English

Research Express@NCKU Volume 5 Issue 6 - August 29, 2008
[http://research.ncku.edu.tw/re/articles/e/20080829/1.html]

Epidemiological Study on the Effect of Pre-hypertension and Family History of Hypertension on Cardiac Autonomic Function

Jin-Shang Wu[12*], Feng-Hwa Lu[12], Yi-Ching Yang[12], Thy-Sheng Lin[3], Jia-Jin Chen[4], Chih-Hsing Wu[2], Ying-Hsiang Huang[2], Chih-Jen Chang[12]

[1]Department of Family Medicine, College of Medicine, National Cheng Kung University,

[2]Department of Family Medicine, National Cheng Kung University Hospital,

[3]Department of Neurology, College of Medicine, National Cheng Kung University,

[4]Institute of Biomedical Engineering, National Cheng Kung University, Taiwan, ROC

[*]Email: jins@mail.ncku.edu.tw

J Am Coll Cardiol 2008;51:1896-1901

Evidence from studies of both animals and humans suggests that the autonomic nervous system plays a crucial role in the development of hypertension, and that autonomic dysfunction underlies the initiation and maintenance of hypertension. Cardiac autonomic function (CAF) can be measured using traditional tests, such as a change in the ratio between the RR intervals during expiration and inspiration (E/I ratio) while deep breathing and the ratio between around the 30th and the 15th RR intervals after standing from the supine position. Heart rate variability (HRV), an indirect measure of cardiac autonomic function (CAF), is a useful tool for evaluating sympathetic and parasympathetic modulation of the heart (Table 1).

Table 1. Examination protocol, label, definition, and meaning of cardiac autonomic function (CAF) tests

Examination protocol	Label	Definition	Meaning of CAF
1. Normal breathing for 5 minutes while in a supine position after a 15-min rest period	LF/HF ratio	The ratio between LF power and HF power	Sympathovagal balance
	LF power (msec^2)	Low-frequency (0.04–0.15 Hz) power in supine position for 5 minutes	Predominantly sympathetic with parasympathetic modulation
	HF power (msec^2)	High-frequency (0.15–0.40 Hz) power in supine position for 5 minutes	Parasympathetic modulation
	SDNN (msec)	The standard deviation of RR interval in supine position for 5 minutes	Parasympathetic modulation
2. An active change from the supine to standing position	30max/15min ratio	The ratio between the longest RR interval around the 30th beat and the shortest RR interval around the 15th beat after standing	Parasympathetic modulation
3. Deep breathing at a rate of six breaths a minute while sitting after a 10-min rest period	E/I ratio	The average of six ratios between the longest RR interval during expiration and the shortest RR interval during inspiration,	Parasympathetic modulation

There has been a hospital-based study of CAF in subjects with high-normal blood pressure of 130-139/85-89 mmHg, rather than 120-139/80-89 mmHg revised by JNC 7 (Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure). The studies on CAF alteration in normotensive subjects with a family history of hypertension (FHH) defined normotension as a blood pressure < 140/90 mmHg, not the revised values of < 120/80 mmHg. Thus, all the above studies may result in a classification bias. We explored the effects of pre-hypertension and FHH on the CAF from the epidemiological data collected in Taiwan.

Community-dwellers were recruited from an epidemiological study on chronic diseases conducted in Tainan city, Taiwan. A three-stage sampling method was used to generate a stratified systematic cluster sample of households throughout the city. A total of 2416 subjects were eligible from the seven selected areas and 1638 subjects (67.8%) completed the study protocol. Finally, 1436 participants were included in the analysis after excluding 202 subjects who had taken medications known to influence CAF. A positive FHH was confirmed when at least one of the subject’s parents had a documented history of hypertension. According to the JNC 7 criteria, the average of two seated readings of blood pressure can be classified as normotension (blood pressure < 120/80 mmHg without history of hypertension), pre-hypertension (blood pressure of 120-139/80-89 mmHg without history of hypertension), and hypertension (blood pressure of ≥ 140/90 mmHg or a documented history of hypertension). RR intervals for the beat-to-beat duration of the cardiac cycle were measured continuously with an EKG monitor (CardiSuny α 800, Fukuda M-E Kogyo Inc. Tokyo, Japan) on a personal computer-based data-acquisition system. The analog signals were immediately sent to the signal-acquiring and processing system (DAQPad-6020E and SCB-68, National Instruments, NI) and stored in a personal computer. The EKG signals were processed for R-peak detection using the LabViewTM 6.1 software program (National Instruments, NI). A power spectral analysis was used to define the temporal fluctuations of the HRV. The examination protocol, labels, definitions, and meaning of the CAF tests are summarized in Table 1.

The subjects were divided into four groups, including normotension without FHH (NT(-), n=630), normotension with FHH (NT(+), n=315), pre-hypertension (n=340), and hypertension (n=153). Table 2 reveals the comparisons of clinical variables among subjects with NT(-), NT(+), pre-hypertension, and hypertension. There were significant differences in age, gender, BMI, the average of two seated systolic/diastolic blood pressure and heart rate, fasting plasma glucose, cholesterol, triglyceride, and HDL-C, and the prevalence of current alcohol use among these four groups.

Table 2. Comparison of clinical variables among subjects with different blood pressure, including normotension with and without a family history of hypertension, pre-hypertension, and hypertension

	NT (-) (n=630)	NT (+) (n=315)	Pre-hypertension (n=340)	Hypertension (n=153)	P value
Age, years	39.1±13.8	38.8±10.3	46.8±15.1	55.5±14.4	<0.001
Male, %	41.5	39.6	59.7	60.1	<0.001
BMI, kg/m^2	22.8±3.3	22.7±2.8	25.0±3.7	25.8±4.0	<0.001
SBP, mmHg	105.7±7.0	106.8±6.8	127.2±6.4	152.8±15.0	<0.001
DBP, mmHg	66.0±6.6	66.3±6.5	75.8±7.0	86.3±10.7	<0.001
HR, beat/min	64.6±11.0	65.1±10.2	67.9±12.8	69.2±12.9	<0.001
Physical activity, met-hr/wk*	60.4±88.0	66.5±111.1	54.2±58.0	55.5±58.8	0.227
Fasting glucose, mmo/l	5.1±1.0	5.0±0.6	5.7±2.0	6.1±2.5	<0.001
Cholesterol, mmol/l	4.8±1.0	4.8±1.0	5.2±1.2	5.3±1.1	<0.001
Triglyceride, mmol/l*	1.2±0.8	1.2±0.7	1.7±2.2	1.7±1.2	<0.001
HDL-C, mmol/l	1.4±0.4	1.4±0.4	1.3±0.3	1.3±0.3	0.003
Current alcohol use, %	10.4	10.4	18.2	17.6	0.002
Current smoking, %	19.9	18.0	24.7	24.2	0.112

NT(-), normotension without a family history of hypertension; NT(+), normotension with a family history of hypertension.; SBP/DBP, average of two seated systolic/diastolic blood pressure readings; HR, average of two seated heart rate readings; * Kruskal-Wallis test.

Figure 1 shows a comparison and adjusted means of CAF among different blood pressure groups from ANCOVA, which was adjusted for age, gender, body mass index, current alcohol use, plasma glucose, cholesterol, triglyceride, and HDL-C. Parasympathetic drive, as indicated by the E/I ratio, the max30/15min ratio, and HF power, decreased in subjects with NT(+), pre-hypertension, and hypertension. The square root of LF/HF ratio increased in both the pre-hypertension and hypertension individuals, but an increase in LF power existed only in subjects with pre-hypertension.

By mapping the CAF across different blood pressure groups, from NT(-), NT(+), then to pre-hypertension, and finally to hypertension, our study reveals that decreased parasympathetic modulation of the heart exists in NT(+) subjects, and this impairment of parasympathetic drive also occurs in subjects with either pre-hypertension or hypertension. In contrast, the LF power, which indicates predominantly sympathetic control with parasympathetic modulation is enhanced in the case of pre-hypertension, but not in those of NT(+) and hypertension. Our result suggests that pre-hypertensive subjects manifest a decreased parasympathetic drive with an autonomic imbalance shifting with augmented sympathetic tone when compared to NT(-) subjects. This may be related to a hemodynamic transition from normotension to pre-hypertension, which is similar to the change from normotension to borderline hypertension that has been characterized by an elevated cardiac output and normal vascular resistance. This high cardiac output has been associated with both an increased cardiac sympathetic drive and a decreased parasympathetic tone in pharmacological blockade studies. The mechanism underlying the absence of a significant elevation of LF powers in the case of hypertension may be related to the down regulation of the sympathetic tone during the transition from a high cardiac output in pre-hypertension to a high resistance in hypertension.

In conclusion, CAF plays a role in pre-hypertension and that altered autonomic function is already present in subjects with FHH. An autonomic imbalance shifting with augmented sympathetic tone was more enhanced in pre-hypertension. In the future, intervention studies are needed to clarify the role of autonomic function in the preventive strategy of high blood pressure in subjects with FHH and pre-hypertension.

