 - w_{13}N1}{3}$$



[Name] How to get the tangent coefficient (the ones on the edge but now curvy)

GEOMETRY - TANGENT COEFFICIENTS



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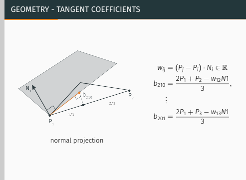
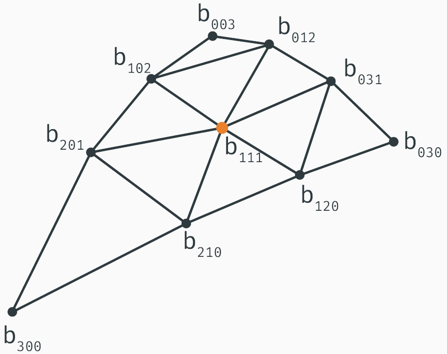


[Name] Projection of the initial control points on the normal plane of a vertex.

GEOMETRY - CENTER COEFFICIENT

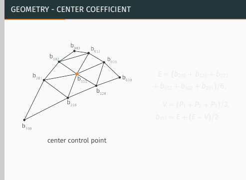


$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

$$V = (P_1 + P_2 + P_3)/3,$$

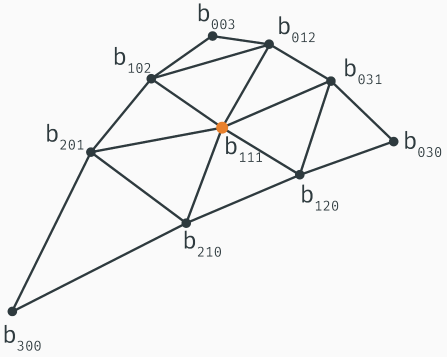
$$b_{111} = E + (E - V)/2$$

center control point



[Name] Note that this is the result of the previous step -> now only center coefficient is left.

GEOMETRY - CENTER COEFFICIENT



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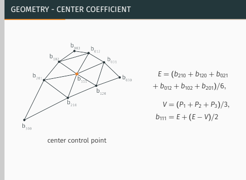
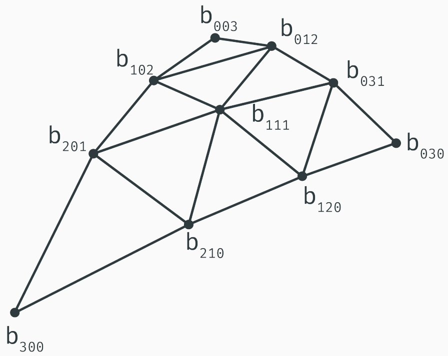
center control point



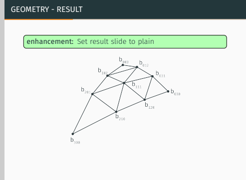
[Name] Average of the tangent coefficients plus half the difference between the tangent and vertex coefficients. -> why?

enhancement: Set result slide to plain



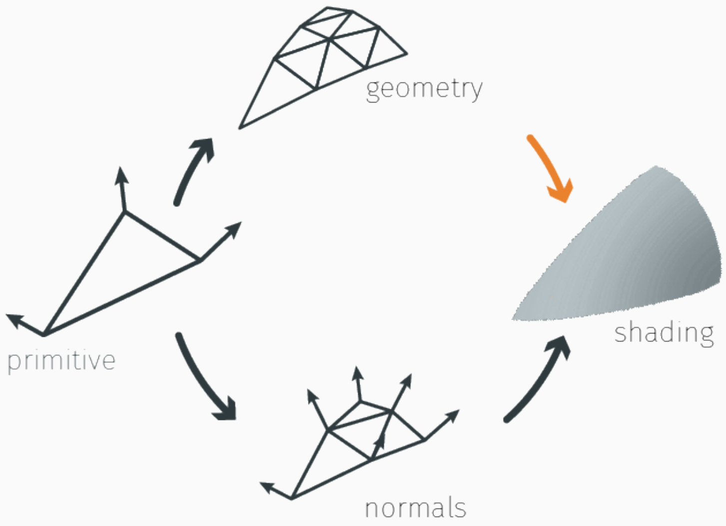
2015-12-09

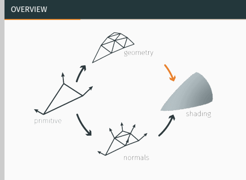
Point Normal triangles
└─Single PN Triangle
└─Geometry - Result



