

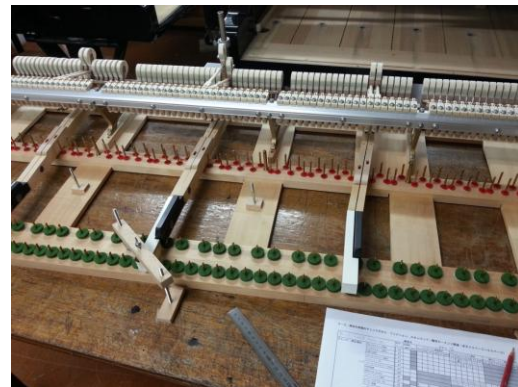
## Grand Action Set Up



## Contents of Class

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- ❖ Basic Measurement & Geometry
- ❖ Touchweight related ratios and weights
- ❖ Some sample procedures



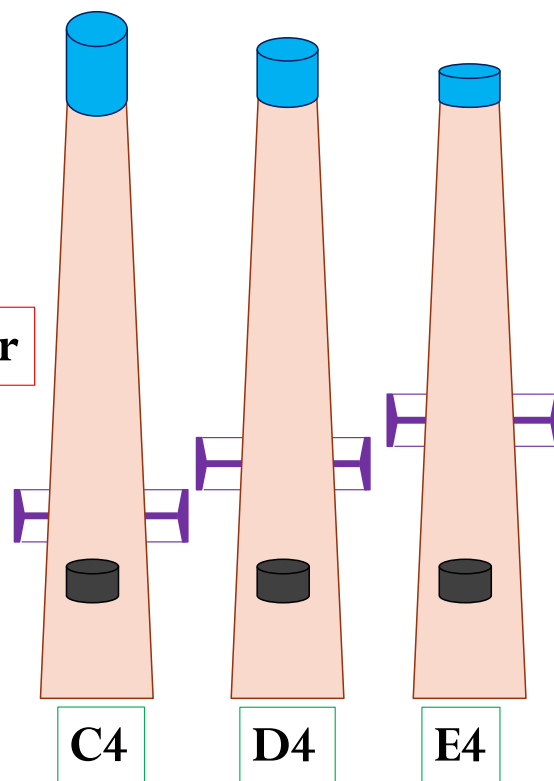
❖ C4 is set up **heavier**

❖ E4 is set up **lighter**

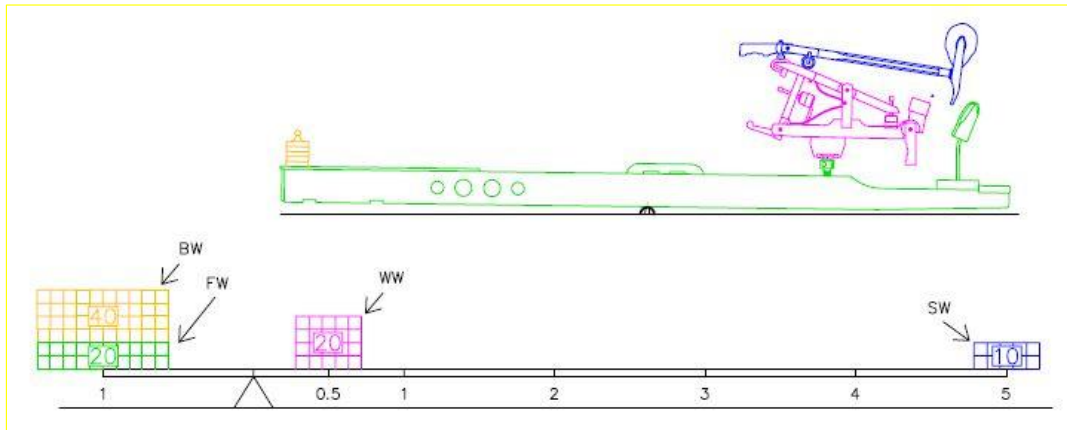
**That relates Ratios & Weights**

**Strike Weight**

**Ratio of the lever**

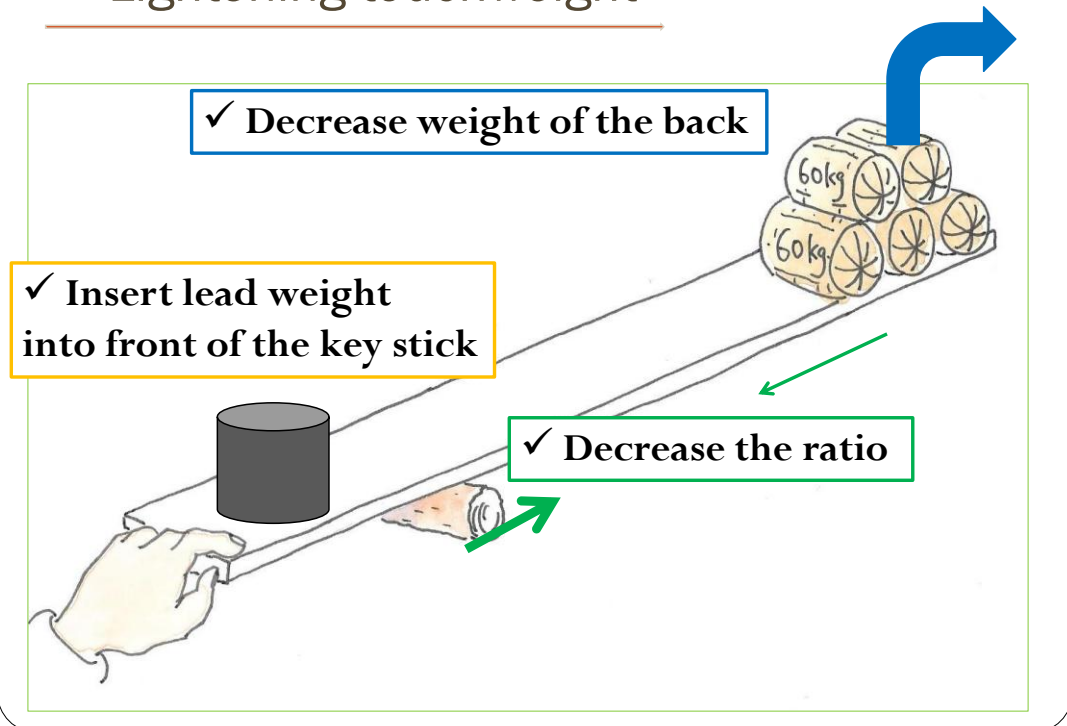


## The action as a lever



Seesaw model by David Stanwood

## Lightening touchweight



# Basics, Ratios & Weights

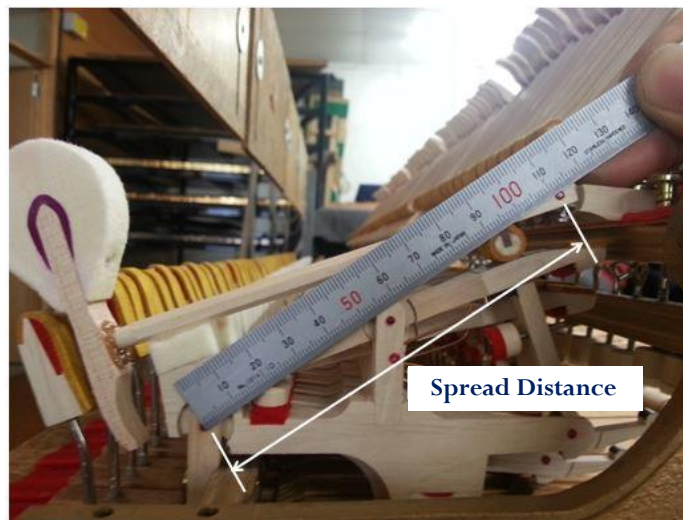
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1. Basic measurement
2. **Action ratio**, view from regulation
3. **Strike ratio**, view from static touchweight
4. **Gear ratios** and linked Moment of Inertia, view from kinetic touchweight
5. **Strike Weight**, majority of the touchweight
6. Front Weight, locating key leads

## 1, Basic measurement

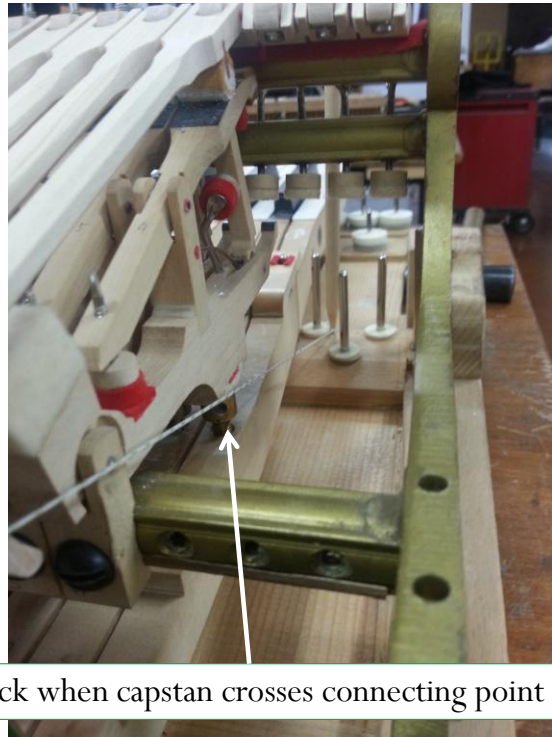
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### ❖ Spread Distance