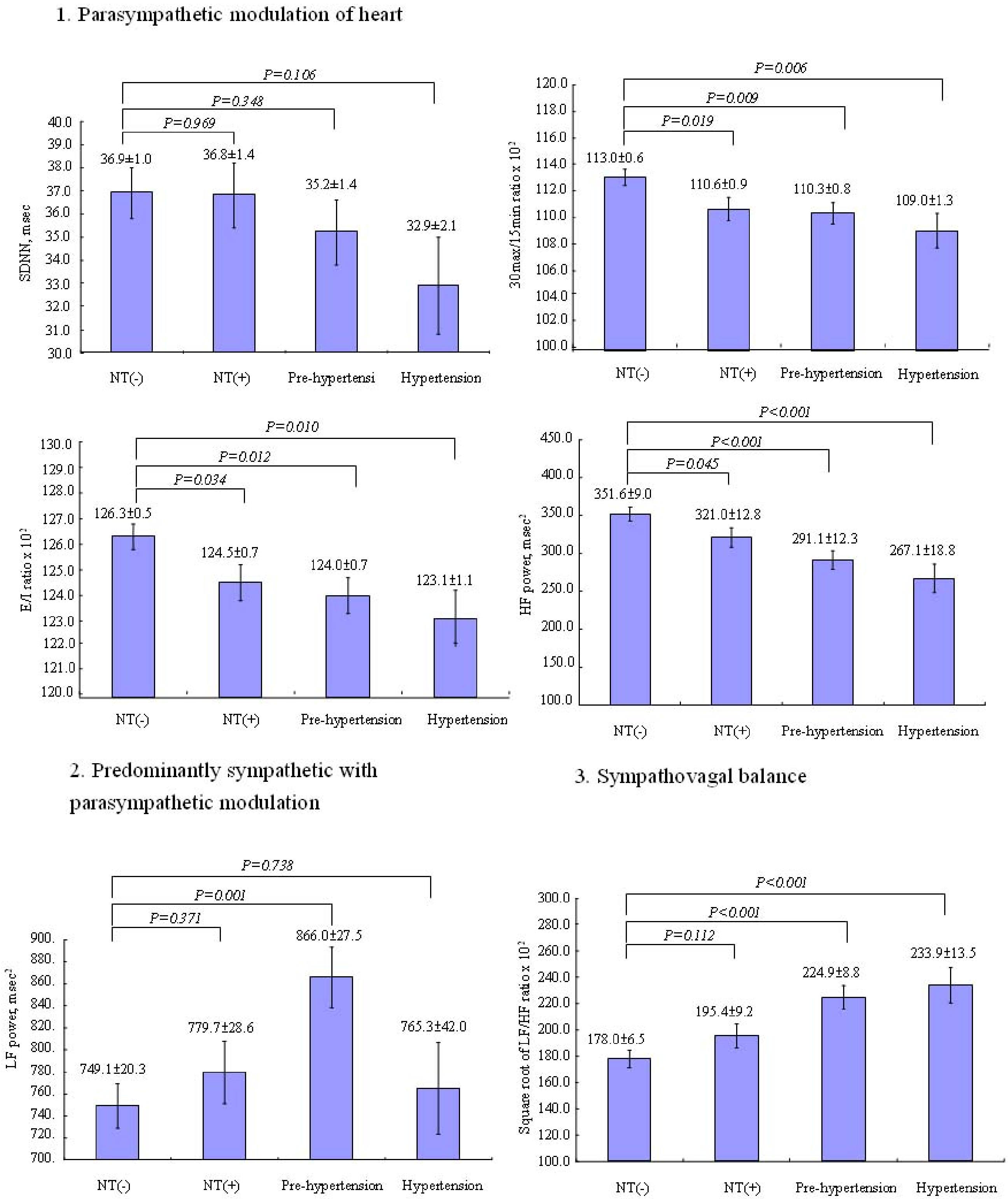


Figure 1. A comparison and adjusted means of CAF among subjects with different blood pressure subgroups based on the analysis of covariance, which was adjusted for age, gender, body mass index, current alcohol use, plasma glucose, cholesterol, triglyceride, and HDL-C. NT(-), normotension without a family history of hypertension; NT(+), normotension with a family history of hypertension. Data

expressed as adjusted mean ± SE.

English

Research Express@NCKU Volume 5 Issue 6 - August 29, 2008
[http://research.ncku.edu.tw/re/articles/e/20080829/2.html]

Static balance in children with developmental coordination disorder

Chia-Liang Tsai[1*], Sheng K. Wu[2], Chi-Huang Huang[3]

[1]Institute of Physical Education, Health & Leisure Studies, National Cheng Kung University*
[2]Institute of Athletics, National Taiwan Sport University (Taichung)
[3]Institute of Coaching Science, National Taiwan Sport University (Taoyuan)
[*]Email: andytsai@mail.ncku.edu.tw

Human Movement Science, 27(1), 142-153. (2008). [SSCI & SCI]

Developmental Coordination Disorder (DCD), as recognized in the diagnostic manuals of the American Psychiatric Association and the World Health Organization, is a term describing motor impairment which can not be accounted for by any identifiable physical or neurological structural abnormalities, developmental delay or mental retardation, or intellectual deficiencies. DCD has been shown to have a strong relationship with perceptual deficits and attention problems, as well as neuro-developmental deviations indicative of 'Deficits in Attention, Motor control, and Perception' (DAMP) or 'Minimal Brain Dysfunction' (MBD), suggesting that DCD is a dysfunction of a certain brain-area, such as the cerebellum or the basal ganglia. Contrary to the belief shared by numerous physicians, teachers, and parents that most children with DCD will grow out of their motor clumsiness, DCD has been shown to often persist into adolescence and early adulthood, along with associated psycho-social problems. In some cases, the motor impairments exhibited by children with DCD may increase. Generally, children with DCD have significantly lower self-esteem and self-worth owing to worse motor competence and self-perception in physical activities, and lower participation rates in all structured or unstructured group physical activities. Moreover, children labeled as having DCD form a heterogeneous group with a diversity of motor control difficulties and functional problems.

Although some researchers found that they had only difficulty standing on one leg with eyes closed, some issues still need to be considered and clarified, such as heterogeneity of children with DCD, smaller sample sizes, children's motor development and gender discrepancy. Therefore, to provide significant implications for the diagnosis, treatment, and design of interventions for children with DCD, a larger sample of children (n = 135) with narrow age ranges (9 to 10 years of age when static balance ability reaches adult levels for open-eye conditions) and similar characteristics of postural sway were observed in this study. Additionally, different gender groups were also compared.

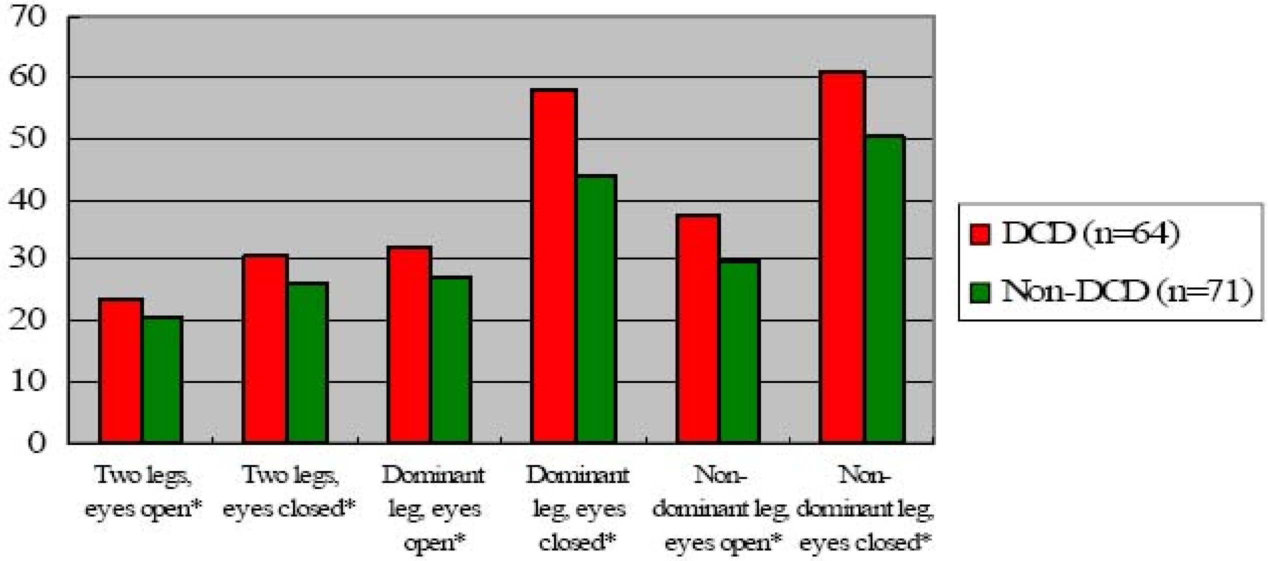


Fig 1. Means of static balance with and without vision for DCD and non-DCD groups based on sway path (mm)[*p < .05]

Each child was screened with the Movement Assessment Battery for Children test and individually completed the balance test. Sway path were recorded during 30-s epochs in two conditions: first eyes open and then closed during both the two-leg and one-leg stances. A significant main effect of sway was found in the total group in all conditions measured by sway path (see Figure 1). Boys with DCD also performed significantly worse compared non-DCD boys in all conditions (see Figure 2). Girls with DCD only demonstrated a significant difference in two conditions: when standing in the two-leg stance with eyes closed; and the dominant-leg stance with eyes closed (see Figure 3). Almost all effect sizes for significant differences were medium to large, ranging between 0.5 and 0.8. In addition, both gender groups consistently reflected increased Romberg coefficient values (> 100%), indicating that eye closure provoked more postural sway than when balancing with vision. However, the DCD and non-DCD groups did not show significant differences in Romberg coefficients, which indicated that children with DCD did not over-rely on visual information during static standing.

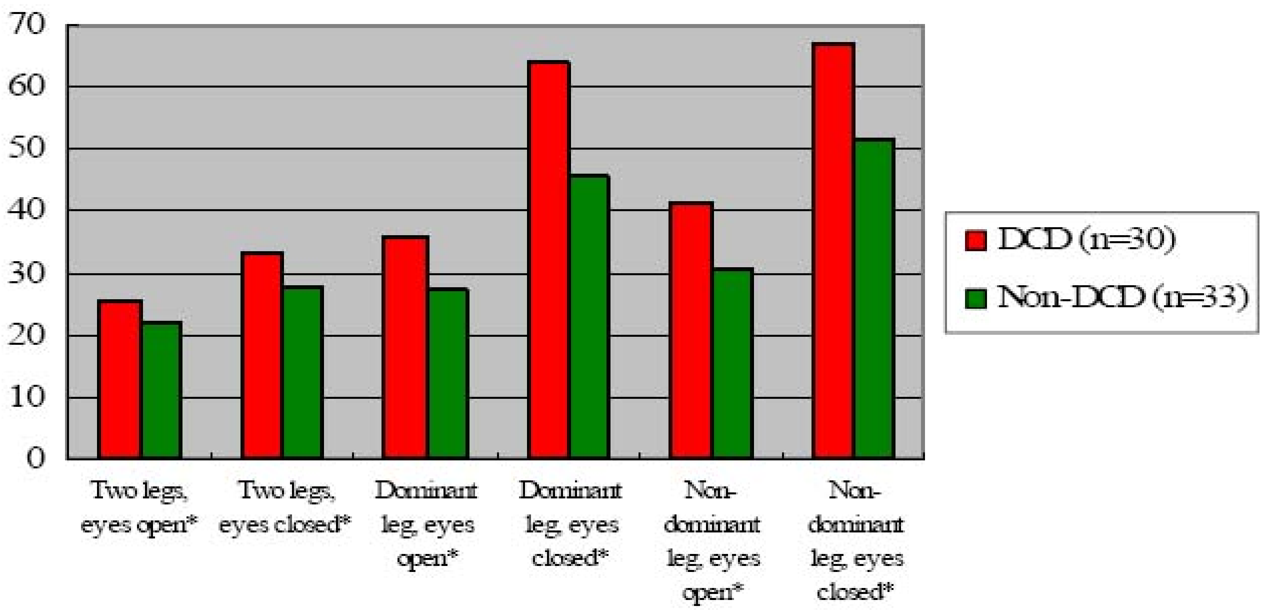


Fig 2. Means of static balance with and without vision for DCD and non-DCD boys based on sway path (mm)[*p < .05]