[Name] Results

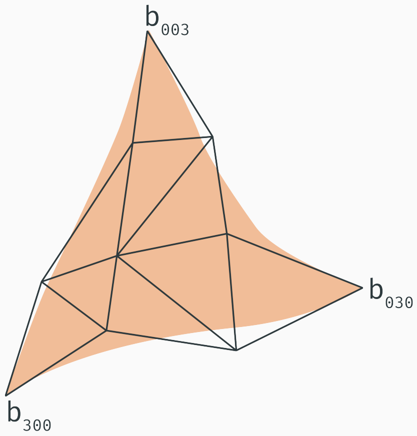
OVERVIEW



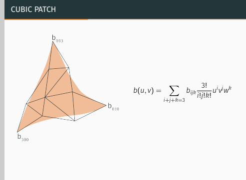


[Name] Overview -> how to get from this to shading.
Sample/subdivide with formula on following slide.

CUBIC PATCH

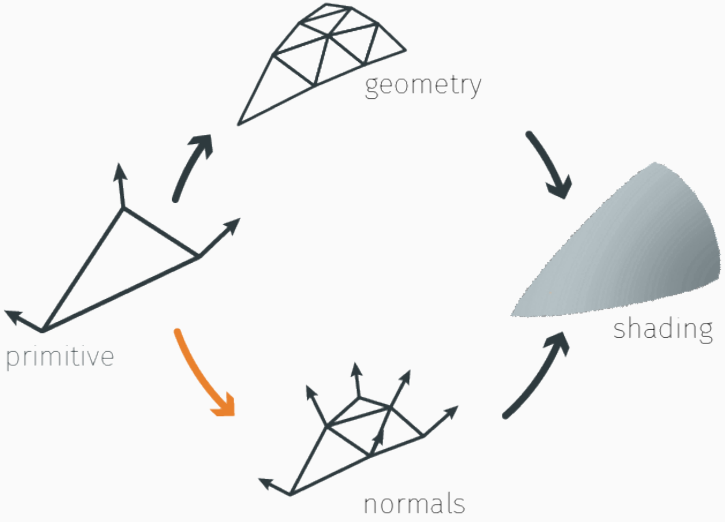


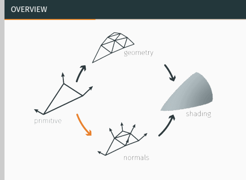
$$b(u,v) = \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k$$



u, v, w are a convex combination**[Name]** Very nice formula with a nice picture.

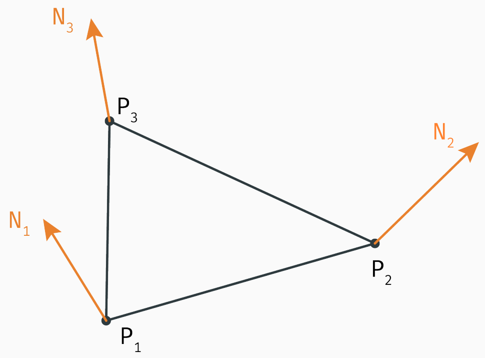
OVERVIEW

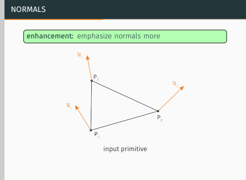




[Name] From the primitive normals the the PN triangle normals

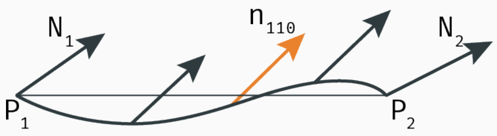
enhancement: emphasize normals more





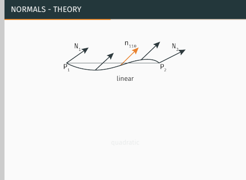
[Name] Recap input primitive and with emphasis on the normals.