## ❖ Magic line

Key – Whippen connection



Check when capstan crosses connecting point

## ❖ Center pin height



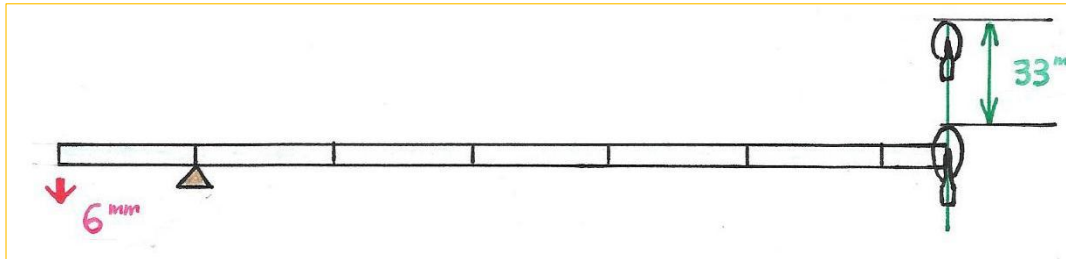
Shank center



Whippen center

## 2, **Action Ratio**, view from travel distance

$$\text{AR} = 33 / 6 = 5.5$$



Measure how much hammer travels by 6 mm dip

$$\text{Hammer travel distance} / 6 = \text{AR}$$



At rest



Depressed by 6 mm jig

Set AR jig to key top at measuring point



Put 6 mm jig between jig and key top

## Calculate key depth

Key dip = (hammer blow – let off) / AR + aftertouch

(Example) Key dip = (47 mm – 2 mm) / 5.5 + 1.5 mm  
= 45 / 5.5 + 1.5 = 9.7 mm

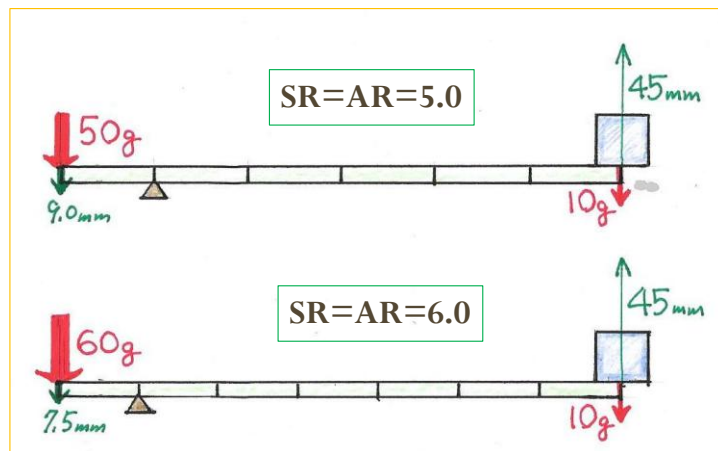
\*at measuring point i.e. 13 mm from front edge



Action Ratio	Key depth at front edge
5.2	10.5
5.4	10.2
5.6	9.9
5.8	9.6
6.0	9.3
6.2	9.1

Figures at: hammer blow 46 mm, let off 2 mm, aftertouch 1.5 mm  
Key length (front side) 200 mm

### 3, Strike Ratio, view from Weight



**Weight ratio between key front and hammer**

The weight needed at key front when balanced 1 g of hammer



## Take measurement

---

$$SR = ((FW + BW) - (WW \times KR)) / SW$$



## Calculate BW by measuring DW & UW

---

1, Measure DW & UW

2, Calculate : **BW** = (DW + UW) / 2



## Measure SR by 2 g weight

$$SR = (BW \text{ with } 2 \text{ g} - BW \text{ without } 2 \text{ g}) / 2$$



Put 2 g weight inline with hammer center line

## Workable range of SR

SR	STRIKE WEIGHT CURVE NUMBER												
	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	35	37	40	42	44
5.2	--	--	--	--	--	--	31	34	37	39	42	44	46
5.4	--	--	--	--	--	31	33	36	39	41	44	47	49
5.6	--	--	--	--	30	33	35	38	41	44	46	49	51
5.8	--	--	--	--	32	35	37	40	43	46	49	52	--
6.0	--	--	--	31	34	37	39	42	45	48	51	--	--
6.2	--	--	30	32	35	38	41	44	47	50	--	--	--
6.4	--	--	31	34	37	40	43	46	49	52	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

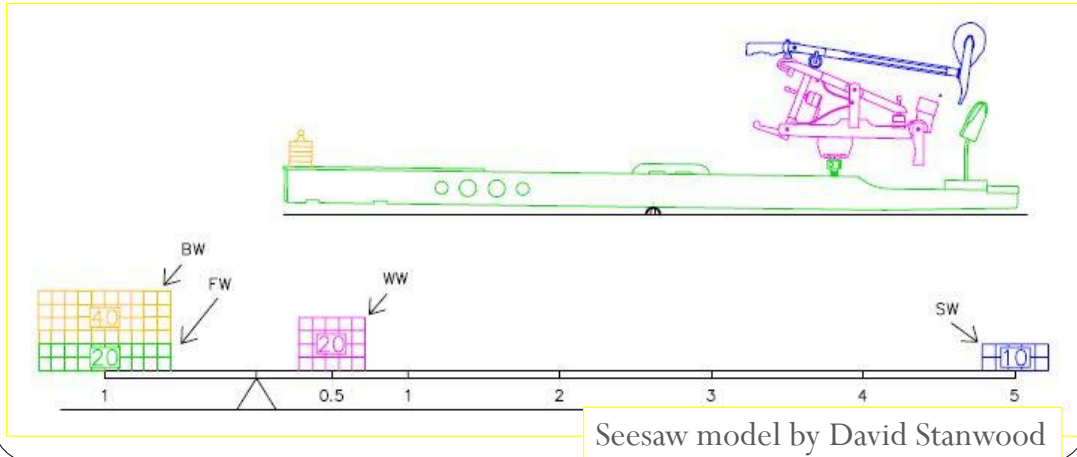
BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

Parameter table by David Stanwood

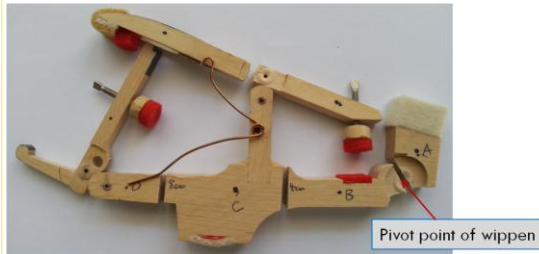
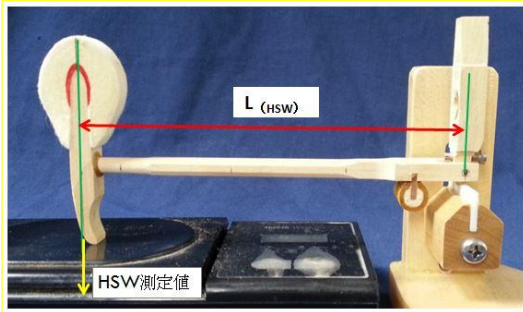
## 4, Gear Ratio and Moment of Inertia

Torque = Moment of Inertia x Angular acceleration

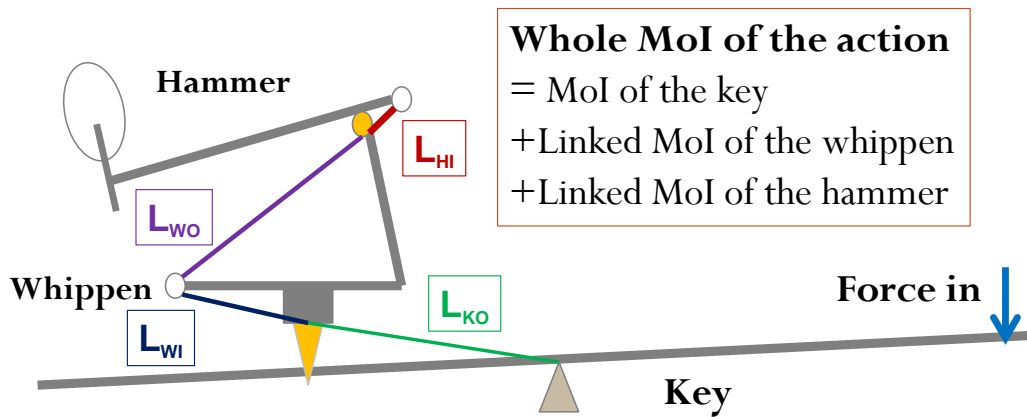
Strike force to the key = MoI x Angular Acceleration of the key