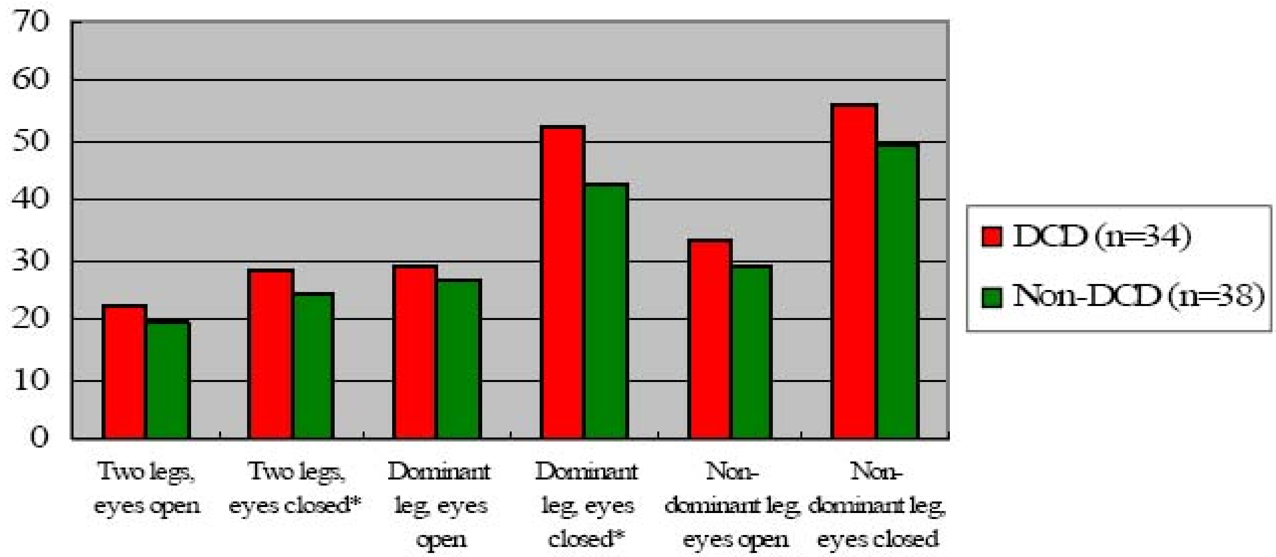


Fig 3. Means of static balance with and without vision for DCD and non-DCD girls based on sway path (mm)[*p < .05]

The analysis of postural sway during upright stance has been used as a simple measure in inspecting a person's ability to maintain balance and in assessing clinical problems of postural ataxia or the nervous system. The results in the present study stand in contrast with the findings of the previous studies which demonstrated that a lack of differences between children with and without DCD on sway measures when standing with two legs, either with eyes open or closed. However, in our study, children with DCD showed significantly larger maximum COP excursions, especially with closed eyes. In addition, the result that no significant differences in Romberg coefficients between these two groups were found seem to support there does not appear to be a major problem for children with DCD to process visual information during static standing. Based on the results of this study, children with DCD may be behind their peers in acquiring the skills of integrating vestibular and proprioceptive information, and be less able to recognize when they approached their balance threshold or less capable of correcting their posture.

In terms of genders we found a surprising result that girls with DCD only showed significant differences when standing upright with eyes closed. The results were apparently distinct from the whole DCD group or the subgroup of boys with DCD, who showed significant deficits on all conditions. The primary results from the present study provide some important implication for decision-making or treatment-intervention for children with DCD in clinical settings.

English

Research Express@NCKU Volume 5 Issue 6 - August 29, 2008
[http://research.ncku.edu.tw/re/articles/e/20080829/3.html]

Modeling and bending vibration of the blade of a horizontal-axis wind power turbine

Shueei-Muh Lin[1], Sen-Yung Lee[2*], Yu-Sheng Lin[2]

[1]Department of Mechanical Engineering, Kun Shan University, Tainan, Taiwan
[2]Department of Mechanical Engineering, National Cheng Kung University, Tainan, Taiwan
[*]E-mail: sylee@mail.ncku.edu.tw

CMES: Computer Modeling in Engineering & Sciences. Vol. 23, No. 2, pp. 175-186, 2008

Due to the increasing demand on the clean energy, wind power turbines are widely installed around the world. In the dynamic analysis of the horizontal-axis wind power turbines (Figure 1), the blade can be modeled as a rotating non-uniform beam with pre-cone angles and setting angles.

The governing characteristic differential equation of the system is a fourth-order differential equation with variable coefficients. In general, the closed-form fundamental solutions of the differential equation are not available. The influence of tip mass, angular speed, hub radius, setting angle, taper ratio, pretwisted angle, inclined angle, and elastic root restraints on the natural frequencies of transverse vibrations of a rotating beam were investigated by many investigators via various approximated and numerical methods such as the finite element method, the finite difference method, the Galerkin method and the dynamic stiffness method, .. etc.. However, all the numerical results can only provide partial qualitative conclusions. The conclusions are valid only in the specialized domains those numerical analysis are performed. In addition, it requires tremendous computer calculation.

Figure 1: The horizontal-axis wind power turbine.

In this paper, a new method is first present to reveal the general qualitative relations between the natural frequencies and the physical parameters, without conducting any numerical analysis. In addition, the conclusions will be valid in the entire domains.

Consider the pure bending vibration of a rotating Bernoulli-Euler beam, as shown in Figure 2. The beam is elastically restrained and mounted with a setting angle• θ and a pre-cone angle ϕ on a hub with radius r_h. It rotates with constant angular velocity Ω. For time-harmonic vibration with angular frequency ω, without considering the Coriolis force, in terms of the following dimensionless parameters:

$$\xi=\frac{x}{L},\quad b(\xi)=\frac{E(x)I(x)}{E(0)I(0)},\quad m(\xi)=\frac{\rho(x)A(x)}{\rho(0)A(0)},$$
$$\Lambda=\sqrt{\frac{\rho(0)A(0)}{E(0)I(0)}}\omega L^2,\quad \mu=\frac{r_h}{L},\quad \beta_T=\frac{K_T L^3}{E(0)I(0)}, \tag{1}$$
$$\alpha=\sqrt{\frac{\rho(0)A(0)}{E(0)I(0)}}\Omega L^2,\quad W=\frac{\tilde{w}}{L},$$

the governing characteristic differential equation is

$$\frac{d^2}{d\xi^2}\left[b(\xi)\frac{d^2W}{d\xi^2}\right]-\frac{d}{d\xi}\left[n(\xi)\frac{dW}{d\xi}\right] \tag{2}$$
$$-m(\xi)\left[\alpha^2\left(\sin^2\theta\cos^2\phi+\sin^2\phi\right)+\Lambda^2\right]W=0.$$

Here ρ, A and L are the mass per unit length, the cross sectional area and the length of the beam, respectively. E is the Young's modulus of the beam. I is the area moment of inertia. β_T is the translational spring constant.

$n(\xi)=\alpha^2\cos^2\phi\int_{\xi}^{1}m(\mu+\chi)d\chi$ is the dimensionless centrifugal force. The boundary conditions are

at ξ = 0:

$$\frac{d}{d\xi}\left(\frac{d^2W}{d\xi^2}\right)-n\frac{dW}{d\xi}+\beta_T W=0,\qquad \frac{dW}{d\xi}=0. \tag{3}$$

and at ξ = 1:

$$\frac{d^2W}{d\xi^2}=0,\qquad \frac{d}{d\xi}\left(b\frac{d^2W}{d\xi^2}\right)=0 \tag{4}$$

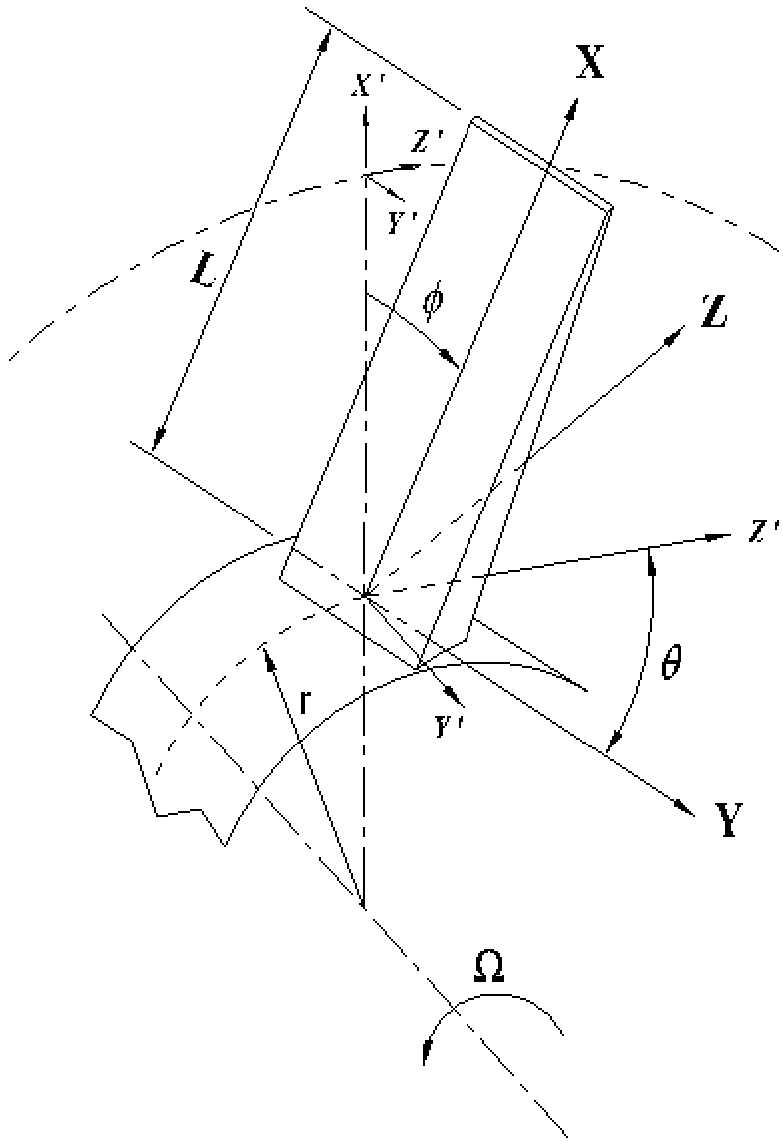


Figure 2: Geometry and coordinate system of a rotating non-uniform beam with an elastically restrained root.

