

One Dimensional Analysis Program for Scramjet and Ramjet Flowpaths

Kathleen Tran

**Thesis submitted to the faculty of the Virginia Polytechnic Institute and State
University in partial fulfillment of the requirements for the degree of**

Master of Science
In
Mechanical Engineering

**Walter F. O'Brien, Chair
Joseph A. Schetz
Mark R. Paul**

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Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Kathleen Tran

Description of item under review for fair use: Figure 1 1: Photograph from the 1st ramjet flight (Heiser 1994)

Report generated on: 01-25-2011 at : 12:13:59

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Virginia Tech ETD Fair Use Analysis Results

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Name: Kathleen Tran

Description of item under review for fair use: Figure 1 3: X-43 Captive and Carry (Kazmar 2005)

Report generated on: 01-25-2011 at : 12:18:44

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Virginia Tech ETD Fair Use Analysis Results

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Name: Kathleen Tran

Description of item under review for fair use: Figure 1-4: Artist Rendering of the X-51 (Warwick 2010)

Report generated on: 01-25-2011 at : 12:25:09

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *against fair use*

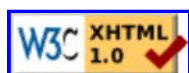
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 1 5: Schematic of a Ramjet Engine (Bonanos 2005)

Report generated on: 01-25-2011 at : 12:21:33

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

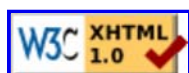
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 1 7: RJPA Schematic (Pandolfini 1992)

Report generated on: 01-25-2011 at : 12:22:20

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

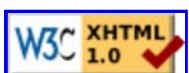
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 1-8: University of Maryland Code Validation (O'Brien T, 2001)

Report generated on: 01-25-2011 at : 12:23:03

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 1-9: University of Adelaide Code Validation with UVA Tunnel Results (Birzer 2009)

Report generated on: 01-25-2011 at : 12:23:54

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 2-2: Scramjet Inlet Efficiency from Van Wie (Van Wie 2001)

Report generated on: 01-25-2011 at : 12:26:09

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

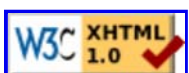
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 2-10: CARS results for Mean Temperature, Oxygen and Nitrogen Mole Fraction Taken From O'Byrne 2007

Report generated on: 01-25-2011 at : 12:27:00

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 4 1: General Trend of Ideal Nozzle Expansion (Bowcutt 2007)

Report generated on: 01-25-2011 at : 12:29:19

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

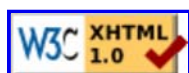
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Kathleen Tran

Description of item under review for fair use: Figure 4 3: Theoretical ISP for Various Systems (Moses 2003)

Report generated on: 01-25-2011 at : 12:30:09

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

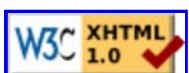
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-1: SCCREAM Combustor Geometry (Bradford 2001)

Report generated on: 01-25-2011 at : 12:30:50

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

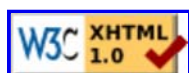
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-2: Bradford Comparison of SCCREAM and SRGULL (Bradford 2001)

Report generated on: 01-25-2011 at : 12:31:21

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-4: ISP vs Mach number as Predicted by SSCREAM, RJPA (Bradford 2001), and VTMODEL

Report generated on: 01-25-2011 at : 12:32:03

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-5: Air Specific Impulse from RJPA (Bonanos 2005)

Report generated on: 01-25-2011 at : 12:32:48

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

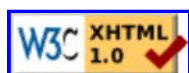
Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-6: Air Specific Impulse from RJPA at Various Total Temperatures (Bonanos 2005)

Report generated on: 01-25-2011 at : 12:33:29

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-7: Air Specific Impulse Predicted by VTMODEL Overlay over Bonanos (Bonanos 2005)

Report generated on: 01-25-2011 at : 12:33:56

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



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Virginia Tech ETD Fair Use Analysis Results

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-8: Air Specific Impulse Predicted by VTMODEL for To=1010K Overlay over Bonanos (Bonanos 2005)

Report generated on: 01-25-2011 at : 12:34:25

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

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Name: Kathleen Tran

Description of item under review for fair use: Figure 5-9: Schematic of UVA Tunnel (Le 2008)

Report generated on: 01-25-2011 at : 12:35:07

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use*



Public Domain Figures:

Figure 1-1: Engine modes vs. Mach Number from the SR 71 Flight Manual (USAF 2002)

Figure 1-6: Scramjet Schematic Courtesy of NASA Langley

Figure 2-15: Chemical Kinetics Effects at Mach 8 for $\Phi=1$ Taken from Jachimowski (1988) (NASA Document Government Report)