## Each part has own MoI



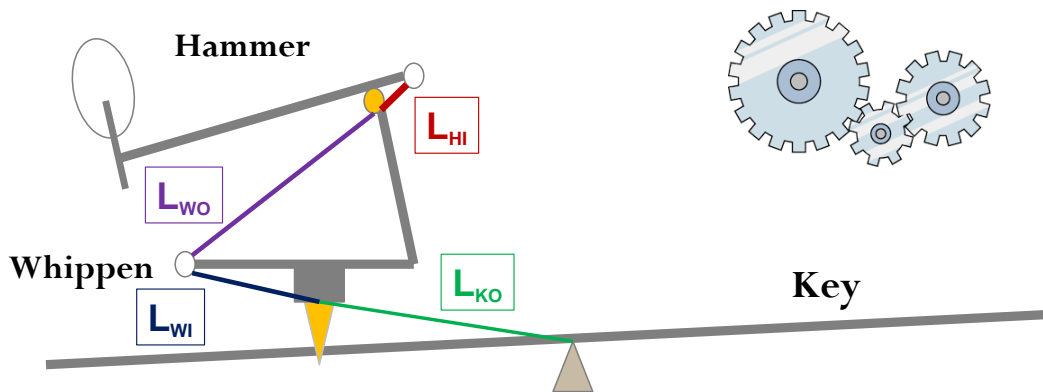
## Linked Moment of Inertia



**Whole MoI of the action**  
 = MoI of the key  
 + Linked MoI of the whippen  
 + Linked MoI of the hammer

$$\begin{aligned} \text{MoI (Whole action at key)} &= \text{MoI}_{(K)} \\ &+ \text{MoI}_{(W)} \times (L_{KO} / L_{WI})^2 \\ &+ \text{MoI}_{(H)} \times (L_{WO} / L_{HI} \times L_{KO} / L_{WI})^2 \end{aligned}$$

## Gear Ratios

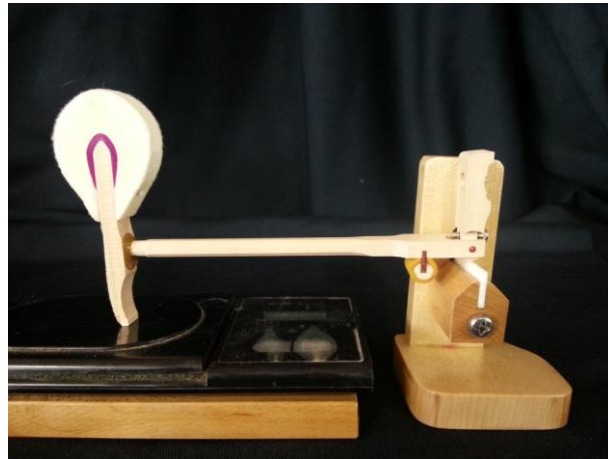


$$\text{Gear Ratio (K - W)} = L_{KO} / L_{WI}$$

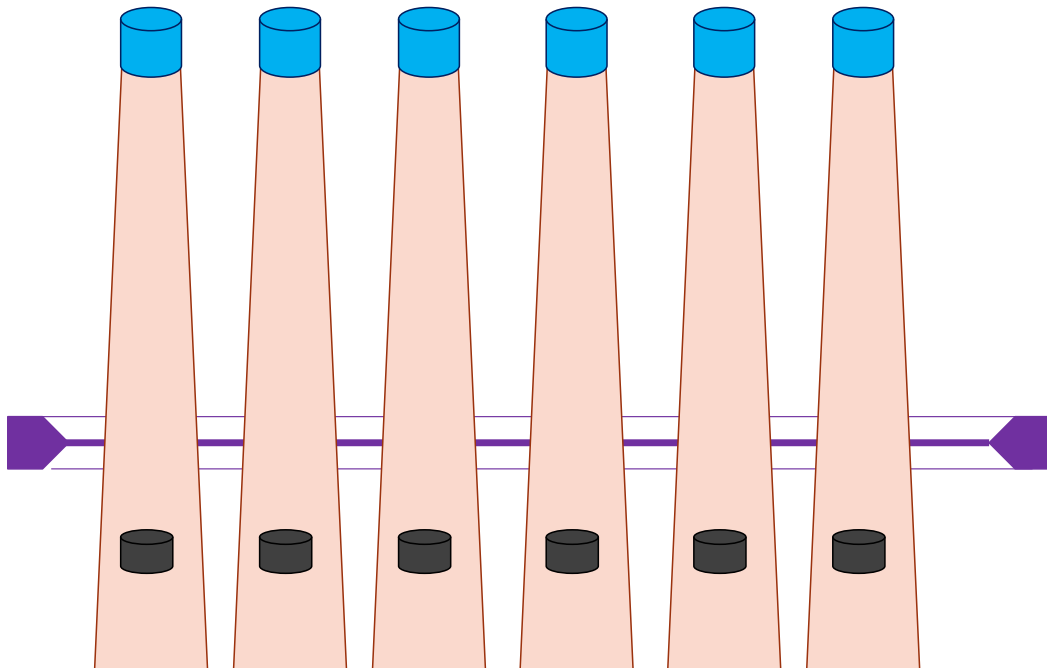
$$\text{Gear Ratio (K - H)} = L_{WO} / L_{HI} \times L_{KO} / L_{WI}$$

## 5, Strike Weight

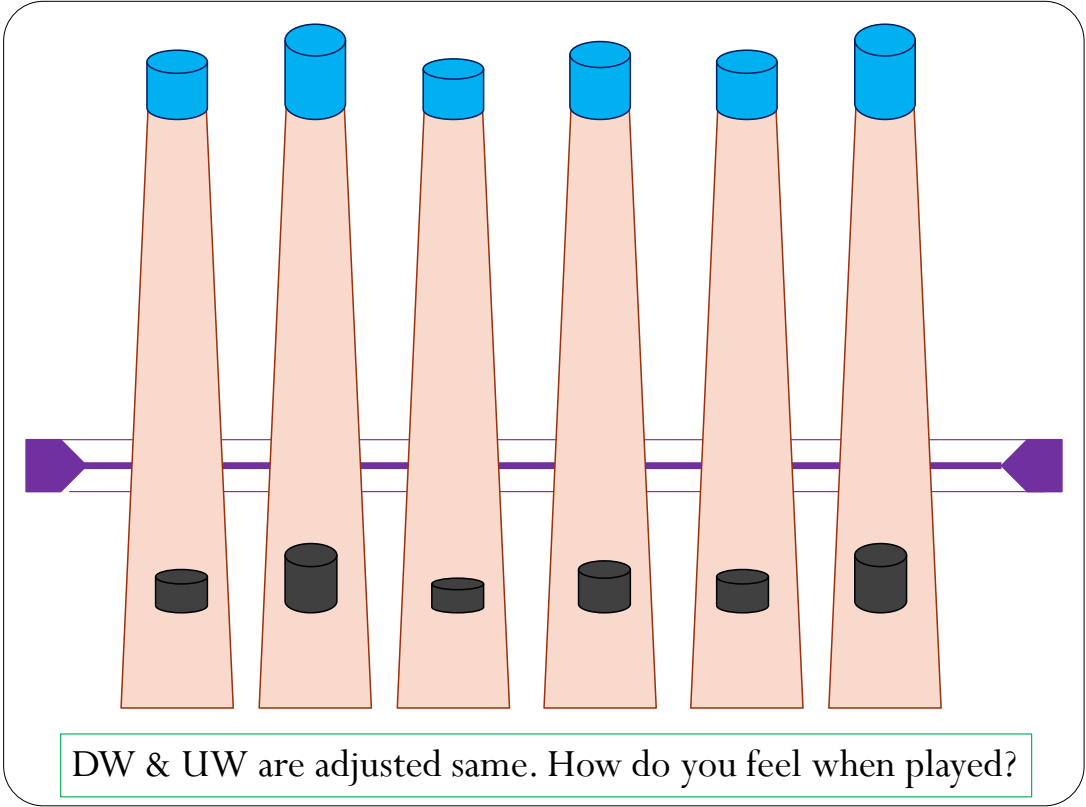
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More than 80% of touchweight is coming from hammer



When all SW and FW are same, BW at front gets same.