NORMALS - THEORY



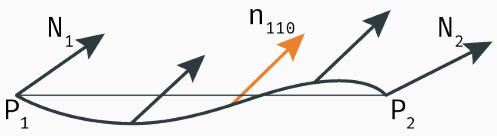
linear

quadratic

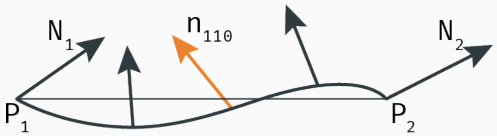


[Name] Stress that there is a need to capture the cubic bezier curve (inflection points) and that this cannot be

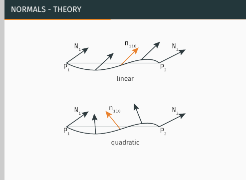
NORMALS - THEORY



linear

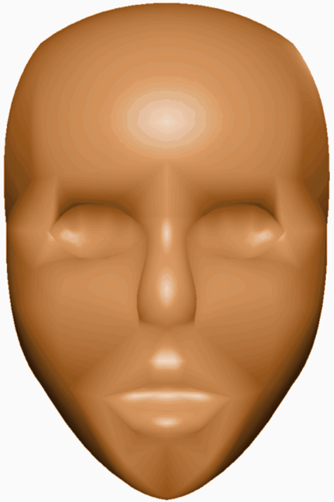


quadratic



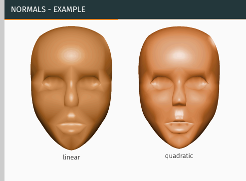
[Name] Quadratic does capture inflection points. Trade off between performance and result (maybe?)

NORMALS - EXAMPLE



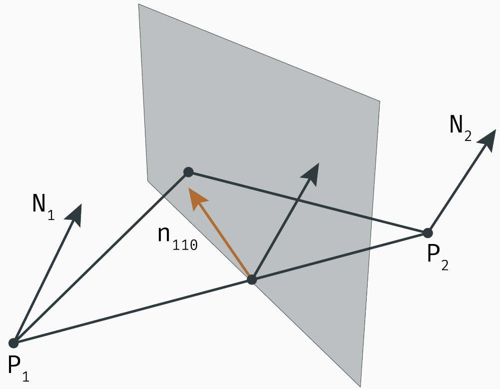
linear

quadratic



[Name] Look how pretty.

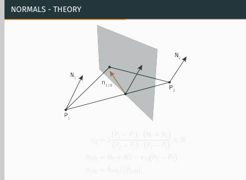
NORMALS - THEORY



$$v_{ij} = 2\frac{(P_j - P_i)\cdot(N_i + N_j)}{(P_j - P_i)\cdot(P_j - P_i)} \in \mathbb{R}$$

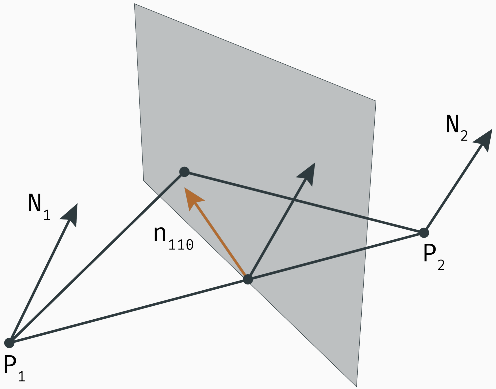
$$h_{110} = N_1 + N2 - v_{12}(P_2 - P_1)$$

$$n_{110} = h_{110}/||h_{110}||$$



[Name] Formula in words: reflect the averaged normal (average of N1 and N2) on the plane orthogonal/perpendicular the the edge at the mid point.