The natural frequencies of the system can be determined by various kinds of numerical methods.

As a matter of fact, most of the physical properties are hidden in the governing differential equation of the system. By analyzing the coefficients of the governing differential equation, without conducting any numerical analysis, we reveal several frequency relations those provide general qualitative relations between the natural frequencies and the physical parameters. These conclusions will be valid in the entire domains.

Frequency relations for the systems with different pre-cone angle rotational speed, setting angle and natural frequency

Consider two dynamic systems with the same physical parameters except the dimensionless rotational speed α, the setting angle θ, the pre-cone angle ϕ and the dimensionless natural frequency Λ_i. Here Λ_i denotes the i-th dimensionless natural frequency. To specify two different systems, subscripts "*a*" and "*b*" are added to the associated physical parameters.

It is observed that if the following relations exist

$$\alpha_a^2 \cos^2 \phi_a = \alpha_b^2 \cos^2 \phi_b, \tag{5}$$

$$\alpha_a^2 \left(\sin^2 \theta_a \cos^2 \phi_a + \sin^2 \phi_a\right) + \Lambda_{a,i}^2 = \alpha_b^2 \left(\sin^2 \theta_b \cos^2 \phi_b + \sin^2 \phi_b\right) + \Lambda_{b,i}^2, \tag{6}$$

then the governing characteristic differential equation (2) and the associated boundary conditions (3-4) will be the same. Therefore the fundamental solutions of the two systems will be the same. It implies that

- If all the physical parameters of the system "*a*"; are known and the dimensionless natural frequencies $\Lambda_{a,i}$ of the system are determined, then the dimensionless natural frequencies $\Lambda_{b,i}$ of the system "*b*" with physical parameters, $\{\alpha_b, \theta_b, \phi_b\}$, satisfying the relations (5-6) can be easily determined via the relation (6).

  The (*i*+*j*)-th dimensionless natural frequency Λ_{i+j} will satisfy the relation (6) as well

$$\alpha_a^2 \left(\sin^2 \theta_a \cos^2 \phi_a + \sin^2 \phi_a\right) + \Lambda_{a,i+j}^2 = \alpha_b^2 \left(\sin^2 \theta_b \cos^2 \phi_b + \sin^2 \phi_b\right) + \Lambda_{b,i+j}^2. \tag{7}$$

  Subtracting equation (6) from equation (7), one has the following frequency relation

$$\Lambda_{a,i+j}^2 - \Lambda_{a,i}^2 = \Lambda_{b,i+j}^2 - \Lambda_{b,i}^2. \tag{8}$$

  This relation shows that

- The difference between the square of the two dimensionless natural frequencies of two systems those satisfy the relations (5-6) are the same.

Frequency relations for the systems with the same angular speed and pre-cone angle

If two systems have the same angular speed and pre-cone angle, then $\alpha_a = \alpha_b = \alpha$, $\phi_a = \phi_b = \phi$, and the relation (5) is satisfied. Relation (6) can be rewritten as

$$\Lambda_{b,i}^2 = \alpha^2 \cos^2 \phi \left(\sin^2 \theta_a - \sin^2 \theta_b\right) + \Lambda_{a,i}^2. \tag{9}$$

This relation reveals the following conclusions:

- When the setting angle is less than 90°, the natural frequencies of a beam with constant angular speed and pre-cone angle will decrease as the setting angle is increased.
- The influence of the setting angle on the natural frequencies of a beam rotating at high speed is greater than that of a beam rotating at low speed.
- The influence of the setting angle on the natural frequencies of a beam with small pre-cone angle is greater than that of a beam with large pre-cone angle.
- The smaller the axial centrifugal factor• $\alpha^2 cos^2\phi$ is, the less influence of the setting angle on the natural frequencies is.
- For a non-rotating beam, the setting angle and the pre-cone angle will have no influence on the natural frequencies of the beam.
- When the pre-cone angle $\phi = 90°$, the setting angle will have no influence on the natural frequencies of the beam.
- For a beam with constant axial centrifugal factor• $\alpha^2 cos^2\phi$ the influence of the setting angle on the natural frequency of higher mode is less significant than that of lower mode.

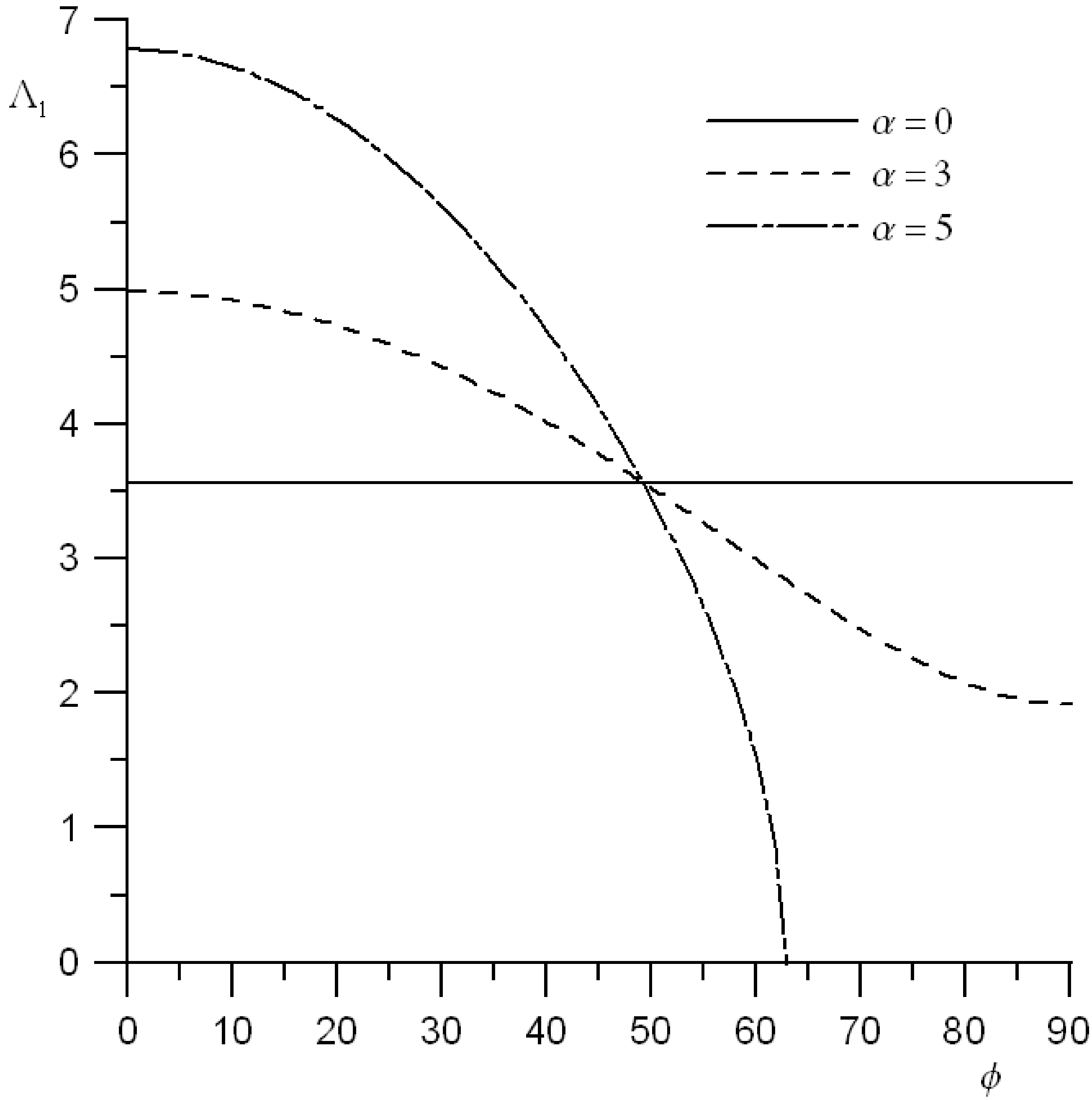


Figure 3: Influence of the pre-cone angle on the first natural frequency of a cantilevered rotating beam with different angular speeds. [m = (1 - 0.1ξ), b = (1 - 0.1ξ)^3, μ = 0.1, θ = 0 °]

Figure 3 shows the influence of the pre-cone angle on the first natural frequency of a rotating cantilevered beam with setting angle being zero and different angular speeds. One can observe that:

- The pre-cone angle will have no influence on the natural frequencies of a non-rotating beam. This conclusion is obvious. Since when the angular speed is zero, the pre-cone angle will also disappeared from the coefficients of the governing characteristic differential equation (2).
- The natural frequencies of a clamped rotating beam will decrease when the pre-cone angle is increased.
- When the pre-cone angle is small, the natural frequencies of a beam with high angular speed are greater than those with low angular speed. However, when the pre-cone angle is greater than the critical value, the natural frequency of the beam with high angular speed will be less than those with low angular speed.

- The influence of the pre-cone angle on the natural frequencies of a beam with high angular speed is greater than that of the beam with low angular speed.
- The phenomenon of rotating divergence instability will happen as the angular speed and the pre-cone angle are greater than certain values.