# Using Smart Chart

FOR SMOOTH STRIKE WEIGHT SPECIFICATION

BY *Shanwood*

SERIES WEIGHT CURVE NUMBER	
R	1 2 3 4 5 6 7 8 9 10 11 12 13
5.0	--- 30 32 35 37 40 44 46
5.2	--- 31 34 37 39 42 45 47 50
5.4	--- 31 33 36 38 41 44 46 49 51
5.6	--- 32 35 38 41 43 46 48 51
5.8	--- 32 35 37 40 43 45 48 51
6.0	--- 31 34 37 39 42 45 48 51
6.2	--- 30 32 35 38 41 44 47 50
6.4	--- 31 34 37 40 43 46 49 51
6.6	--- 30 33 35 38 42 45 48 51
6.8	--- 31 34 37 40 44 47 50
7.0	--- 32 36 39 42 46 49 52

BY FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

STRIDE WEIGHT CURVE NUMBER	
R	1 2 3 4 5 6 7 8 9 10 11 12 13
5.0	--- 31 33 36 38 41 43 46 49 50
5.2	--- 30 33 36 37 40 43 45 48 50 52
5.4	--- 30 32 34 37 39 42 45 47 50
5.6	--- 31 33 36 39 41 44 47 50 52
5.8	--- 30 33 35 38 41 43 46 49 52
6.0	--- 31 34 37 40 43 45 48 51
6.2	30 33 36 38 41 44 47 50
6.4	31 34 37 40 43 46 49 52
6.6	32 36 39 41 45 48 51
6.8	34 37 40 43 46 50
7.0	35 38 42 45 50 52

BY FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

**Touch Weight Parameters Tables**

Weight Between Weights is Bold

Balance Weights for Support Springs with springs off are underlined

DESIGNED BY  
SHANWOOD BOWLING EQUIPMENT INC.  
1000 N. W. 10th St.  
OAK RIDGE, FL 32909  
WWW.SHANWOOD.COM  
Version No. 1.001

**INSTRUCTIONS**

1. Measure Strike Weights and fill in the corresponding blocks with pencil.
2. Determine the average Strike Weight Ratio Level by measuring sample notes.
3. Choose the touch weight parameters table for your desired front weight level.

# Adjusted SW with new hammer

FOR SMOOTH STRIKE WEIGHT SPECIFICATION

BY *Shanwood*

FRONT WEIGHT	STRIKE WEIGHT	CURVE NUMBER
4.2	30 32 35 38 41 44 47 50	1
4.4	31 34 37 40 43 46 49 52	2
4.6	32 35 38 41 44 47 50	3
4.8	33 36 39 42 45 48 51	4
5.0	34 37 40 43 46 49 52	5
NO FOR FRONT WEIGHT CEILING MINUS 3 GRAMS		
R	1 2 3 4 5 6 7 8 9 10 11 12 13	
4.0	31 33 36 38 41 43 46 48 50	1
4.2	30 33 36 39 42 45 47 50	2
4.4	31 34 37 40 43 45 48 51	3
4.6	32 35 38 41 43 46 49 52	4
4.8	33 36 39 42 44 47 50	5
5.0	34 37 40 43 46 49 52	6
5.2	35 38 41 44 47 50	7
5.4	36 39 42 45 48 51	8
5.6	37 40 43 46 49 52	9
5.8	38 41 44 47 50	10
6.0	39 42 45 48 51	11
6.2	40 43 46 49 52	12
6.4	41 44 47 50	13
6.6	42 45 48 51	14
6.8	43 46 49 52	15
7.0	44 47 50	16
NO FOR FRONT WEIGHT CEILING MINUS 3 GRAMS		

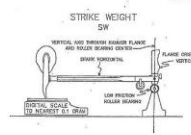
Touch Weight Parameters Tables  
Indicate Balance Weights in Grams  
Balance Weights for support systems with springs off an unbalanced

DESIGNED BY  
SHANWOOD PIANO ACCESSORIES INC.  
New York, NY 10018  
(800) 451-5555  
WWW.SHANWOOD.COM

- INSTRUCTIONS
1. Measure Strike Weights and fill in the corresponding blocks with pencil.
  2. Determine the average Strike Weight Ratio Level by measuring sample notes.
  3. Choose the touch weight parameters table for your desired front weight level.
  4. Choose a desired balance weight specification.
  5. Determine the recommended strike weight level from the parameters table.
  6. Use a flexible wood batten to pencil a line for the desired strike weight specification.  
Refer to the Touch Designers Toolkit manual for protocols and methods.

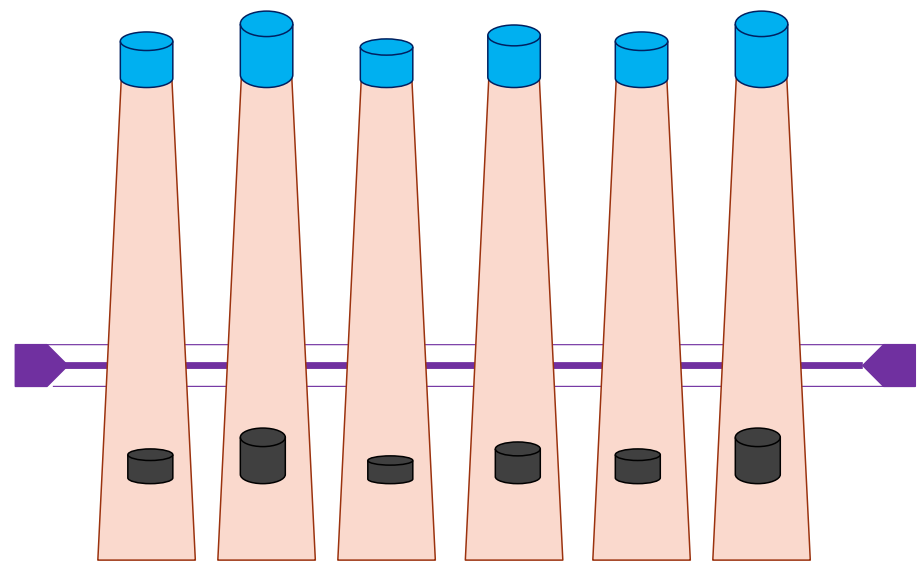
**HSW Final**

Piano Make	Yamaha	Model	C7	Serial #	662XXXX	Date	
Owner Name	Soli...	Class	Bass	Average Strike Weight Ratio	Middle	Treble	
Comments							

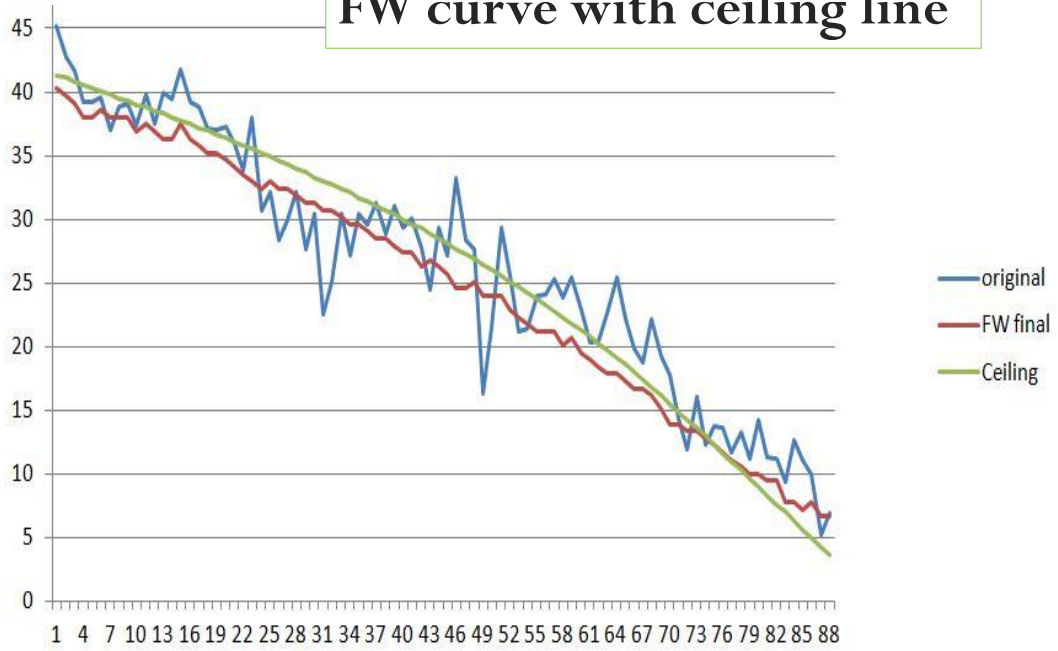


## 6, Front Weight

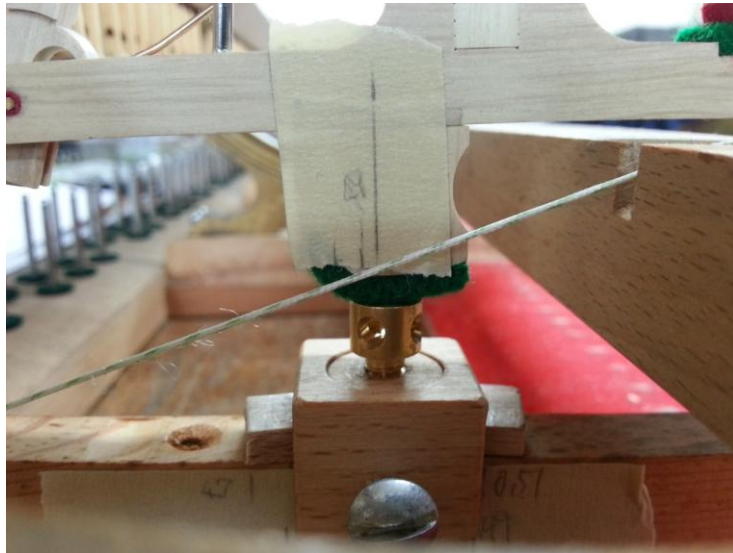
FW is not aligned smoothly.