NORMALS - THEORY



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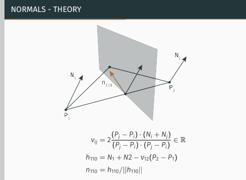

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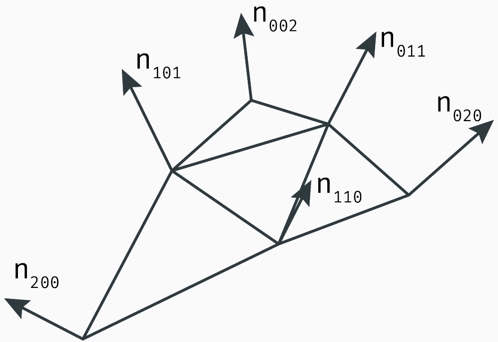
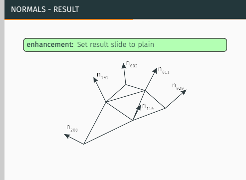
NORMALS - RESULT

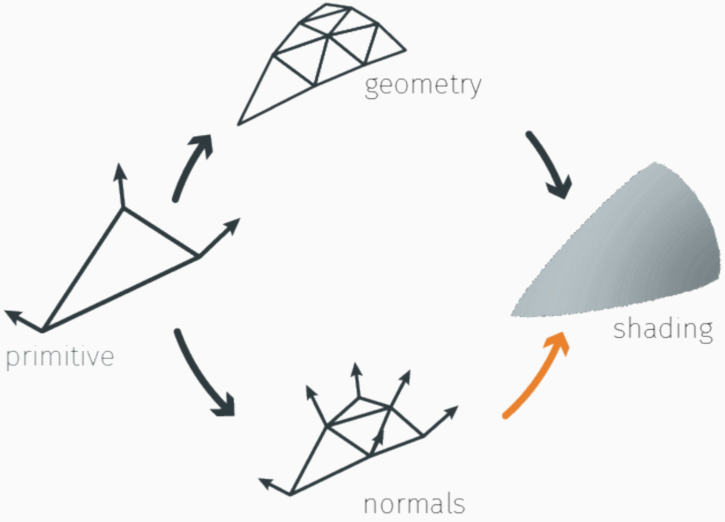
enhancement: Set result slide to plain

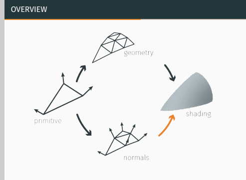




[Name] Result

OVERVIEW





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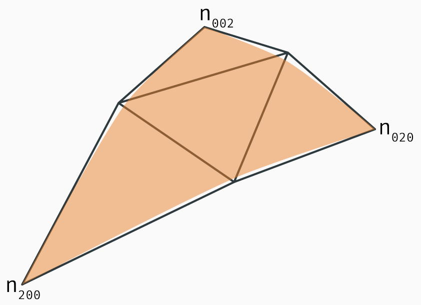
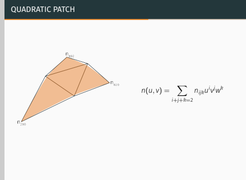
QUADRATIC PATCH