It can be observed that the last 2nd term, $-m(\xi)\alpha^2(\sin^2\theta\cos^2\phi + \sin^2\phi)W$ in the governing differential equation (2) acts as a negative spring. As the value of $m(\xi)\alpha^2(\sin^2\theta\cos^2\phi + \sin^2\phi)$ is increased, the natural frequencies of the system will decrease. The decreasing rate of the natural frequencies for the beam with high angular speed will be greater than that with low angular speed as the pre-cone angle is increased. This explains the last three phenomena revealed in Figure 3.

In Figure 4, the influence of the pre-cone angle on the first three natural frequencies of a cantilevered rotating beam with setting angle being zero and different angular speeds is shown. It can be found that the critical pre-cone angle, as mentioned in the conclusion "c" in Figure 3, associated with higher vibration mode will be greater than that associated with lower vibration mode.

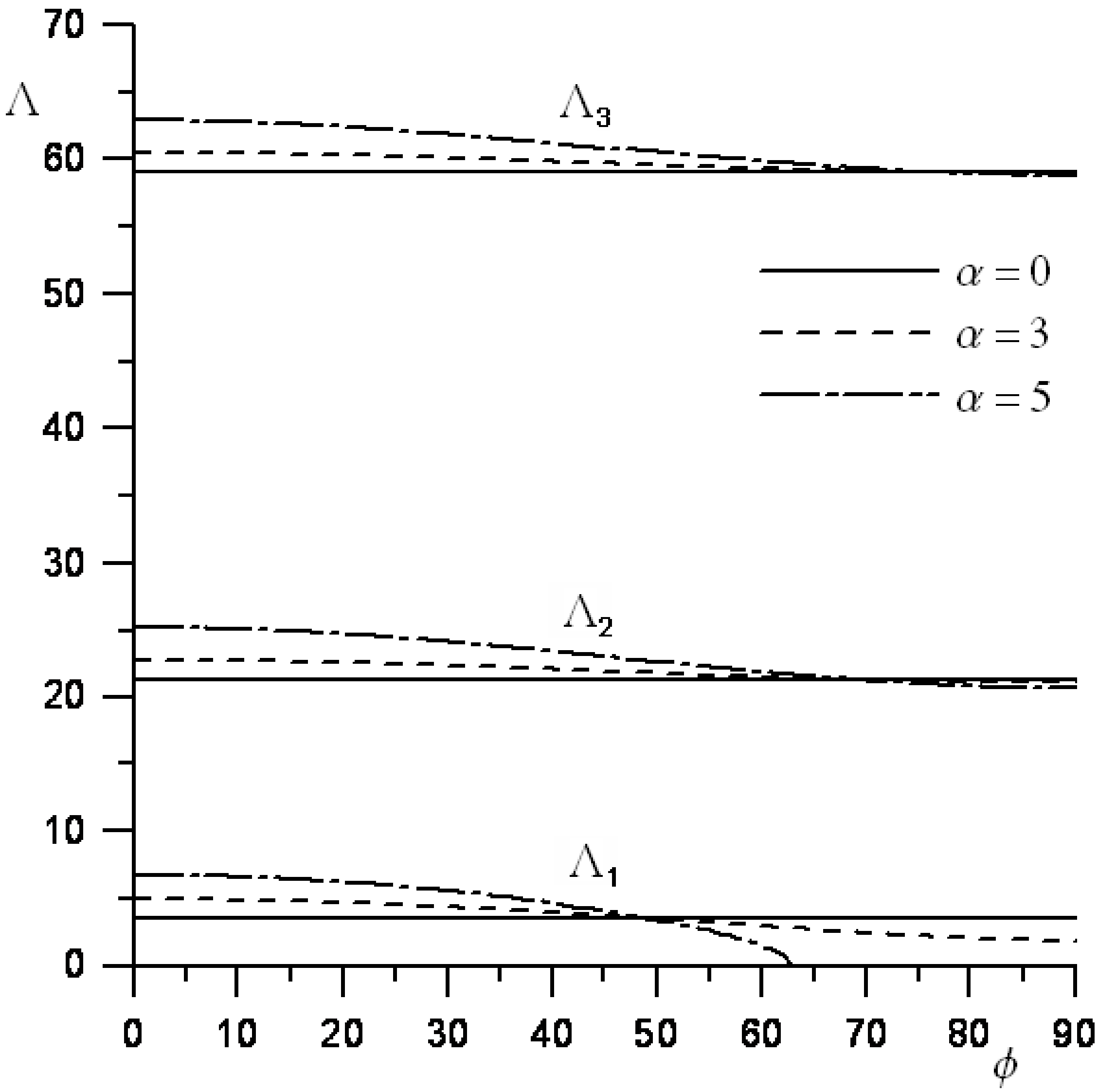


Figure 4: Influence of the pre-cone angle on the first three natural frequencies of a cantilevered rotating beam with different angular speeds. [$m = (1 - 0.1\xi)$, $b = (1 - 0.1\xi)^3$, $\mu = 0.1$, $\theta = 0^\circ$]

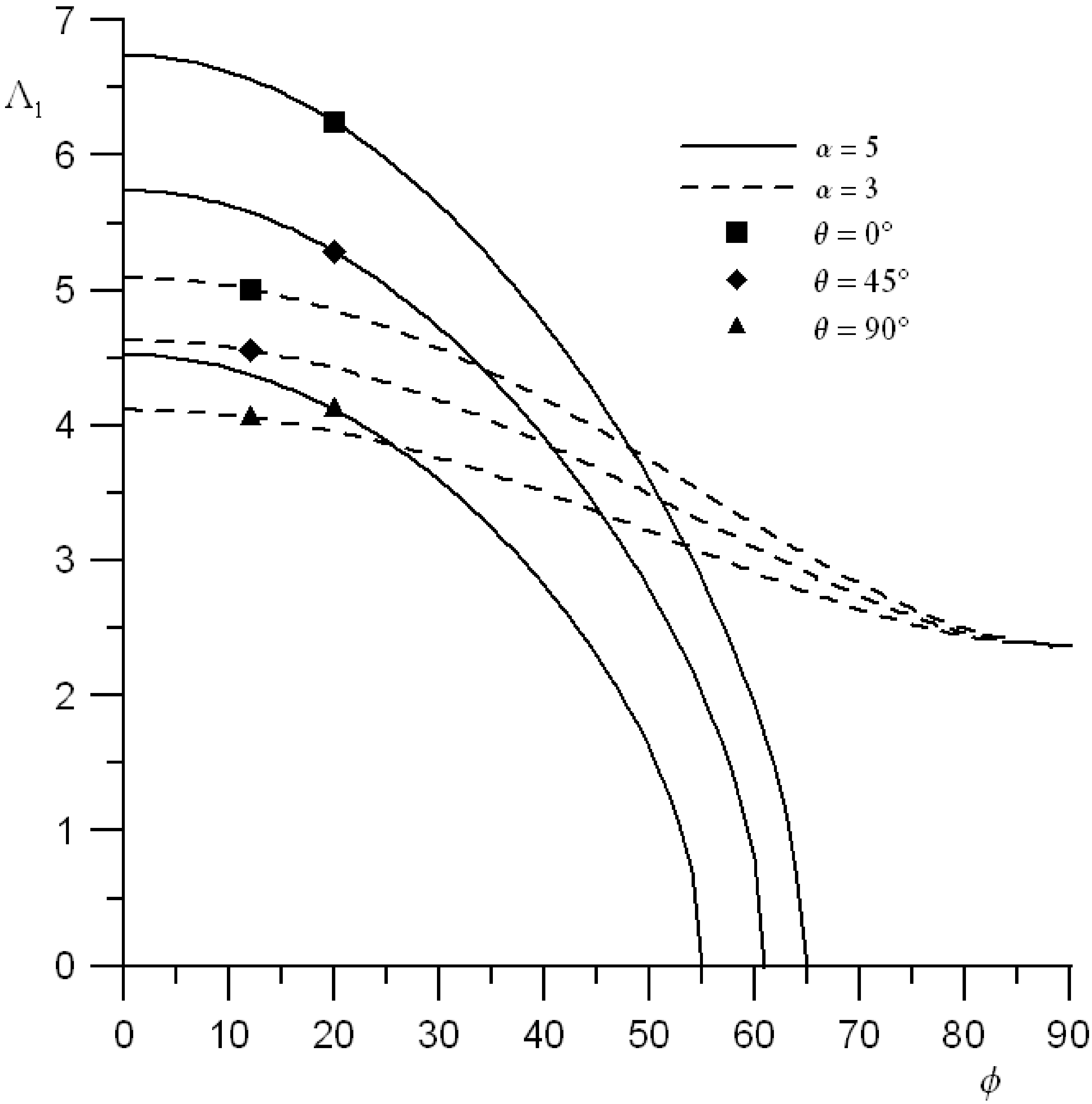


Figure 5: Influence of the angular speed and the pre-cone angle on the first natural frequency of a cantilevered beam. [m = (1 - 0.1ξ), b = (1 - 0.1ξ)^3, μ = 0]

In Figure 5, the influence of the pre-cone angle, the setting angle and the angular speed on the first natural frequency of a cantilevered beam is shown. It can be found that:

- When the pre-cone angle or the setting angle is increased, the associated natural frequencies decrease.
- When the setting angle is the same, the influence of the pre-cone angle on the natural frequencies of a beam with high angular speed is greater than that of the beam with low angular speed. This conclusion is an extension of the conclusion “d” revealed in Figure 3, in which the setting angle of the beam is zero.
- When the pre-cone angle ϕ=90 ° , there is no axial centrifugal force. In this case, the setting angle θ will have no influence on the natural frequencies of the beam. This conclusion is consistent with our common physical sense.
- When the setting angle is increased, the associated critical pre-cone angle for the happening of the

divergence instability phenomenon will decrease.