## FW curve with ceiling line



## 6, Set up the action, Procedure





## Sample 1: only existing parts

---



S&S B # 50\*\*\*\*

Someone put new hammers and shanks not so long ago.

The customer wanted to;

- **make lighter slightly**
- **have smoother touch through all registers**
- **better response**

\* It was difficult to play pp when playing lightly in tenor and bass area

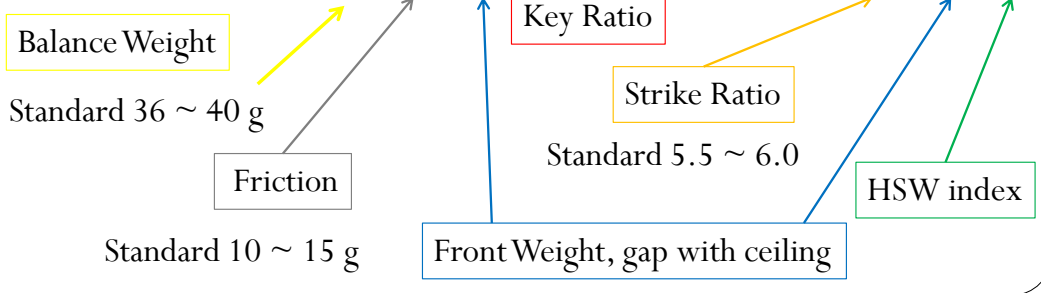
## Observation

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- Damper timing is too early
- Split wedge felts are too long in tenor section
- Action centers are tight
- The spread distance is shorter in tenor to bass
- Balance weight index is standard to a bit higher
- Key ratio is vary due to uneven positioning of capstans

# Equation of Balance

Key #		Front (BW+FW)					=	Back (WBW+HSWxSR)					FW ce index	HSW
		DW	UW	BW	F	FW		KR	WW	WBW	HSW	SR		
16	original	54	30	42.0	12.0	39.4	0.53	18.4	9.8	11.6	6.2	37.5	#8.5	
17	original	51	28	39.5	11.5	38.9	0.5	18.4	9.2	11.6	6.0	37.2	#9	
40	original	50	28	39.0	11.0	29.1	0.52	18.4	9.6	10.1	5.8	30.0	#8	
41	original	49	21	35.0	14.0	30.0	0.51	18.4	9.4	9.9	5.6	29.6	#8	
64	original	52	18	35.0	17.0	25.5	0.52	18.4	9.6	8.3	6.1	19.1	#8.5	
65	original	44	22	33.0	11.0	22.1	0.51	18.4	9.4	8.0	5.7	18.6	#9	



## SMART CHART™

FOR SMOOTH STRIKE WEIGHT SPECIFICATION

BY *Shanwood*

**INSTRUCTIONS**

- Measure Strike Weights and fill in the corresponding blocks with pencil.
- Determine the average Strike Weight Ratio Level by measuring sample notes.
- Choose the touch weight parameters table for your desired front weight level.
- Choose a desired balance weight specification.
- Determine the recommended strike weight level from the parameters table.
- Use a flexible wood batten to pencil a line for the desired strike weight specification.

Refer to the Touch Designers Toolkit manual for protocols and methods.

*original*

**STRIKE WEIGHT CURVE NUMBER**

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	---	---	---	---	---	---	---	---	---	---	---	---	---
5.2	---	---	---	---	---	---	---	---	---	---	---	---	---
5.4	---	---	---	---	---	---	---	---	---	---	---	---	---
5.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.0	---	---	---	---	---	---	---	---	---	---	---	---	---
6.2	---	---	---	---	---	---	---	---	---	---	---	---	---
6.4	---	---	---	---	---	---	---	---	---	---	---	---	---
6.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.8	---	---	---	---	---	---	---	---	---	---	---	---	---
7.0	---	---	---	---	---	---	---	---	---	---	---	---	---

USE FOR FRONT WEIGHT TESTING NUMBERS 3 GRAMS

**STRIKE WEIGHT CURVE NUMBER**

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	---	---	---	---	---	---	---	---	---	---	---	---	---
5.2	---	---	---	---	---	---	---	---	---	---	---	---	---
5.4	---	---	---	---	---	---	---	---	---	---	---	---	---
5.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.0	---	---	---	---	---	---	---	---	---	---	---	---	---
6.2	---	---	---	---	---	---	---	---	---	---	---	---	---
6.4	---	---	---	---	---	---	---	---	---	---	---	---	---
6.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.8	---	---	---	---	---	---	---	---	---	---	---	---	---
7.0	---	---	---	---	---	---	---	---	---	---	---	---	---

USE FOR FRONT WEIGHT CEILING NUMBERS 9 GRAMS

**Touch Weight Parameters Tables**

Medium balance weights in bold  
balance weights that support strikes with ceiling are unbolded

DESIGNED BY  
DESIGNED AND MANUFACTURED BY  
BY  
MANUFACTURED BY  
MANUFACTURED BY

**STRIKE WEIGHT**

VERTICAL AND THROUGH HANGER PLANE  
AND HANGER BEARING CENTER  
HANGER CENTER  
PLANE ORIENTED  
HORIZONTALLY  
USE FRONT-TO-REAR  
HANGER CENTER

MANUFACTURED BY  
MANUFACTURED BY  
MANUFACTURED BY

# SMART CHART™

FOR SMOOTH STRIKE WEIGHT SPECIFICATION

BY *Shanwood*

STRIKE WEIGHT CURVE NUMBER

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	35	37	40	42	44
5.2	--	--	--	--	--	--	31	34	37	39	42	44	46
5.4	--	--	--	--	--	--	31	33	36	39	41	44	47
5.6	--	--	--	--	--	30	33	35	38	41	44	46	49
5.8	--	--	--	--	32	35	37	40	43	46	49	52	--
6.0	--	--	31	34	37	39	42	45	48	51	--	--	--
6.2	--	30	32	35	38	41	44	47	50	--	--	--	--
6.4	--	31	34	37	40	43	46	49	52	--	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

STRIKE WEIGHT CURVE NUMBER

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	34	36	38	41	43
5.2	--	--	--	--	--	--	31	33	35	37	40	42	44
5.4	--	--	--	--	--	--	31	33	34	37	39	42	45
5.6	--	--	--	--	--	30	33	34	37	39	42	45	47
5.8	--	--	--	--	31	33	35	38	41	44	47	50	52
6.0	--	--	30	33	35	38	41	43	46	49	52	--	--
6.2	--	30	32	34	37	40	43	45	48	51	--	--	--
6.4	--	31	34	37	40	43	46	49	52	--	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

**INSTRUCTIONS**

1. Measure Strike Weights and fill in the corresponding blocks with pencil.
2. Determine the average Strike Weight Ratio Level by measuring sample notes.
3. Choose the touch weight parameters table for your desired front weight level.
4. Choose a desired balance weight specification.
5. Determine the recommended strike weight level from the parameters table.
6. Use a flexible wood batten to pencil a line for the desired strike weight specification.

Refer to the Touch Designers Toolkit manual for protocols and methods.