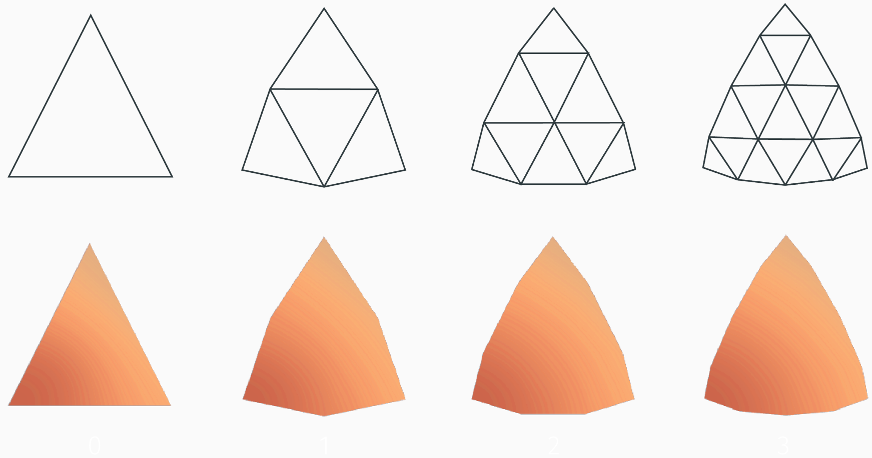


$$n(u,v) = \sum_{i+j+k=2} n_{ijk} u^i v^j w^k$$

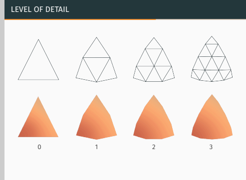


u, v and w are an convex combination

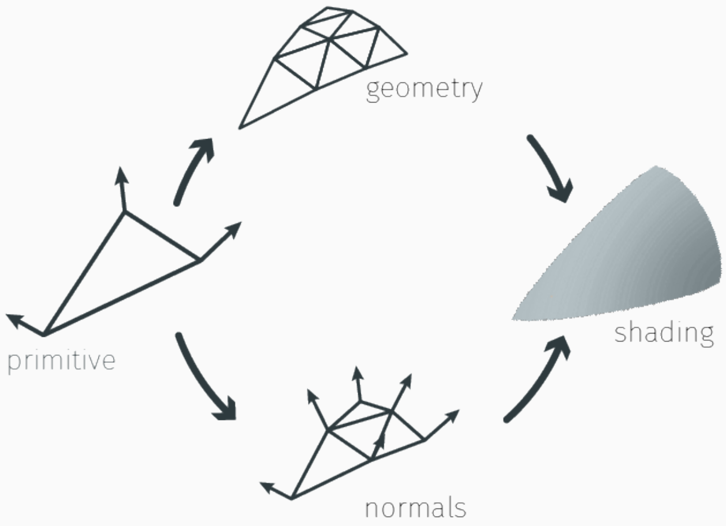
LEVEL OF DETAIL

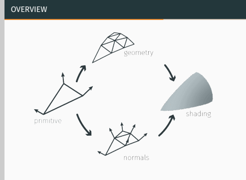


Point Normal triangles
└─Single PN Triangle
└─Level Of Detail



OVERVIEW





A TRIANGLE MESH

A TRIANGLE MESH

PROPERTIES

"PN triangles should not deviate too much from the original triangle to preserve the shape and avoid interference with other curved triangles." [1]

[1] Vlachos et al.

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CONTINUITY

PN triangles have:[2]

- C^1 continuity in the vertex points
- C^0 continuity everywhere else

[2] Jiao and Alexander

CONTINUITY

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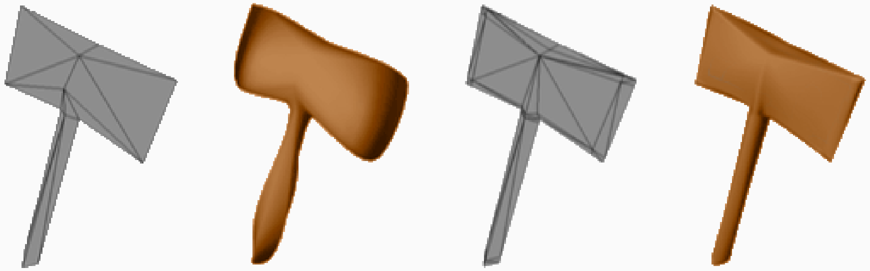
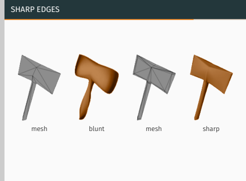
- C^0 continuity everywhere else