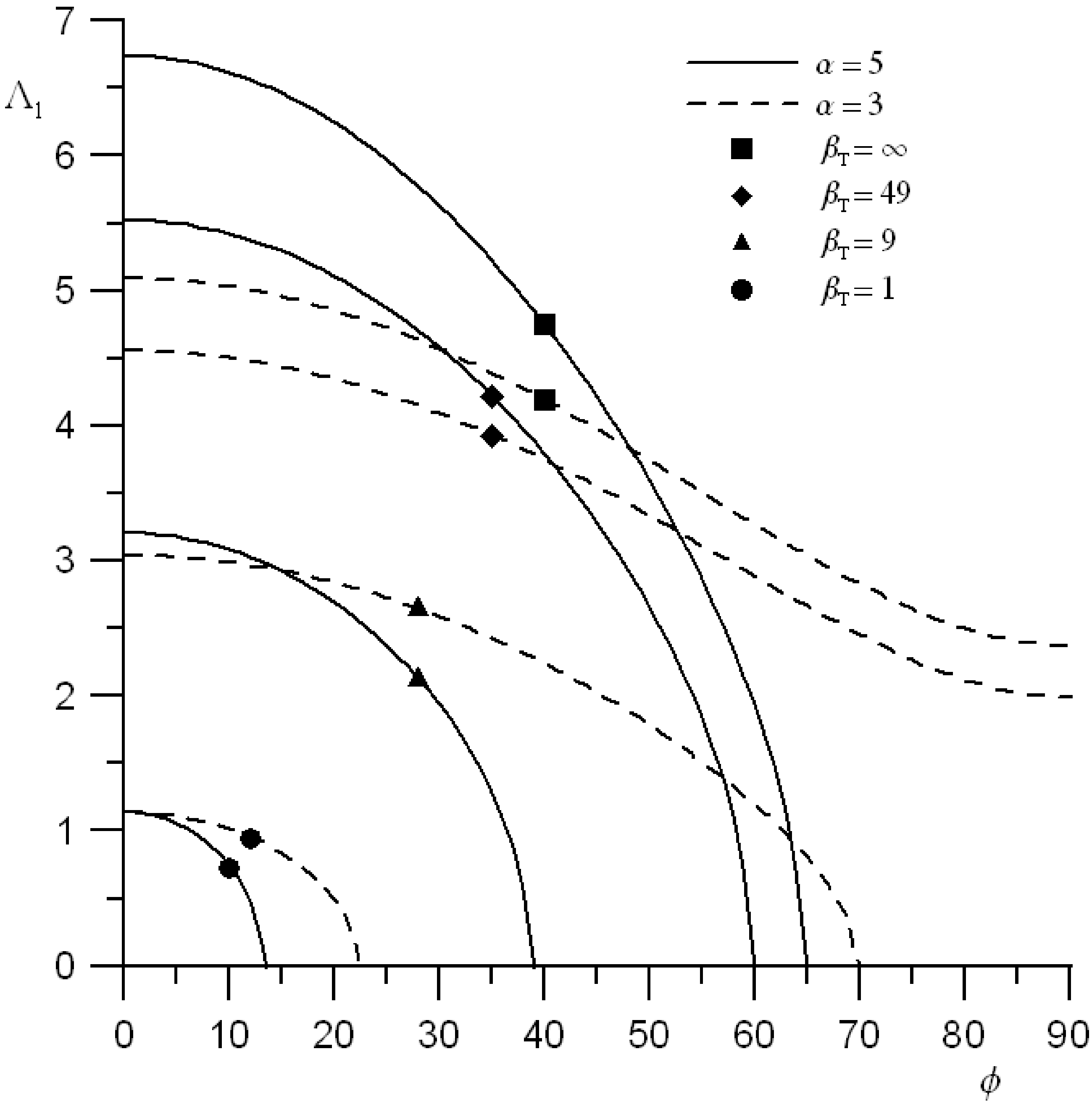


Figure 6: Influence of the translational spring constants •T and the pre-cone angle on the first natural frequency of a beam. [m = (1 - 0.5ξ), b = (1 - 0.5ξ)^3, μ = 0, θ = 0 °]

In Figure 6, the influence of the translational spring constant and the pre-cone angle on the first natural frequency of a beam is revealed. One can observed that when the translational spring constant is decreased, the associated critical pre-cone angle for the happening of the divergence instability phenomenon will decrease.

Conclusions

In this paper, a wind power turbine blade is modeled as a rotating beam with pre-cone angles and setting angles. A new method is first present to reveal the general qualitative relations between the natural frequencies and the physical parameters. By analyzing the coefficients of the governing differential equation, several frequency relations are revealed. Based on these frequency relations, many general qualitative conclusions between the natural frequencies and the physical parameters of the beams are explored without numerical analysis. These conclusions are valid in the entire domains.

English
Research Express@NCKU Volume 5 Issue 6 - August 29, 2008
[http://research.ncku.edu.tw/re/articles/e/20080829/4.html]

Synthesis of Monodisperse FeAu Nanoparticles with Tunable Magnetic and Optical Properties

I-Chen Chiang and Dong-Hwang Chen*

Department of Chemical Engineering, National Cheng Kung University
***Email: chendh@mail.ncku.edu.tw**

Advanced Functional Materials 2007, 17, 1311-1316
(SCI impact factor 6.779; Ranking: 7/175= 4%(materials science, multidisciplinary))

Magnetic nanoparticles are always receiving considerable attention because of their great potential applications in magnetic recording devices, bioseparation, medical diagnoses, magnetically targeted therapy, and magneto-optical systems. In the past several years, significant efforts have been made on their preparation via the thermal decomposition or reduction of organometallic complexes because the resultant magnetic nanoparticles usually exhibit good monodispersity and high crystallinity. The most typical example is FePt nanoparticles. Other examples include many magnetic alloy nanoparticles (e.g., FePd, FeCo, FeMo, CoPt, and CoNi) and core-shell nanoparticles (e.g., FePt@Fe_3O_4, Pt@Fe_2O_3, Co@Pt, Pt@Co, and Ni@Pd). In general, by controlling the reaction conditions and compositions, the particle size and size-related properties could be tuned. As compared to these magnetic nanoparticles with potential applications in high-density data storage and high-performance permanent magnets, significantly fewer efforts have been made on the synthesis of metallic alloy nanoparticles simultaneously with magnetic and optical properties.

FeAu nanoparticles are expected to exhibit the magnetic property of Fe and the surface plasmon resonance property of Au. Their preparation has not been reported until now. This is the first study on the synthesis of FeAu nanoparticles via the high-temperature organometallic route. Typically, iron pentacarbonyl, gold acetate, and 1,2-hexadecanediol were dissolved in a dioctylether solution of oleic acid and oleylamime under an Ar atmosphere. After stirring for 1 h at room temperature, the temperature was raised to 250 ˚C and the reaction mixture was refluxed for 1 h under a flow of Ar to form FeAu nanopaticles. In the absence of gold acetate or iron pentacarbonyl, pure Fe and Au nanoparticles could be obtained.

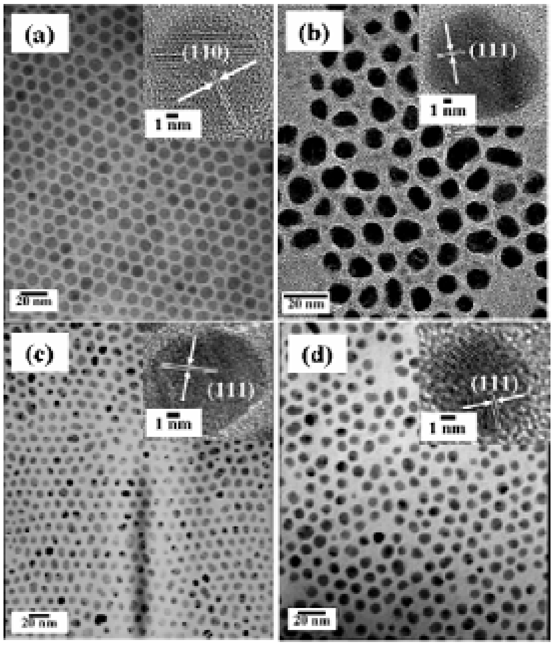


Fig. 1. TEM images of pure Fe (a) and FeAu nanoparticles with the Au/Fe molar ratios of 0.25(b), 0.5(c), and 1(d) obtained at 250 ˚ C and 1 h. The insets indicate the high-resolution TEM images.

From TEM analysis (Fig. 1a), it was found that the resultant Fe nanoparticles were monodisperse with a mean diameter of 8.9±0.8 nm and well arranged into a 2-D nearly hexagonal close-packed array. The high-resolution TEM image further revealed they had a highly crystallinity, and the lattice spacing of 2.00 Å related to the (110) plane of bulk body-centered cubic (bcc) Fe. The FeAu nanoparticles obtained under the same reaction conditions essentially remained nearly monodisperse (Figs. 1b-d). When Au/Fe=0.25, 0.5, and 1, the mean diameters were 9.8±1.1, 7.7±0.9, and 8.9±0.9 nm, respectively. The variation of particle size with composition might be referred to the difference in nucleation process. Since the reduction rate of gold acetate was faster than the decomposition rate of iron pentacarbonyl, Au nuclei might be formed preferentially and used as seeds to accelerate the decomposition of iron pentacarbonyl and formation of FeAu nanoparticles. So, a higher Au/Fe molar ratio might lead to a smaller particle size due to the increase in the number of seeds. However, when the concentration of iron pentacarbonyl was fixed, the increase in the Au/Fe molar ratio implied the increase in the total metal precursor concentration. Hence, when the Au/Fe molar ratio was too high, particle size might increase contrarily owing to the increased collision probabilities of metal atoms or nuclei. In addition, from EDX analysis, we demonstrated that the compositions in the products were roughly consistent with those in the feed solutions, confirming the formation and composition of alloy nanoparticles.