*original*

**STRIKE WEIGHT**

Piano Make	Model	Serial #	Date
Sg.S	B		
Owner Name	Base	Average Strike Weight Ratio	Treble
Mr. Y			
Comments			

## Check parameter table

STRIKE WEIGHT CURVE NUMBER													
R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	35	37	40	42	44
5.2	--	--	--	--	--	--	31	34	37	39	42	44	46
5.4	--	--	--	--	--	31	33	36	39	41	44	47	49
5.6	--	--	--	--	30	33	35	38	41	44	46	49	51
5.8	--	--	--	--	32	35	37	40	43	46	49	52	--
6.0	--	--	--	31	34	37	39	42	45	48	51	--	--
6.2	--	--	30	32	35	38	41	44	47	50	--	--	--
6.4	--	--	31	34	37	40	43	46	49	52	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

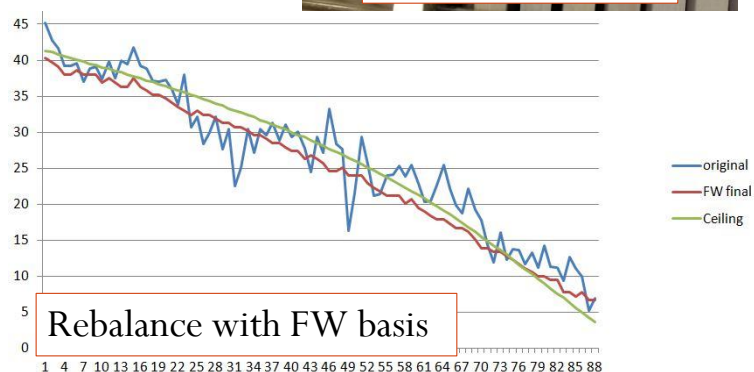
BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS


# Simulate by equation of balance

Original + trial				Front (BW+FW)			=			Back (WBW+HSWxSR)			HSV
Key #		DW	UW	BW	F	FW		KR	WW	WBW	HSW	SR	FW ce inde
16	original	54	30	42.0	12.0	39.4		0.53	18.4	9.8	11.6	6.2	37.5 #8
	shim whippen heel	49	25	37.0	12.0	39.4		0.53	18.4	9.8	11.6	5.7	
	re-balance	52	28	40.0	12.0	36.4		0.53	18.4	9.8	11.6	5.7	
17	original	51	28	39.5	11.5	38.9		0.5	18.4	9.2	11.6	6.0	37.2 #8
	shim whippen heel	46	23	34.5	11.5	38.9		0.5	18.4	9.2	11.6	5.5	
	re-balance	51	28	39.5	11.5	33.9		0.5	18.4	9.2	11.6	5.5	

## Actual work

- Re-center flanges
- Correct spread distance
- Trim split wedge felts
- Adjust damper timing etc





FOR SMOOTH STRIKE WEIGHT SPECIFICATION

BY *Shanwood*

STRIKE WEIGHT CURVE NUMBER

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	---	---	---	---	---	---	---	---	---	---	---	---	---
5.2	---	---	---	---	---	---	---	---	---	---	---	---	---
5.4	---	---	---	---	---	---	---	---	---	---	---	---	---
5.6	---	---	---	---	---	---	---	---	---	---	---	---	---
5.8	---	---	---	---	---	---	---	---	---	---	---	---	---
6.0	---	---	---	---	---	---	---	---	---	---	---	---	---
6.2	---	---	---	---	---	---	---	---	---	---	---	---	---
6.4	---	---	---	---	---	---	---	---	---	---	---	---	---
6.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.8	---	---	---	---	---	---	---	---	---	---	---	---	---
7.0	---	---	---	---	---	---	---	---	---	---	---	---	---

FOR FRONT WEIGHT CURVE NUMBER 3 (BASE)

STRIKE WEIGHT CURVE NUMBER

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	---	---	---	---	---	---	---	---	---	---	---	---	---
5.2	---	---	---	---	---	---	---	---	---	---	---	---	---
5.4	---	---	---	---	---	---	---	---	---	---	---	---	---
5.6	---	---	---	---	---	---	---	---	---	---	---	---	---
5.8	---	---	---	---	---	---	---	---	---	---	---	---	---
6.0	---	---	---	---	---	---	---	---	---	---	---	---	---
6.2	---	---	---	---	---	---	---	---	---	---	---	---	---
6.4	---	---	---	---	---	---	---	---	---	---	---	---	---
6.6	---	---	---	---	---	---	---	---	---	---	---	---	---
6.8	---	---	---	---	---	---	---	---	---	---	---	---	---
7.0	---	---	---	---	---	---	---	---	---	---	---	---	---

FOR FRONT WEIGHT CURVE NUMBER 9 (BASE)

Touch Weight Parameters Tables

Below tables relate to Ball

Below weights are subject to slight variations

COILED #1

STRIKE WEIGHT CURVE NUMBER

FOR FRONT WEIGHT CURVE NUMBER 9 (BASE)

INSTRUCTIONS

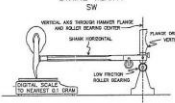
1. Measure Strike Weights and fill in the corresponding blocks with pencil.
2. Determine the average Strike Weight Ratio Level by measuring sample notes.
3. Choose the touch weight parameters table for your desired front weight level.
4. Choose a desired balance weight specification.
5. Determine the recommended strike weight level from the parameters table.
6. Use a finished wood bottom to pencil a line for the desired strike weight specification.

Refer to the Touch Designer's Toolkit manual for protocols and methods.

• original (Even) • Original (Odd)