[2] Jiao and Alexander

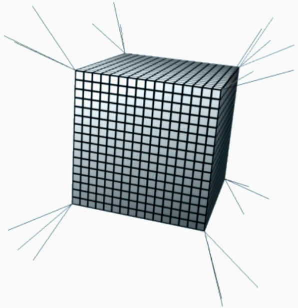
SHARP EDGES



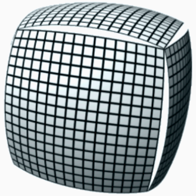
mesh blunt mesh sharp



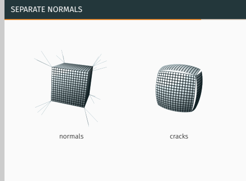
SEPARATE NORMALS



normals



cracks



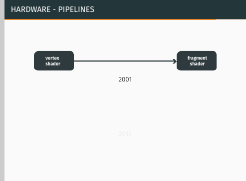
GRAPHICS PIPELINE

GRAPHICS PIPELINE

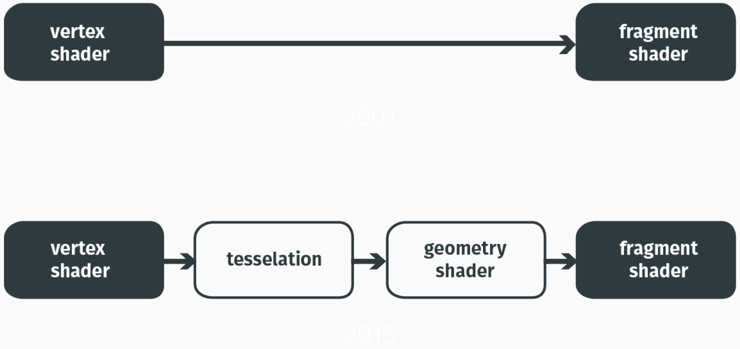
HARDWARE - PIPELINES

2001

2015



HARDWARE - PIPELINES



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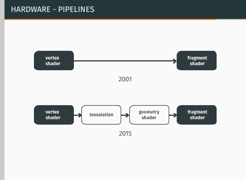
Point Normal triangles
└─Graphics Pipeline
└─Hardware - Pipelines



CONCLUSION

Point Normal triangles

└─Conclusion

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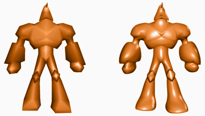
CONCLUSION

CONCLUSION

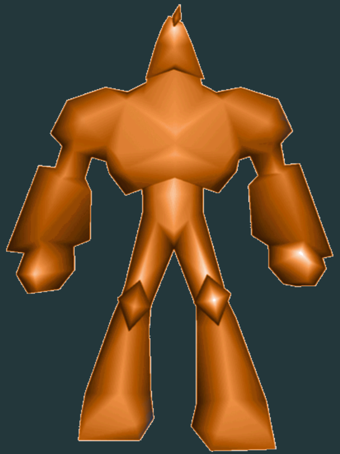
Some conclusion?

CONCLUSION

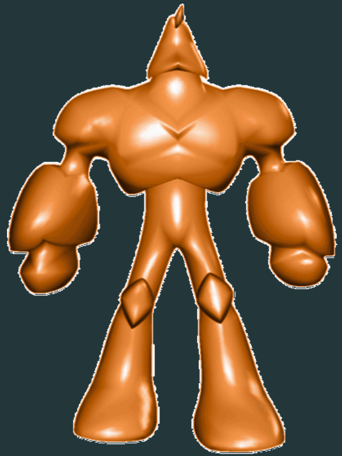
Some conclusion?



QUESTIONS?



TRIANGLES



PN TRIANGLES

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