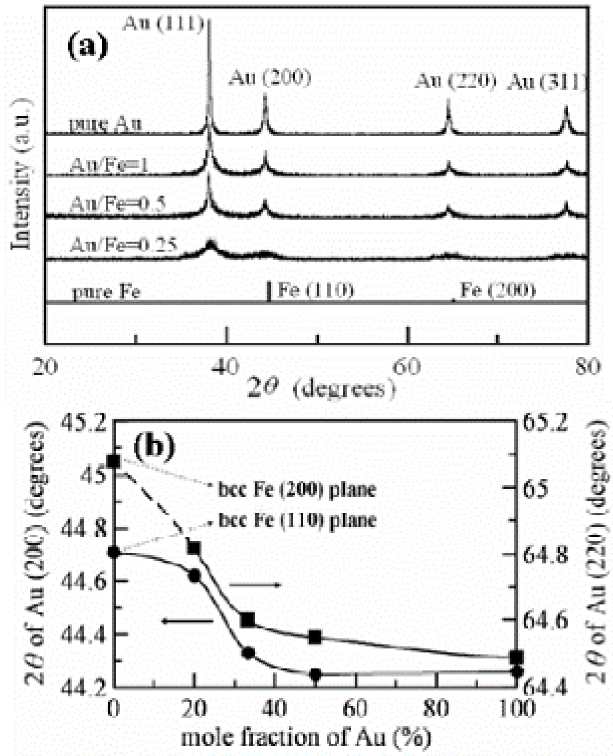


Fig. 2. (a) XRD patterns of Au, Fe, and FeAu nanoparticles with various Au/Fe molar ratios. (b) Composition-dependences of the diffraction angle at (200) and (220) planes.

When Au/Fe ratios were 0.25, 0.5, and 1, the lattice spacings were found to be 2.22, 2.24, and 2.21 Å respectively. They all related to the (111) plane of face centered cubic (fcc) FeAu alloys. Furthermore, the XRD patterns of FeAu nanoparticles exhibited four similar characteristic peaks as Au nanoparticles did (Fig. 2a). The characteristic peak was broader at a lower Au/Fe molar ratio, implying the crystallinity of FeAu nanoparticles was poorer than that of Au nanoparticles. In addition, the characteristic peaks for the (200) and (220) planes of fcc Au or FeAu nanoparticles were quite close to those for the (110) and (200) planes of bulk bcc Fe. The dependences of their diffraction angles on the composition (Fig. 2b) indicated that the diffraction angles for both the characteristic peaks decreased significantly when Au atoms were incorporated into the bcc structure of Fe. This might be attributed to the structural change from bcc to fcc.

In addition, we also examined the effects of reaction time and temperature on the synthesis of FeAu nanoparticles. It was found that then increases in reaction time or reaction temperature did not lead to the structural change. Longer reaction time (>3 h) or higher reaction temperature (297 ° C) led to smaller mean diameter and broader particle size distribution due to the atom rearrangement and faster nucleation rate, respectively. Also, the reduction rate of gold acetate and the deposition rate of Au atoms on the nuclei were enhanced more significantly by increasing reaction temperature than the decomposition rate of iron pentacarbonyl and the deposition rate of Fe atoms on the nuclei.

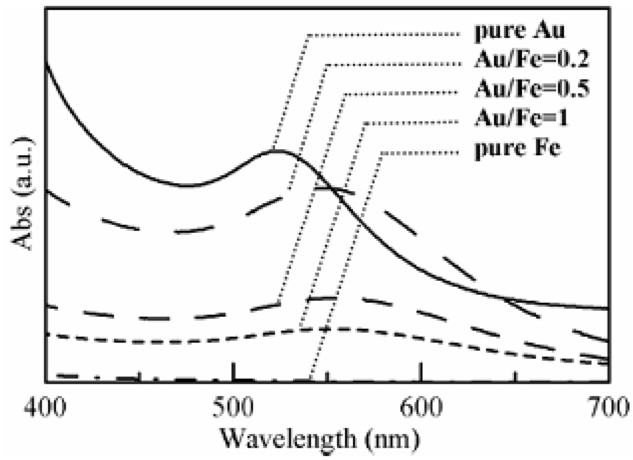


Fig. 3. UV-VIS absorption spectra of Fe, Au and FeAu nanoparticles with various molar ratios in hexane.

As expected, the UV-VIS absorption spectra (Fig. 3) revealed that FeAu nanoparticles exhibited the characteristic absorption bands similar to that of Au nanoparticles. Also, with decreasing the Au/Fe molar ratio, the characteristic absorption band red-shifted and the absorbance decreased because the electron cloud oscillation of surface Au atoms was perturbed by Fe atoms.

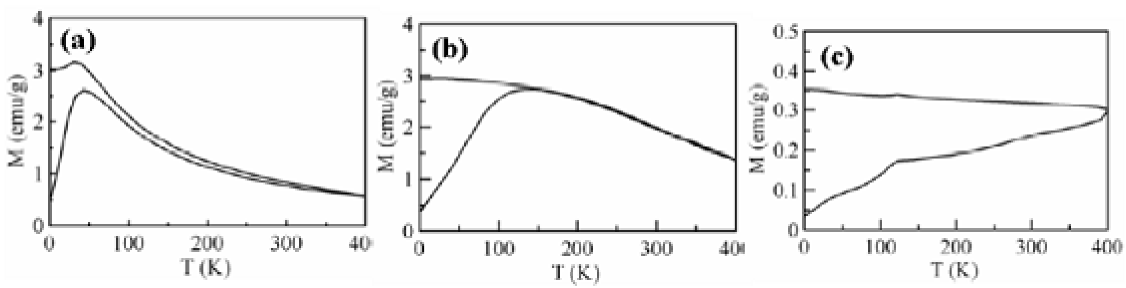


Fig. 4. ZFC/FC curves of Fe (a) and FeAu nanoparticles with the Au/Fe molar ratios of 0.25(b), and 0.5 (c) obtained at 1 h and 250 ˚C. The external magnetic field is 100 Oe.

Of course, FeAu nanoparticles were also expected to possess the magnetic property of Fe. By measuring the field cooled (FC) and zero field cooled (ZFC) curves of Fe and FeAu nanoparticles under an external magnetic field of 100 Oe (Fig. 4), we found that the blocking temperatures (T_B) of Fe and FeAu nanoparticles at Au/Fe=0.25 were 42.7 and 143 K, respectively. Because their T_B values were significantly lower than room temperature, they were expected to be superparamagnetic at room temperature. When Au/Fe=0.5, the magnetization decreased significantly and T_B was above 400 K. Further analyzing the field-dependences of the magnetization at 300 K for Fe and FeAu nanoparticles (as shown in Fig. 5), it was found that the hysteresis phenomenon was weak for each case. This could be attributed to the fact that they were quite small and nearly superparamagnetic. The corresponding saturation magnetization (Ms), remnant magnetization (Mr), and coercivity (Hc) were listed in Table 1, together with the T_B values. Obviously, the increase in the Au content led to the decrease in magnetization and the deviation from the superparamagnetic property.

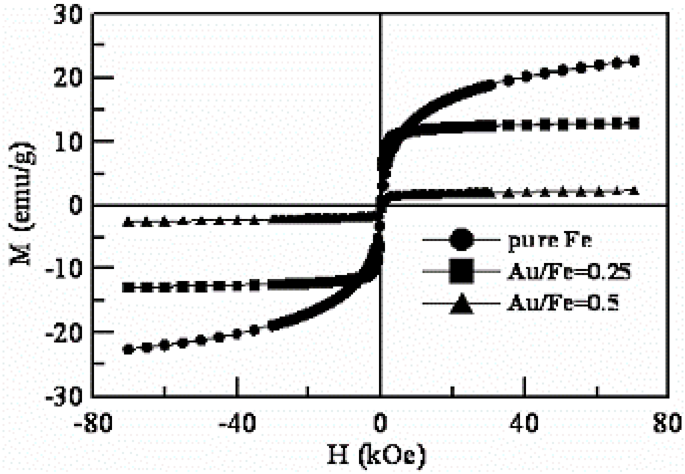


Fig. 5. Magnetic hysteresis loops at 300K for Fe and FeAu nanoparticles with various Au/Fe molar ratios obtained at 1 h and 250 ˚ C.

Table 1. A list of the T_B, Ms, Mr, and Hc values for Fe and FeAu nanoparticles with various Au/Fe molar ratios obtained at 1 h and 250 ˚ C.

Au/Fe molar ratio	T_B [K]	Ms [emu g^{-1}]	Mr [emu g^{-1}]	Hc [Oe]
0	42.7	22.6	0.09	14.3
0.25	143	13.0	0.3	23.7
0.5	>400	2.4	0.12	55.9

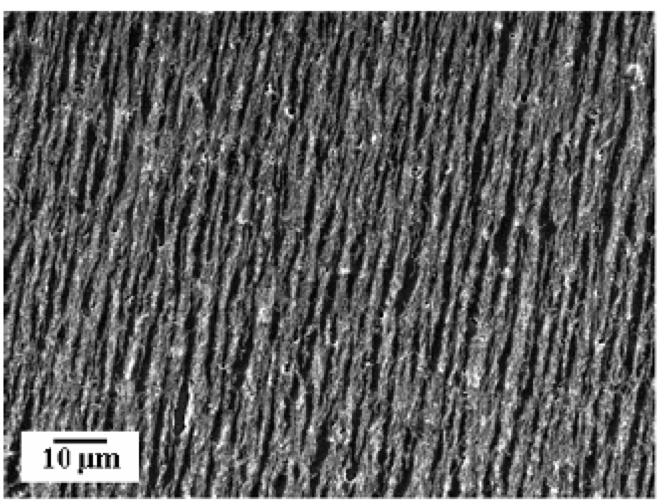


Fig. 6. SEM image of self-assembled line pattern of FeAu nanoparticles with a Au/Fe molar ratio of 0.25 under an external magnetic field. The FeAu nanoparticles were obtained at 1 h and 250 ˚ C.

By dropping the FeAu nanoparticles-containing alcohol solution of polyethyleneimine on the transparency film on a permanent magnet, it was found that these nanoparticles were quickly aligned into stripes in the direction of magnetic field (Fig. 6). Such a 1-D pattern has the potential applications as the anisotropic optical, magnetic, or conducting materials.

In conclusion, the synthesis of monodisperse FeAu nanoparticles was achieved by a high-temperature organometallic route. The effects of composition, reaction time, and reaction temperature on their size, structure, and optical and magnetic properties were studied and well discussed. The resultant FeAu nanoparticles indeed possessed the optical property of Au nanoparticles and the magnetic property of Fe nanoparticles. This is novel product is expected to be useful in optical, magnetic, and biotechnological fields.