• Final

STRIKE WEIGHT



VERTICAL USE DESIGNER'S PLACE AND ROLLER BEARING CENTER

FLANGE CENTER

ROLLER BEARING CENTER

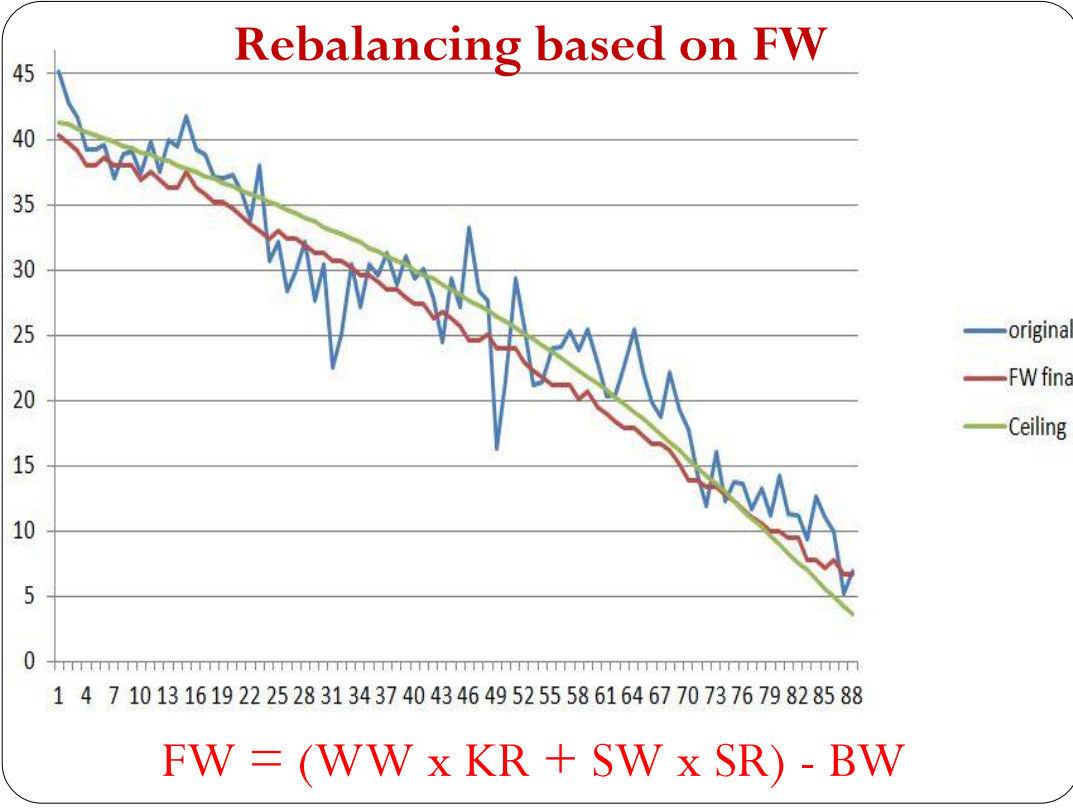
TO CENTER OF GRAVITY

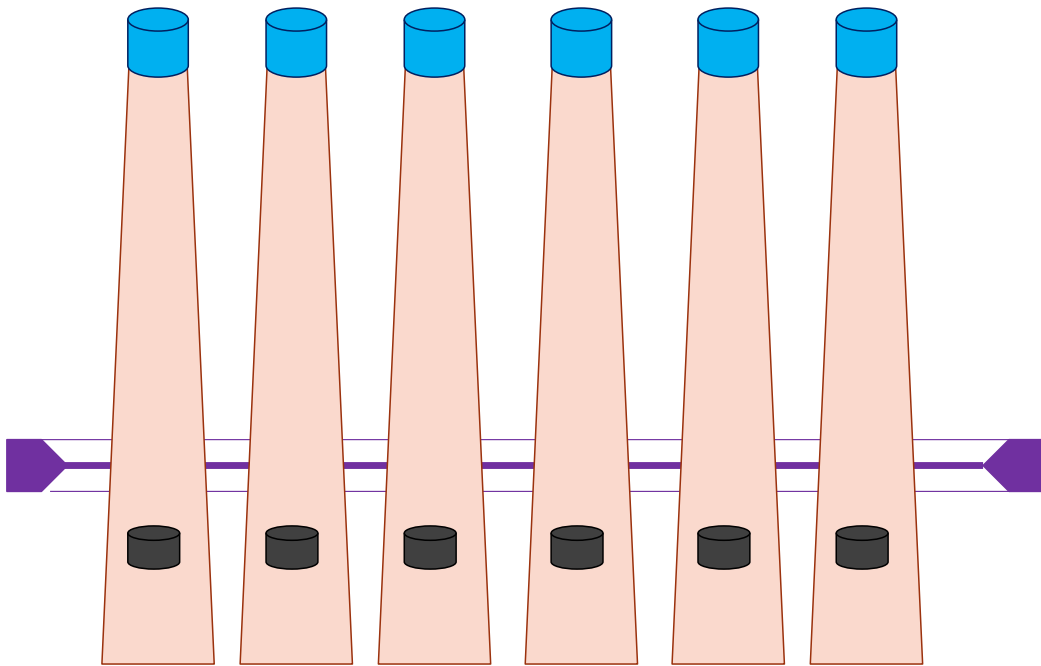
INSPECTED BY

DATE

REMARKS

Piano Make	Model	Serial #	Date
Steinway	B		
Owner Name	Base	Average Strike Weight Ratio	Treble
Mr. Y			
Comments			





When all SW and FW are same, BW at front gets same.

## Sample 2: whippen assist spring



# Measurement of a Kawai KG3

Key #	details specified	Front (BW+FW)					=	Back (WBW+WAS+HSWxSR)				FW	HSW		
		DW	UW	BW	F	FW		KR	WW	WBW	WAS			HSW	SR
40	original with spring	62	29	45.5	16.5	17.7		0.53	20.3	10.8	-18.0	10.8	6.5	30.0	#9.5
	Original without spring	79	48	63.5	15.5	17.7		0.53	20.3	10.8		10.8	6.5		

High Strike ratio

Difference of Balance Weights Equals whippen assist spring force

Whippen Assist Spring Force

Front Weight, much less than the ceiling

## Parameter table

STRIKE WEIGHT CURVE NUMBER													
R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	35	37	40	42	44
5.2	--	--	--	--	--	--	31	34	37	39	42	44	46
5.4	--	--	--	--	--	31	33	36	39	41	44	47	49
5.6	--	--	--	--	30	33	35	38	41	44	46	49	51
5.8	--	--	--	--	32	35	37	40	43	46	49	52	--
6.0	--	--	--	31	34	37	39	42	45	48	51	--	--
6.2	--	--	30	32	35	38	41	44	47	50	--	--	--
6.4	--	--	31	34	37	40	43	46	49	52	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

BW: 63.5 g, SR: 6.5, SW: #9.5, FW: -12 g

# Plan 1

Rebalancing only

#	details specified	DW	UW	Front (BW+FW)			=	Back (WBW+WAS+HSWxSR)				FW	HSW	
				BW	F	FW		KR	WW	WBW	WAS			HSW
an 1	original with spring	62	29	45.5	16.5	17.7	0.53	20.3	10.8	-18.0	10.8	6.5	30.0	#9.5
	Original without spring	79	48	63.5	15.5	17.7	0.53	20.3	10.8		10.8	6.5		
	Key balancing	55	24	39.5	15.5	41.7	0.53	20.3	10.8		10.8	6.5		

FW gets more than 10 grams heavier than the ceiling

# Plan 2

Reduce SW and SR then key balancing

#	details specified	DW	UW	Front (BW+FW)			=	Back (WBW+WAS+HSWxSR)				FW	HSW	
				BW	F	FW		KR	WW	WBW	WAS			HSW
2	original with spring	62	29	45.5	16.5	17.7	0.53	20.3	10.8	-18.0	10.8	6.5	30.0	#9.5
	Original without spring	79	48	63.5	15.5	17.7	0.53	20.3	10.8		10.8	6.5		
	SW adjustment	76	45	60.5	15.5	17.7	0.53	20.3	10.8		10.4	6.5		#8.5
	Half cut punching	72	41	56.5	15.5	17.7	0.53	20.3	10.8		10.4	6.1		
	Shim capstan	68	37	52.5	15.5	17.7	0.53	20.3	10.8		10.4	5.7		
	Key balancing	55	24	39.5	15.5	30.7	0.53	20.3	10.8		10.4	5.7		

FW is about the ceiling

Strike ratio gets standard



# Plan 3

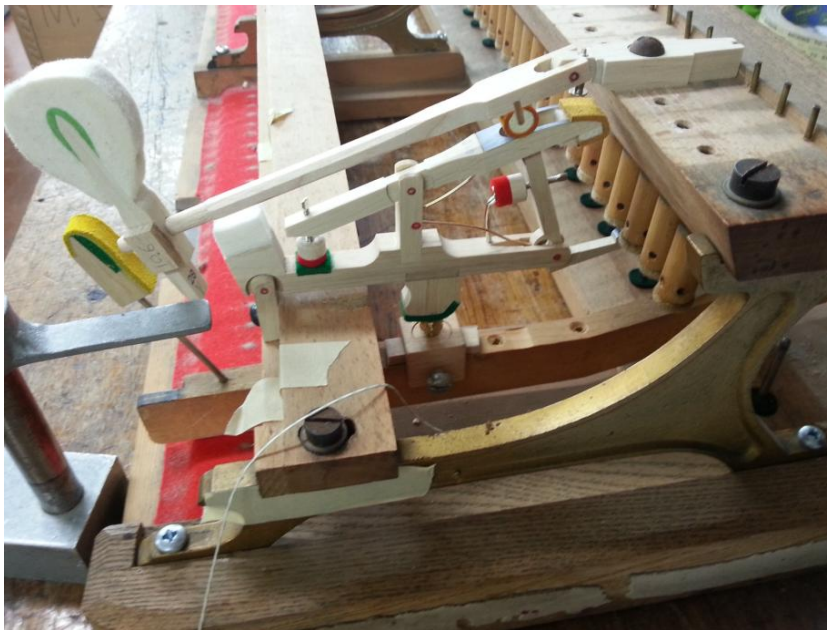
## Reduce SW, SR and WAS then key balancing

#	details specified	Front (BW+FW)					=	Back (WBW+WAS+HSWxSR)					FW	HSW	
		DW	UW	BW	F	FW		KR	WW	WBW	WAS	HSW			SR
13	original with spring	62	29	45.5	16.5	17.7		0.53	20.3	10.8	-18.0	10.8	6.5	30.0	#9.5
	Original without spring	79	48	63.5	15.5	17.7		0.53	20.3	10.8		10.8	6.5		
	SW adjustment	76	45	60.5	15.5	17.7		0.53	20.3	10.8		10.4	6.5		#8.5
	Half cut punching	72	41	56.5	15.5	17.7		0.53	20.3	10.8		10.4	6.1		
	Weaken assist spring	64	33	48.5	15.5	17.7		0.53	20.3	10.8	-8.0	10.4	6.1		
	Key balancing	55	24	39.5	15.5	26.7		0.53	20.3	10.8	-8.0	10.4	6.1		

Reduced whippen Assist spring force

Front Weight, 3 grams minus the ceiling

## Sample 3: with new parts



## Change parameters

---

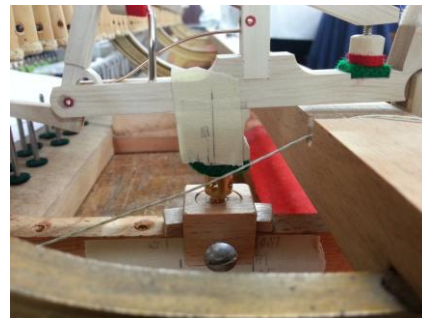
- ❖ Friction
- ❖ Geometry
- ❖ SW, SR, WW, KR and BW
- ❖ Moment of Inertia and Gear ratio



## Find desired geometry

---

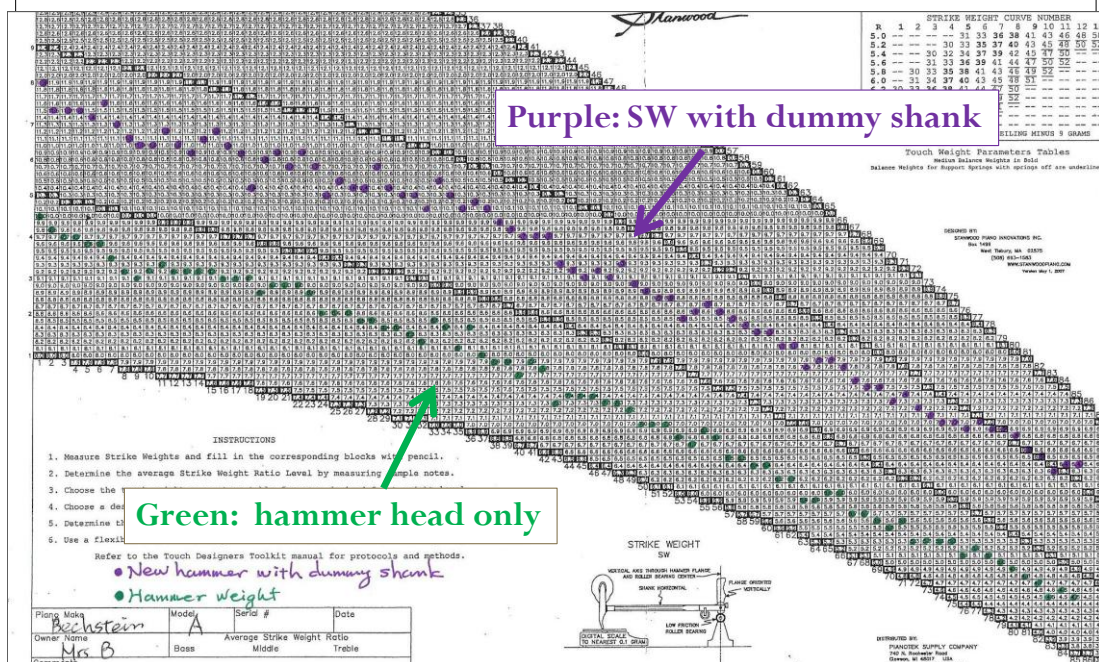
- ❖ Install new shank and a hammer which has similar SW of new hammer (or actual one)
- ❖ Install whippen with temporary fixed heel
- ❖ Set temporary capstan to original position
- ❖ Check regulation with AR



# Adjust SW of new set of hammers

1. **Weight** raw hammer heads
2. **Calculate SW** or measure it with dummy shank
3. **Pre-taper** heavier ones
4. **Measure SW** after gluing shanks and chopped excess
5. **Tail and taper** hammer to get desired SW
6. **Bore and add hammer lead** if necessary

## Calculate proposed SW





# Check equation of balance

Key #	details specified	Front (BW+FW)					=	Back (WBW+HSWxSR)					FW ce index	
		DW	UW	BW	F	FW		KR	WW	WBW	HSW	SR		
16	original	63	21	42.0	21.0	29.8		0.54	19.3	10.4	10.2	6.0	37.5	#6
	new hammer, shank & whippen, cut punching	65	33	49.0	16.0	20.2		0.52	16.6	8.6	10.5	5.8		#6.5
	rebalance	56	24	40.0	16.0	29.2		0.52	16.6	8.6	10.5	5.8		
17	original	56	13	34.5	21.5	36.0		0.52	19.3	10.0	9.7	6.2	37.2	#5
	new hammer, shank & whippen, cut punching	57	27	42.0	15.0	26.5		0.52	16.6	8.6	10.4	5.8		#6.5
	rebalance	55	25	40.0	15.0	28.5		0.52	16.6	8.6	10.4	5.8		
40	original	72	22	47.0	25.0	23.2		0.53	19.2	10.18	9.0	6.67	30	#6
	new hammer, shank & whippen, cut punching	61	33	47.0	14.0	13.5		0.52	16.6	8.63	9.3	5.58		#6.5
	rebalance	54	26	40.0	14.0	20.5		0.52	16.6	8.63	9.3	5.58		
41	original	64	22	43.0	21.0	25.0		0.52	19.2	9.98	8.8	6.59	29.6	#5.5
	new hammer, shank & whippen, cut punching	60	29	44.5	15.5	15.6		0.52	16.6	8.63	9.2	5.59		#6.5
	rebalance	56	25	40.5	15.5	19.6		0.52	16.6	8.63	9.2	5.59		

Original, Actual test and proposed rebalance

## Check Parameter

R	1	2	3	4	5	6	7	8	9	10	11	12	13
5.0	--	--	--	--	--	--	30	32	35	37	40	42	44
5.2	--	--	--	--	--	--	31	34	37	39	42	44	46
5.4	--	--	--	--	--	31	33	36	39	41	44	47	49
5.6	--	--	--	--	30	33	35	38	41	44	46	49	51
5.8	--	--	31	34	37	39	40	43	46	49	52	--	--
6.0	--	--	31	34	37	39	42	45	48	51	--	--	--
6.2	--	--	30	32	35	38	41	44	47	50	--	--	--
6.4	--	--	31	34	37	40	43	46	49	52	--	--	--
6.6	--	30	33	35	39	42	45	48	51	--	--	--	--
6.8	--	31	34	37	40	44	47	50	--	--	--	--	--
7.0	--	32	36	39	42	46	49	52	--	--	--	--	--

BW FOR FRONT WEIGHT CEILING MINUS 3 GRAMS

**INSTRUCTIONS**

1. Measure Strike Weights and fill in the corresponding blocks with pencil.
2. Determine the average Strike Weight Ratio Level by measuring sample notes.
3. Choose the touch weight parameters table for your desired front weight level.
4. Choose a desired balance weight specification.
5. Determine the recommended strike weight level from the parameters table.
6. Use a flexible wood batten to pencil a line for the desired strike weight specification.

Refer to the Touch Designers Toolkit manual for protocols and methods.

*Final*

STRIKE WEIGHT SW  
OPTICAL AND MECHANICAL DESIGNER  
AND BALLER DESIGN CENTER  
SHAW-WHEATON  
PLEASE REFER TO  
MANUAL

# Calculate Mol of the keys

## ❖ 目標

	3	B0	measured original FW	29.8														
a	3	B0	calculated original FW	34.9	front	55.1	back	20.2	difference	-5.1								
b			least inertia with new FW	32.7	front	53.0	back	20.2	aiming FW	32.7								
c			economical setting with new FW	32.7	front	52.9	back	20.2	aiming FW	32.7								
d				32.7	front	52.9	back	20.2	aiming FW	32.7								

	Key #	Note	Status	Whole Inertia	FW point distn	Center of torque	COG position	Lead (front)											
								distan ce #5 (mm)	mass of lead	distan ce #4 (mm)	mass of lead	distan ce #3 (mm)	mass of lead	distan ce #2 (mm)	mass of lead	distan ce #1 (mm)	mass of lead		
a	3	B0	Original	38816	247	175.7	0.676	198	11.2	176	11.2	153	11.2						
b			least inertia	33417	247	85.2	0.328			135	6.0	110	19	80	19	50	19.0		
c			economical	36057	247	135.8	0.522			176	11.2	153	11.2	98	17				
d			Final	36057	247	135.8	0.522			176	11.2	153	11.2	98	17				

# Positioning of the key leads

- Needs more key leads when locating near to balance pin
- More Mol when locates key leads to farer than pin
- Watch CoG to even Mol

Status	Whole Inertia	FW point distn	Center of torque	COG position	Lead (front)													
					distan ce #5 (mm)	mass of lead	distan ce #4 (mm)	mass of lead	distan ce #3 (mm)	mass of lead	distan ce #2 (mm)	mass of lead	distan ce #1 (mm)	mass of lead				
Original	38816	247	175.7	0.676	198	11.2	176	11.2	153	11.2								
least inertia	33417	247	85.2	0.328			135	6.0	110	19	80	19	50	19.0				
economical	36057	247	135.8	0.522			176	11.2	153	11.2	98	17						

↖ **7% reduction**

## Check how MoI is set

How moment of inertia changes							
		Hammer	H at key	Whip	W at key	Key	Whole action
Expecting MoI after modification		1,825	152,190	756	3,263	36,057	191,511
% deducted from original		4%		0%		7%	8%
Existing MoI (gcm <sup>2</sup> )		1,893	164,973	756	3,411	38,816	207,199
HSW (g)	original	11.2 g					
	new	10.8 g					
Hammer distance (cm)	original	13 cm					
distance between balance hole center and center at the top of capstan screw							
		13.7 cm	13.4 cm				
distance between center at the top of capstan screw and whippen center							
		6.45 cm	6.15				
distance between whippen center and 1mm forward from back side of the jack at top of jack							
		9.45 cm					
distance between shank flange center and connecting point at roller leather with jack							
		2.15 cm					

**8% of MoI reduction is expectable**



Golden Bay, South island, New Zealand