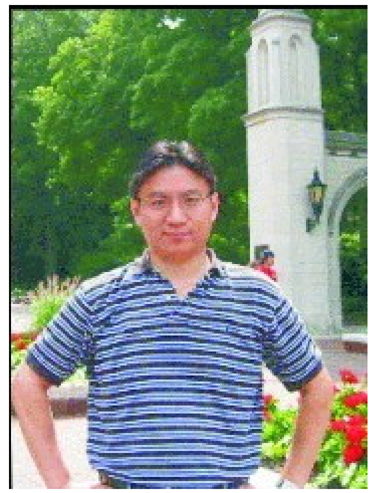
English
Research Express@NCKU Volume 5 Issue 6 - August 29, 2008
[http://research.ncku.edu.tw/re/articles/e/20080829/5.html]

Innovating research topics in learning technology: Where are the new blue oceans?

Gi-Zen Liu

Graduate School & Department of Foreign Languages and Literature, College of Liberal Arts, National Cheng Kung University
Email: gizen@mail.ncku.edu.tw

British Journal of Educational Technology, Volume 39, Issue 4, p. 738-747. July 2008. (SSCI)



New research topics for advancing knowledge and developing its applications

Creative research topics are always needed when we conduct research in order to advance knowledge and develop its new applications in LT with regard to technological evolution, paradigm shifts in learning and value innovation (Richey, 1998). Some scholars attempt to find current research trends or some existing problems of research outcomes in an effort to provide a new direction. For example, Shih *et al* (2008) identify the recent research trends in papers published in the five major LT journals from 2001 to 2005, finding that the most popular research topics were instructional approach, learning environment and meta-cognition. However, it is open to question whether the recent research trends and topics reflect the needs of LT practitioners and researchers. Kanuka *et al* (2007) review the literature and indicate that new guidelines or models which can help conduct LT research on the most advanced computer technologies are still insufficient. It seems that the recent research trends and the research outcomes are not yet able to match up well in order to meet the needs of LT researchers and practitioners to further develop what Richey (1998) calls the "useable knowledge". This, we may need new research topics and research methodologies to improve the current situation.

The need for value innovation in LT research

Value is what is important in learning, teaching or research related activities. Value—which is significant in the process or product of learning—plays a key role in LT. The value of LT should be that, when applied or guided properly, technologies can facilitate human learning efficiently and effectively, with more personal enrichment or enjoyment. Value in instructional design, for example, is important for guiding the selection of the goals, scope, guidelines, method and situation for its theories or models (Reigeluth, 1999). Liu (2005) suggests that an instructor should develop hybrid instruction or blended learning based on identified values, including proficiency of a skill or language as the ultimate goal, learner-focused learning, customized learning, active learning and interactive learning. Other identified LT values, to name only a few, include assessable technology for teaching and learning, facilitating the skills of learning, facilitating social skills and widening horizons.

Along with the evolution of LT integrated into teaching and research of various fields and disciplines (Boylan, 2004), innovation is considered playing a major role in improving the current state and scope of LT contexts and developments (Chou, 2005; Hannan, 2005). However, when it comes to value innovation in LT research, some questions still need to be answered. For example, how can we create or innovate values to promote LT research? Are there any other values that we have not yet identified? If so, what are they, and how can we take advantage of these new and meaningful ideas? LT practitioners and researchers need to think about these questions and try to answer them when developing and promoting LT.

The BOS for value innovation in LT research

The BOS was designed to help companies jump from competitive, crowded contexts (red oceans) to innovative, developmental territory (blue oceans) for future business and opportunities (Kim & Mauborgne, 2004b). Kim and Mauborgne argue that companies continuously benefit from operating in such blue oceans, which they define as industries or market spaces that do not exist now but will be created or invented soon and in which new demands and profitable opportunities will be generated. LT practitioners also need a similar strategy to innovatively apply LT in current domains as well as create new domains for future research and development.

The research methodology

According to Collins *et al* (2004), design research has been developed as a new method 'to carry out formative research to test and refine educational designs based on principles derived from prior research' (p. 15). It was applied in this study for the researcher to validate and refine (1) the guidelines adapted from the BOS and (2) the novel framework composed of the components of the widely accepted ADDIE instructional design model and Gagne's (1985) nine events of instruction. In this qualitative study, it was assumed that value innovation in LT research topics would bring about more cutting-edge research and developments in academic and industrial fields. This study is a response to Rushby's (2007) call for new methodologies to help create applicable research questions or topics in LT.

The research questions and research procedures

The research questions driving this study are: 'Are there any guidelines for developing novel research topics or questions with value innovation in LT as new technologies constantly emerge?' and 'if so, what are they?' The five guidelines for value innovation in LT research (see Figure 1) with a novel framework (see Table 1) were reviewed by 12 LT practitioners and researchers in mid-2007.

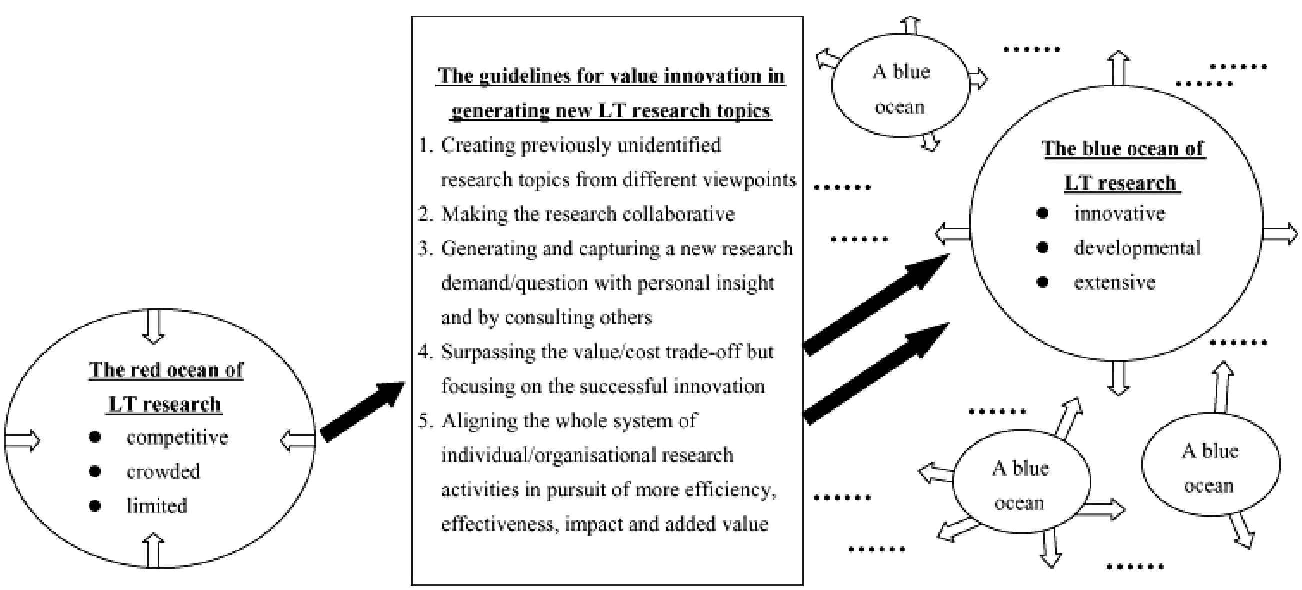


Figure 1: The guidelines for value innovation in LT research from the red to blue oceans

Table 1: A framework of the 45 possible areas for generating new research topics in learning technology

Gagne's nine events of instruction	The ADDIE model				
	Analysis	Design	Development	Implementation	Evaluation
Gain attention	Area 1	Area 2	Area 3	Area 4	Area 5
Inform learner of objectives	Area 6	Area 7	Area 8	Area 9	Area 10
Stimulate recall of prior learning	Area 11	Area 12	Area 13	Area 14	Area 15
Present stimuli with distinctive features	Area 16	Area17	Area 18	Area 19	Area 20
Guide learning	Area 21	Area 22	Area 23	Area 24	Area 25
Elicit performance	Area 26	Area 27	Area 28	Area 29	Area 30
Provide feedback	Area 31	Area 32	Area 33	Area 34	Area 35
Assess performance	Area 36	Area 37	Area 38	Area 39	Area 40
Enhance retention and learning transfer	Area 41	Area 42	Area 43	Area 44	Area 45

The five refined guidelines for value innovation in LT research

- Creating previously unidentified research topics from different viewpoints: to explore trans-disciplinary knowledge we need to be aware of the conditions and possibilities of integrating the diverse perspectives of various disciplines.
- Making the research collaborative: we should work with practitioners and researchers in different departments and colleges, or with different backgrounds (Latchem, 2006), but we need to be careful about the conflicts that may be inherent in the meeting of different perspectives.
- Generating and capturing a new research demand/question with personal insight and consulting with others: we should search and review the latest literature in various trans-disciplinary fields in databases and search engines for new LT tools, areas and demands, using our own direct intuition, prior experience and imagination. We should then ask reliable experts for their opinions on the newly self-devised research topic or question in order to obtain a better research design.
- Surpassing the value/cost trade-off and focusing on successful innovation: we should aim to realize short-term and long-term plans in an organized way with reasonable expenses, and anticipate unexpected outcomes. While in the research process, we should prioritize successful innovation, not the value/cost ratio. New opportunities, including financial support, are likely to come from this approach.
- Aligning the whole system of individual/organizational research activities in pursuit of more efficiency, effectiveness, impact and added value: we need to work independently, but with the relevant research activities fostered by others in the workplace or learning organization. We should always remember that new ideas, with direct and indirect innovation that drives creativity, are the ultimate goal. What we should treasure most is the positive influence that the research,

with new LT tools, will bring about. However, it should be noted that the possible negative effects of using LT tools is a good research question that remains to be investigated.

Some novel LT research topics or blue oceans, as examples

- Global, long-term, international and intercontinental research topics.
- New taxonomies and instructional design models and theories for various LT applications on CALL.
- A third category to be investigated other than LT process and product: is the individual and interpersonal vitality, enrichment and enjoyment of using e-learning.
- Novel added values: added values can be related to research, business or others.

The conclusions

LT, as a trans-disciplinary field, is broad and diverse in its nature. The computer (hardware), the communication system (software) and the user constitute the ultimate 'creativity machine', which provides various contexts and opportunities to foster innovation. I hope the refined guidelines and framework presented in this paper will be helpful to interested researchers and practitioners, and look forward to learning new guidelines, devices and blue oceans in LT from you.

Please see the original paper published in *BJET* for references or contact the author.